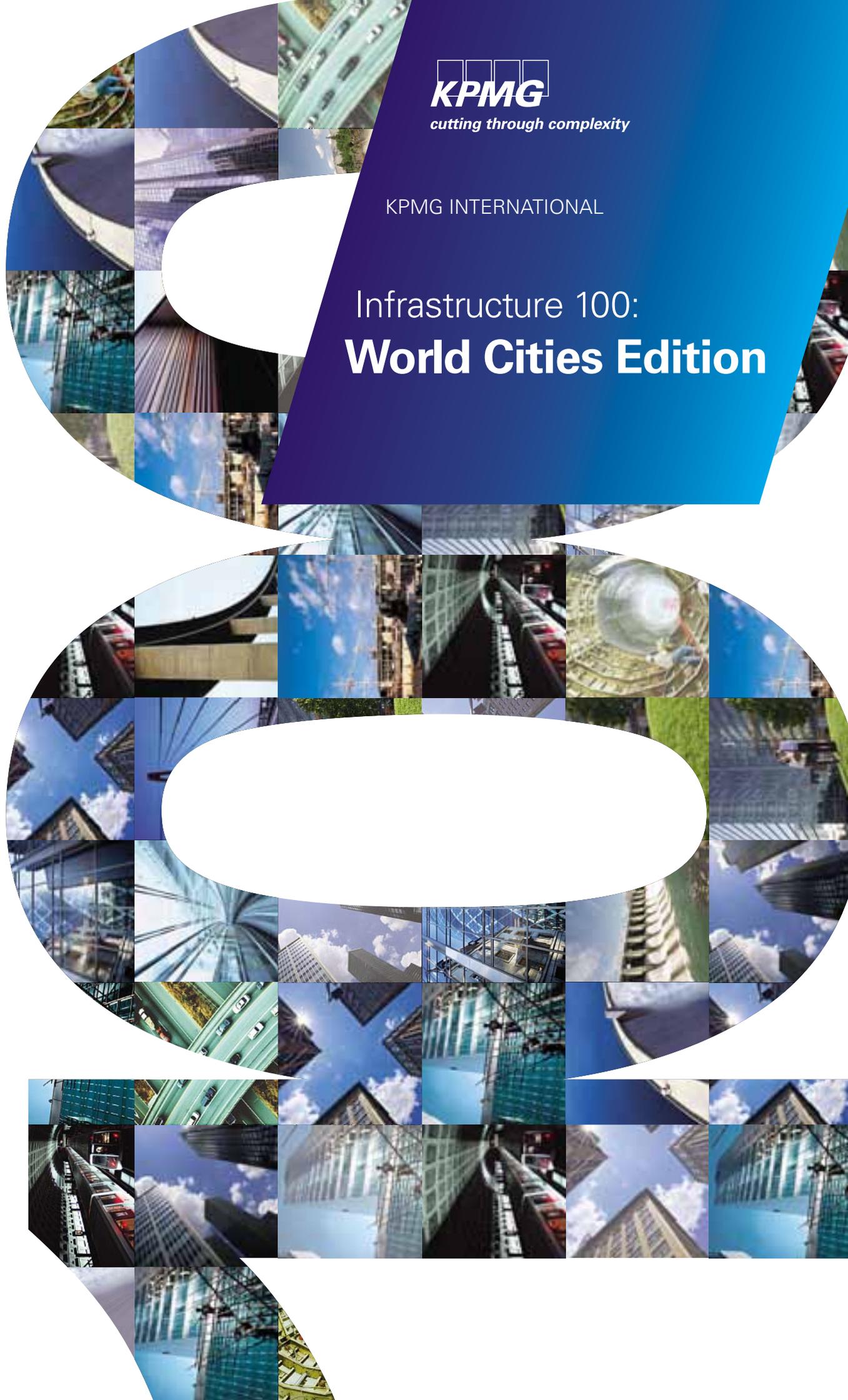


INFRASTRUCTURE



cutting through complexity

KPMG INTERNATIONAL

Infrastructure 100: World Cities Edition

Welcome

Urban infrastructure is undoubtedly one of the greatest challenges facing the world today. With more than half of the global population already huddled into cities that – together – make up less than two percent of the planet’s land cover, the pressure now being placed on urban infrastructure is unprecedented.

But, as this publication demonstrates, these challenges are clearly not insurmountable. All around the world, we see inspirational and innovative examples of projects that are sure to transform not only the urban setting, but also the way the world’s urban populations interact with their infrastructure, their governments, their cities and the environment.

KPMG’s Global Infrastructure practice is proud, therefore, to present *The Infrastructure 100: World Cities Edition*, a showcase of one hundred urban infrastructure projects that embody the spirit of innovation and stand as an inspiration to infrastructure participants and city leaders around the world.

We were also encouraged by the response to our call for submissions which – between

March and April 2012 – brought forward a wide range of world-class projects through our open online nomination process. With the support of an external and independent group of expert industry professionals (moderated by a third party) our judging panels selected the one hundred projects that most excelled against five criteria: scale, feasibility, technical or financial complexity, innovation and impact on society.

It is worth noting that no KPMG employees participated as judges, making this report a truly independent and unbiased reflection of some of the best urban infrastructure projects currently under way around the world.

On behalf of the *Infrastructure 100* project team, we would like to thank each of our distinguished panel judges for their time, their insight and their participation in this process. We are confident that – thanks to their individual participation and engagement – we have compiled a list of projects that truly reflects the diversity and scale of today’s urban infrastructure projects.

We hope you find the one hundred projects that were selected as motivational as we do. ■

Nick Chism
KPMG’s Global Head
of Infrastructure

Certain information contained within the feature project articles and sector articles of the *Infrastructure 100* Report are provided by *Infrastructure Journal* (IJ). *Infrastructure Journal* assisted with collating and analyzing projects to be considered by regional and global judging panels for the *Infrastructure 100* Report, and conducted in-depth research which was used to develop the project profiles contained within this publication. A special thanks to the following individuals from *Infrastructure Journal* for their valued contributions: John Kjorstad, Sophia Furber, Kay Litzinger, James Kenny and Vanessa Buendia. While KPMG makes every attempt to provide accurate and timely information to readers of this publication, neither KPMG nor *Infrastructure Journal* guarantees its accuracy, timeliness, completeness or usefulness, and are not responsible or liable for any such content.



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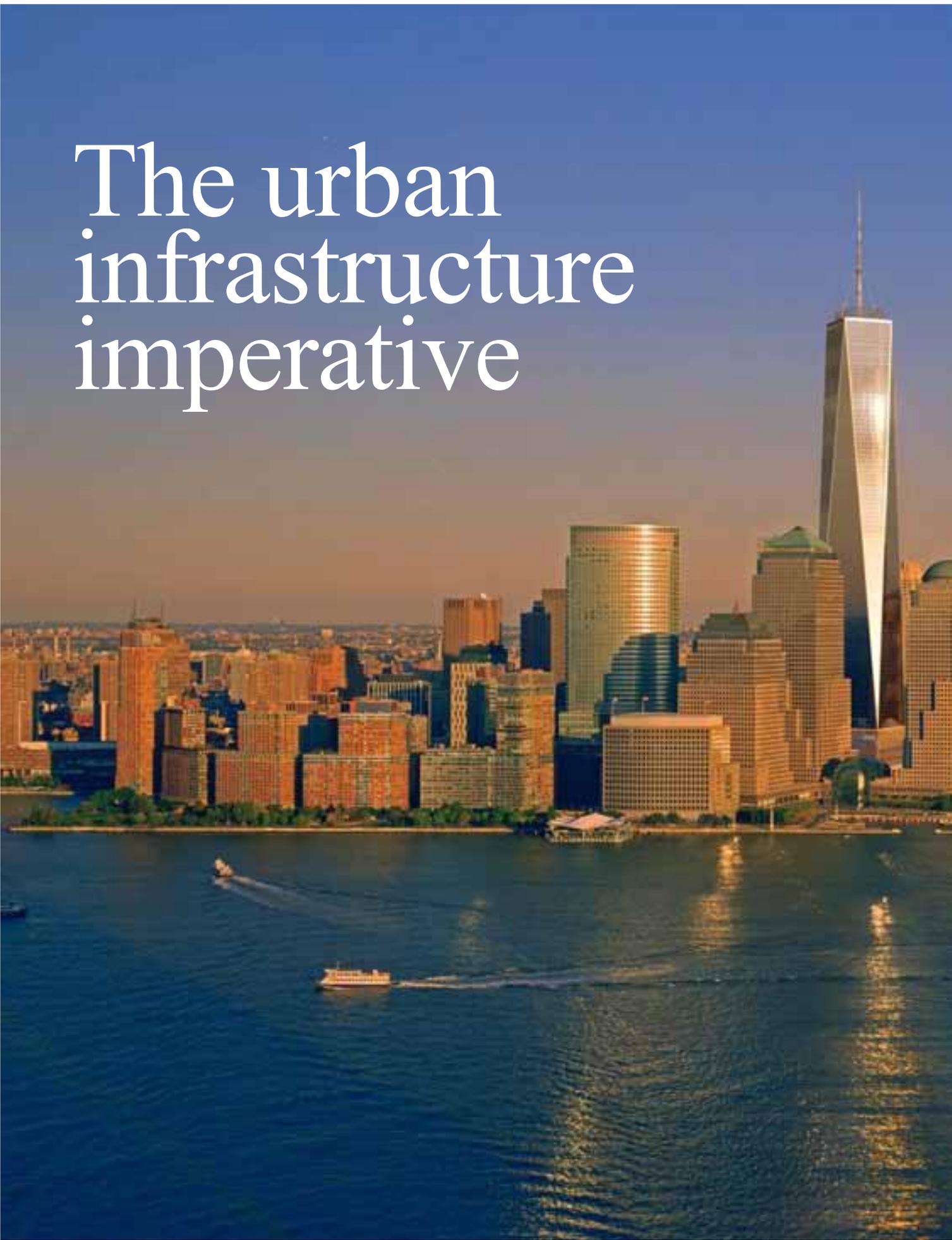
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The urban infrastructure imperative



One World Trade Center, viewed from New Jersey



One would be hard pressed to underestimate the challenges now facing the world's urban areas. Already, cities account for more than half the global population, 70 percent of greenhouse gas emissions and vast amounts of national productivity.

Indeed, in both the developed and developing world, cities are striving to provide a raft of critical urban infrastructure assets to support their burgeoning – in some cases unrelenting – growth; more effective transportation systems, reliable and low-carbon energy, safe and secure water networks, and efficient and scalable social infrastructure will all play central roles in the smooth transition to urbanization.

So it is hardly surprising that political and business leaders are now keenly focused on cities and their impact on everything from economic growth and social well-being to climate change and sustainability.

There is no time to waste. In the developing world, the urban population is expected to jump by more than 1.3 billion over the next two decades, with each new entrant seeking better employment opportunities and a higher quality of living that can only be delivered through efficient and effective urban infrastructure.

In the developed world, too, a massive amount of new infrastructure will need to be cultivated to meet the growing and shifting demands of established urban populations.

Rapid urbanization isn't the only change facing urban infrastructure planners. Technology is sprinting away at an amazing pace. Twenty years ago, no city planner had considered the benefits of a smart grid, the internet was virtually non-existent and commercially available electric cars were the stuff of science fiction.

Environmental concerns have also risen up to the top of the agenda for citizens, businesses and politicians alike. Today, it is no longer good enough to simply maintain the status quo; rather the world now demands that our infrastructure not only be efficient and effective, but environmentally sustainable as well.

So it is encouraging that – as we stand on the verge of a new era of urban infrastructure development – there is clear and ample evidence that the world is beginning to innovate and bring new solutions to respond to these deep and simmering challenges.

Looking around the world of urban infrastructure, it is not difficult to find examples of city planners, developers, engineers, investors and policy makers who are re-examining and re-inventing the way infrastructure is delivered.

Many of these triumphs of humanity are showcased within the pages of this report and each should provide inspiration to urban infrastructure participants that change is not only possible but achievable.

We hope that the projects highlighted in the coming pages help solidify a new vision for the future and catalyze a fundamental change in the way we interact with the urban environment.

David O'Brien

Leader, KPMG's Global Center of Excellence for Cities

The Infrastructure 100







Exploring World Cities in 100 Projects

Judging panel Q&A

With hundreds of projects vying for a place on this year's *Infrastructure 100*, KPMG's Global Infrastructure practice enlisted a group of esteemed infrastructure experts with the insight, expertise and experience to help us select 100 of the most inspirational urban infrastructure projects from around the world. Our judging panel, made up of some of the best minds in architecture, engineering, construction, finance, law, public policy and

academia, hail from every region and represent every sector in the infrastructure spectrum.

After concluding their panel debates, we polled the judges to find out what they believed were the greatest challenges, opportunities and future trends facing urban infrastructure today and in the future. We also asked them what influenced their judging decisions and which projects stood out as their personal favorites. Here is a selection of their responses. ▶

What do you think are the greatest infrastructure and investment challenges facing cities today?

TASSOS CHRISTAKIS Likely the most significant challenge for cities today is to prioritize economic competitiveness and employment, since these play a paramount role in helping cities function effectively. It is critical that – when deciding on infrastructure issues – cities create a competitive environment to attract private investment. That being said, the environment is another important factor as pollution and congestion are both very high on the agenda for policymakers and city administrators as they strive to ensure a high quality of life for their citizens. However, if the decision needs to be made between

environmental sustainability and economic growth, it seems the latter will likely prevail.

ROLDAN TRUJILLO In ‘frontier’ and emerging countries, the biggest challenge for infrastructure relates to the influx of new residents into cities from rural areas, particularly because most of these new arrivals are either poor or low-income and are seeking employment and better living conditions. To meet some of these challenges, some cities are learning to incorporate private sector investment solutions.

KENDRA YORK In the more developed markets, rapidly aging infrastructure is one of the – if not the most – significant challenges facing cities today. Whether the objective is to rehabilitate existing assets or develop greenfield infrastructure, cities and states are now facing significant investment challenges. In our current economic climate,

it is especially important to think outside of the box and consider innovative solutions that can meet the infrastructure needs of the community in question.

CHANGHUA WU In my opinion, the biggest challenge facing city managers today is how to effectively piece together the puzzle, such as creating policy incentives that drive technology innovation which, in turn, attracts capital flows that then drive the market.

ANNE KERR Many cities already have transport systems in place, so new proposals to introduce mass transit systems such as new railways create significant challenges when trying to find fresh corridors or underground areas to develop. The proposition can often be expensive and difficult, and may impact existing utilities, infrastructure or even the water table. For new towns or developments the situation is often simpler. However, while

Meet the Judges

Global panel



Steve Allen

**Transport for London
European panel Chair**

Steve Allen is the Managing Director, Finance at Transport for London (TfL) where he is responsible for the business planning and financial control of the organization’s £9 billion turnover and £29 billion capital investment program. In this role, Mr. Allen manages major corporate finance activity and TfL’s information management strategy. He currently also leads a major program to reduce operating costs across the TfL organization. Mr. Allen is responsible for TfL’s key support functions including Group Procurement and Property & Facilities. Prior to joining TfL, Mr. Allen worked with the UK’s Department for Transport, Citigroup and led the Rail Infrastructure team at Abbey National Treasury Services.



Anne Kerr

**Mott MacDonald
Asia Pacific panel Chair**

Dr. Anne Kerr is Director, Environment for Mott MacDonald based in Hong Kong, where she also serves as the organization’s Practice Leader for Environment and Sustainable Development for all activities throughout Asia Pacific and Australasia, and champions the Eco-City Working Group for Mott MacDonald across the globe. With more than 20 years of experience in water engineering and environmental assessment and management, Dr. Kerr has worked in more than 25 countries on a wide range of infrastructure projects including the strategic planning of new towns, airports, port developments, water supply and wastewater management, roads and railways. Drawing on her experience of planning and implementing eco-communities, Dr. Kerr has advised on a range of innovative projects such as the ‘zero carbon city in the desert’, and the ‘world’s first zero carbon dam’.



Peter Luchetti

**Table Rock Capital LLC
North America panel Chair**

As the founder of Table Rock Capital, a private equity infrastructure fund, Mr. Luchetti focuses on project and structured finance in the transportation, energy, power, communications and infrastructure sectors. Prior to founding Table Rock Capital, Mr. Luchetti was the Senior Managing Director and Global Head of Project & Structured Finance for Banc of America Securities LLC where he led a team of professionals working in 32 countries on the origination and execution of project and structured finance advisory and capital raising roles. In this role, Mr. Luchetti was responsible for a US\$5.5 billion portfolio of privately placed debt and private equity transactions in the infrastructure sector. Mr. Luchetti holds a BA Economics from Hobart & William Smith Colleges and an MA Economics from Duke University.



Roldan Trujillo

**Corporación Interamericana
para el Financiamiento
de Infraestructura (CIFI)
Latin America panel Chair**

Mr. Trujillo is the founding General Manager of CIFI, a firm that provides financing products and advisory services to private sector infrastructure companies and projects in Latin America and the Caribbean. Prior to joining CIFI, Mr. Trujillo led the Corporate Finance and Financial Services Groups at the Inter-American Investment Corporation, part of the Inter-American Development Bank (IDB) Group. He has also served as President of a US publicly-traded company, as Senior Loan Officer at the IDB and is now an outside Director of the Raza Development Fund. He earned his Juris Doctor law degree from the University of California, Davis; an MS in Applied Economics from Purdue University; and a BS in Agricultural Economics and Business from New Mexico State University.

none of these challenges are insurmountable, they do require investment and funding, often through more creative mechanisms than in the past.

Is there political will in your region to address these challenges?

CHENG HSING YAO Political will is certainly important. But we must remember that, in infrastructure development, one of the fundamental roles of government is to provide the broader framework within which the private sector can actively participate in line with balanced and optimized social, environmental and economic objectives. Therefore, governments must come up with

the overall vision and create plans and policies that make that vision attractive to the private sector in a transparent and credible way.

INIGO MEIRAS I believe that there is political will. But the ability to transform that will into solutions is being tested by some challenges. For example, public administrators are often in a weak position to develop those infrastructure assets that could typically be procured as availability projects due to the state of the public balance sheets. Tied to this is the fact that authorities are often also working with an existing infrastructure network that also requires financial support to maintain, making the funding challenge even more difficult.

ANNE KERR I would generally say yes, there is political will, but this largely depends on whether careful consideration has been given to costs early in the discussion. Often, the political will seems to evaporate when insufficient

costing has been conducted in the early stages. Once the development has been publicized, political leaders need to be sure the plans have credibility in terms of costs and applicability of the proposals. There are many examples of situations where political will was positive at inception, only to dissipate in the face of a lack of robust engineering and 'proofing' of concept plans.

ROLDAN TRUJILLO As Latin America is made up of very diverse countries with differing political systems and cultures, the will (or, more accurately, the capacity) to address the lack of adequate infrastructure tends to vary. Nevertheless, there are a number of major projects (such as the Ciudad Verde project in Colombia and the Integrated Health and Water Management project in Brazil) that clearly demonstrate there is political will to address these challenges with creative solutions. ▶

North America panel



Fred Blaney

Partnerships New Brunswick
Fred Blaney is the Assistant Deputy Minister of Partnerships New Brunswick where he holds responsibility for all Public Private Partnerships (PPPs) and the New Brunswick Highway Corporation. Mr. Blaney has served as Government Representative across a wide range of transportation infrastructure delivery projects including Project Director for the Fredericton to Moncton Highway Project, a 200km DBFOM valued at US\$900 million; Project Manager for the Trans Canada Highway Project, a 275km DBFOM valued at US\$750 million; and the The Fundy Isles Ferry Project, a DBFOM for the supply and operation of three new ferries. Mr. Blaney holds a BSc in Civil Engineering from the University of New Brunswick and represented Canada in Judo at the 1984 Los Angeles Olympic Games.



Dan Doyle

BC Hydro
Dan Doyle is the Chair of BC Hydro's Board of Directors and the past Executive Vice President of the Vancouver Olympic Committee (VANOC). With deep experience in large, complex building projects, Mr. Doyle was responsible for the US\$580 million development and building of the 2010 Winter Olympic and Paralympic Games venues. Prior to assuming the role of Chair of BC Hydro, Mr. Doyle spent more than 30 years with the province's Ministry of Transportation, most recently as Deputy Minister. In this role, he led the development of some of the province's landmark construction projects, including Lion's Gate Bridge and the Sea-to-Sky Highway Improvement project. Mr. Doyle also served as chairman of Rapid Transit 2000, where he was responsible for building the Millennium Line extension. Mr. Doyle holds a degree in Civil Engineering.



Tony Kinn

Commonwealth of Virginia
Tony Kinn is the Director of the Commonwealth of Virginia's Office of Transportation Public Private Partnerships (PPPs), where he is responsible for developing and implementing a state-wide program for transportation project delivery. Prior to that, Mr. Kinn served as the Assistant Vice President and Director of Corporate Relations for the University of Virginia's Engineering Foundation. With a deep experience in new business development, Mr. Kinn was the principal owner of the James A Weaver Company, which was the third largest food brokerage firm in the US, and served as Executive Vice President of the Federated Group in Chicago. Mr. Kinn also served as Director of the Commonwealth's Department of Economic Development's International Division, where he was responsible for drawing firms to the Commonwealth from the Pacific Rim and Europe.



Kendra York

Indiana Finance Authority
As the Public Finance Director of the State of Indiana, Kendra York is the head of the Indiana Finance Authority (IFA), the quasi-governmental agency responsible for overseeing State debt. She has also served the IFA as General Counsel and Chief Operating Officer. In these roles, she has managed the financing of the Lucas Oil Stadium and Convention Center construction and expansion, the State of Indiana's relationship with the Indiana Toll Road, and is currently the project lead for the Ohio River Bridges Project-East End Crossing. Before joining the IFA, she was a counsel with the law firm of Ice Miller LLP, where she focused on tax-exempt financings for the State of Indiana and healthcare institutions. Ms. York holds an MBA from California State University and a JD from the University of the Pacific, McGeorge School of Law.

Meet the judges

KENDRA YORK In my region, I would say yes and in Indiana, there is certainly the political will to address these challenges. Governor Daniels, for example, is known for his success with the lease of the Indiana Toll Road, which provided the State with the opportunity to create a state-financed 10-year transportation construction plan.

As an *Infrastructure 100* judge, what unexpected reflections did you come away from the process with?

ROLDAN TRUJILLO I think I was most impressed with the extensive range of infrastructure challenges being faced

around the world and some of the innovative, creative and complex projects being advanced in response.

TASSOS CHRISTAKIS Having focused most of my investment and lending activities in the developed world, I believe that the process helped me realize how important it is to address the long-term social benefits when reviewing the candidate projects, rather than just their monetized effect.

KENDRA YORK I was amazed at the vast array of incredibly creative ideas that government sponsors have developed to deal with the infrastructure and investment challenges that they face.

TIM TREHARNE While it was not entirely unexpected, I found that I was impressed with the sheer scale of the amount of infrastructure work that is required around the world.

CHANGHUA WU All of the candidate projects reconfirmed for me that in today's world, we now have the technology and solutions to help address our environmental and social challenges through infrastructure.

CASSIO TANIGUCHI I was pleasantly surprised at the creativity of the projects which – in many cases – provided simple and affordable solutions to meet the needs of both the population and the local budgets.

Was there any project in particular that stood out? If so, which one and why?

ANNE KERR For me, there were a number of stand-out projects. But I would suggest that the Princess Nora Bin AbdulRahman

Latin America panel



Milton von Hesse La Serna

ProInversion

Milton von Hesse La Serna is the Executive Director of ProInversion, Peru's private investment promotion agency. Mr. von Hesse La Serna has held a number of senior positions within the public sector, including roles in Peru's Ministry of Economy and Finances, the World Bank's Water and Sanitation Program, Aeropuertos del Perú, the National Project of Rural Telecommunications at FITEL and the Agricultural Development Unit at the United Nations Economic Commission for Latin America and the Caribbean. Mr. von Hesse La Serna has also served as a Director for a number of Peruvian public entities and has been a consultant for several international organizations such as the World Bank, IFC, WSP and IDB. He holds a degree in economics from Universidad del Pacifico and a Master's degree in economics from Georgetown University.



Steven Puig

Inter-American Development Bank

Steven Puig is the Vice President for the Private Sector and Non-Sovereign Guaranteed Operations at the Inter-American Development Bank (IDB). As such, Mr. Puig is responsible for coordinating the private sector and non-sovereign guaranteed operational programs of the IDB Group, including the development and implementation of a private sector integrated business plan and the individual business plans for each of the group's private sector entities. Prior to joining the IDB, Mr. Puig held a number of senior positions with Citigroup including Global Head of Trade for Latin America, Country Corporate Officer in both Columbia and El Salvador and Vice President of Corporate Banking and Corporate Finance in the Dominican Republic. Mr. Puig holds an MA in International Management and a degree in Economics, International Finance and Commerce.



Cassio Taniguchi

Secretary of State for Planning and General Coordination, Paraná, Brazil

For more than 45 years, Cassio Taniguchi has helped guide the urban development of Paraná State in Brazil. Mr. Taniguchi has held a range of high profile positions within the state, including President of the Company of Urbanization of Curitiba (1972-1975), and President of the Research and Planning Institute of Curitiba (IPPUC) from 1980-1983 and 1989-1994. He served as Secretary of State for Planning and Industry and Trade from 1995-1996, after which he was elected Mayor of Curitiba for two terms from 1996-2004. Mr. Taniguchi was the President of the Institute of Paraná Reginal Tancredo Neves (ITN-PR) in 2005 and was elected as a federal deputy in 2006, and acted as Secretary of State for Urban Development and Environment of Brasilia (2007-2009). In 2011, he took on his current role as Secretary of State for Planning and General Coordination.



Tim Treharne

Meridiam Infrastructure

As Chief Operating Officer for Meridiam's European operations, Tim Treharne is responsible for all of the organization's projects in the European region. Prior to joining Meridiam in 2011, Tim worked with KPMG's Infrastructure Team, leading the development of teams in the UK, the US, France and – most recently – in Latin America. Over a period of 20 years, Mr. Treharne has gained deep experience in project finance, including having established NatWest's project finance advisory team and serving as Global Head of Infrastructure at Bank of America / Banc of America Securities, where he was responsible for advisory and lending activities in the infrastructure sector.

University for Women was the most notable for its social benefits, the multiplicity of uses and the scale of the project. The Aqueduct II in Querétaro, Mexico was also an important project in my mind for the fact that it was a regeneration project that included a recovery program for the aquifer in an area where water scarcity and aquifer overuse prevails.

INIGO MEIRAS The Barcelona and Amsterdam smart city projects stood out as good examples of how information and communication technologies can be applied to optimize infrastructure and provide more efficient and sustainable services to the population. By applying technology to areas such as energy consumption in public buildings, rain water usage, and bus and parking networks, cities can improve the quality of life for their citizens and ensure sustainable economic development.

TIM TREHARNE I think all of the projects in the water and sanitation sector are transformational and will really improve the quality of life for a large number of people. At the same time, the Porto Marabilha project in Rio de Janeiro is very impressive in its scale and transformational impact.

CHANGHUA WU While it is difficult to pick any one project in particular, I am impressed with those projects that have clearly demonstrated integrated solutions that deliver obvious benefits, such as the Tianjin Eco-City Project and some of the water and waste reuse projects in Singapore.

CHENG HSING YAO One of the projects that really impressed me was the Gardens by the Bay development. In my opinion, it reflects the values of leadership and political vision by setting aside a very large and valuable piece of land in the middle of Singapore for parks and

gardens rather than developing it into another commercial area for sale. The project is also innovative in its design, particularly in terms of using compost to generate energy and the purification of storm water before it enters Marina Reservoir.

What major changes do you expect to occur in your region that will impact urban infrastructure development in the next 10 or 20 years?

CHENG HSING YAO One of the major challenges I see moving forward is the rapid rate and scale of urbanization and the need to ▶

ASPAC panel



Rahul Asthana

Mumbai Metropolitan Region Development Authority (MMRDA)
As the Metropolitan Commissioner for MMRDA, Mr. Asthana oversees the planning, coordination and development of infrastructure for the Mumbai Metropolitan Region. Mr. Asthana has broad public sector experience and has held a number of senior roles within national, state and local government. Mr. Asthana has served as the Chairman of Mumbai Port Trust, Principal Secretary of the Government of Maharashtra's Energy Department, Joint Secretary of the Department of Atomic Energy, and the General Manager of Transport at the Brihanmumbai Electric Supply and Transport Undertaking (BEST). As the Additional Municipal Commissioner of the Municipal Corporation, Mr. Asthana dealt with World Bank projects in the water supply and sewerage department. Mr. Asthana holds an Aeronautical Engineering degree from IIT Kanpur and an MBA from ICPE Ljubljana.



Changhua Wu

Greater China Director, The Climate Group
As the Greater China Director of The Climate Group, Changhua Wu leads the organization's strategic development in the region and manages the group's Greater China operations. In this role, Ms. Wu focuses on forging public and private partnerships with key infrastructure stakeholders to support the development of low-carbon solutions. She is a frequent speaker on the subject of China's progress in achieving green growth and low-carbon development. Prior to joining The Climate Group, Ms. Wu was the Executive Director of China Operations at ENSR. Ms. Wu has also directed the Program for China Studies at the World Resources Institute (WRI) in Washington, DC and consulted for a range of multinational organizations such as the World Bank, UNEP and UNDP.



Cheng Hsing Yao

Centre for Liveable Cities
Hsing Yao Cheng is the Deputy Executive Director of the Centre for Liveable Cities, a practice-based knowledge centre for urban solutions set up by the Singapore Government. Prior to being appointed to the Centre, he was with the Urban Redevelopment Authority for 13 years, overseeing major planning, urban design and development projects in Singapore. He was also involved in the planning of the Sino-Singapore Tianjin Eco-City and setting up of the Development Agency that manages Marina Bay. He holds a Masters in Design Studies from Harvard University and a Bachelor of Architecture from Newcastle University.



Ajit Gulabchand

Hindustan Construction Co. Ltd.
Ajit Gulabchand is the Chairman and Managing Director of Hindustan Construction Company (HCC) Ltd. Over the past 25 years, Mr. Gulabchand has transformed the company into a global business group focused on developing and building responsible infrastructure. Over the years, HCC has constructed more than a quarter of India's hydro-power, more than half of India's nuclear power generation capacities, in excess of 3,300 lane kilometers of expressways and highways, 204 kilometers of complex tunneling and over 320 bridges. Mr. Gulabchand was Co-Chair of the World Economic Forum's India Economic Summit, 2010 and the only Indian business leader to participate on panels at the UN's Annual Summit on Climate Change, as well as the UN's Global Compact Summit. Mr. Gulabchand is also the President of the International Federation of Asian and Western Pacific Contractors' Associations.

create higher density, particularly in Asia. But to achieve high density while also remaining livable and sustainable requires infrastructure to be planned with long-term vision. We also need comprehensive masterplanning to ensure we achieve orderly growth and not the same type of chaos that is the main culprit for poor livability in many of today's high density urban environments.

CASSIO TANIGUCHI As cities in Brazil prepare to host the soccer World Cup in 2014 and Rio de Janeiro prepares for the Olympics in 2016, we anticipate many investments that I hope will transform cities into good places to live. This should lead to water and sanitation projects, road networks, new buildings (such as museums, arenas and hotels) as well as new recreational spaces with parks and green areas.

TASSOS CHRISTAKIS We are seeing the growth of the middle class which – while

happening slowly in places like Turkey – will hopefully swell in the aftermath of the Arab spring. This will mean that a wider section of society will be able to enjoy activities that they could not before such as leisure travel domestically or abroad. This, in turn, will have significant impact on the transportation systems including railways, highways, ports and airports. I also see a trend towards wider home ownership in North Africa and the Middle East, where traditionally people tend to live with their families or relatives, and this will enlarge the footprint of cities and increase the demand for services such as water and energy facilities.

INIGO MEIRAS I think we'll see two obvious changes. The first is that the quality of the existing network will diminish significantly, which will both bring disappointment from users and – hopefully – change their perception about the value of infrastructure. People will

also hopefully become more aware of how costly and difficult it is to build and operate infrastructure assets and, as a result, this may change their personal willingness to pay for the use of assets that are high quality, convenient and well operated. The second trend is that populations and user demand will grow in the medium and long-term but likely without the expansion of the city footprint, which will lead to greater traffic congestion.

ANNE KERR We're seeing more mass transit railway projects being rolled out in the urban and highly populated cities such as Jakarta and Manila which will change the traditional mode of transport from bicycles and car to mass transit. As a result, I hope to see populations start to work from home or – at least – work and live within a smaller area, thus bringing about more of an 'eco-city' type of model with more focus on energy and water together.

Europe panel



Paul Finch
UK Design Council

Paul Finch is the Deputy Chairman of the UK Design Council and the Chairman of the Design Council Commission for Architecture and the Built Environment (CABE). Mr. Finch currently also serves as the program director of the World Architecture Festival and the Editorial Director of the *Architectural Review* and *Architects' Journal*. In the past, he also served CABE as Deputy Chair (1999-2007) and Chair (2009-2011). From 2006-2010, Mr. Finch was the Chair of the Olympic Design Review Panel and has been the joint Editor of *Planning in London* since 1992. Mr. Finch received an honorary FRIBA in 1994; an honorary doctorate from the University of Westminster in 2004; and an honorary fellowship from University College London in 2006. He was also awarded an OBE for services to architecture in 2002.



Dirk Grevink
BNV Mobility

Dirk Grevink is the Chief Executive Officer of BNV Mobility B.V., a 50/50 joint venture between Brisa (a world leading concessionaire company in Portugal) and NedMobiel B.V. Mr. Grevink is also the CEO of NedMobiel, a consultancy firm focused on financial modeling and operations and maintenance of complex infrastructure assets such as tunnels, where he started as the Co-Founder and Managing Director. In his role with BNV Mobility, Mr. Grevink focuses on two main objectives: operations and maintenance services covering all stages of road infrastructure management; and the development of mobility services for metropolitan congestion management projects and mobility budgets.



Inigo Meiras
Grupo Ferrovial

Mr. Meiras is the Chief Executive Officer of Ferrovial, a Spanish multinational group involved in the design, construction, financing, operation (DBFO) and maintenance of transport, urban and services infrastructure. Since joining grupo Ferrovial in 1992, Mr. Meiras has held a number of senior positions within the group including CEO at Ferrovial Servicios, CEO at Ferrovial Aeropuertos, Chairman of Cespa (Spain); Deputy Chairman of Amey plc. (UK), Swissport Int. (Switzerland) and BAA Ltd. (UK); and Board Director of Tube Lines (UK). Prior to joining Ferrovial, Mr. Meiras worked for Unión Marítima Internacional (Holcim Ltd.) and Carrefour Group. He is a graduate in Law and holds a Masters of Business Administration (MBA) from the Instituto de Empresa (Madrid).



Mansur Ahmed
Infrastructure Concession
Regulatory Commission (ICRC)

Mr. Ahmed is the Director General and Chief Executive of ICRC, where he is responsible for leading the development of a sound regulatory and institutional framework for promoting private sector participation in the financing, construction, operation and maintenance of Nigeria's federal infrastructure services through concessions and other Public Private Partnership (PPP) arrangements. Prior to joining ICRC, Mr. Ahmed was the Director General and CEO of the Nigerian Economic Summit Group, a not-for-profit organization committed to fostering Nigeria's economic development, and the Group Executive Director with the Nigerian National Petroleum Corporation. Mr. Ahmed holds a degree in Mechanical Engineering from Nottingham University (UK) and a Master's degree in Industrial Engineering and Administration from Cranfield University (UK).

Middle East & Africa panel

How does the infrastructure where you live impact your life?

CASSIO TANIGUCHI In my city, Curitiba, we are working to transform the urban area into a 'smart eco-city' with the intensive use of new technologies that will lead to the development of a city that is a place for conviviality and a meeting place for people rather than one characterized by cars and pollution.

ROLDAN TRUJILLO I currently live and work in the Washington D.C. area, which has some of the most highly congested road traffic in the United States. For me, the metro system has a significant positive impact in reducing the number of motor vehicles on the road and

the current expansion of the system will certainly provide additional relief.

TASSOS CHRISTAKIS Living between the two mega-cities of London and Paris, I frequently recognize the importance of having an efficient intra-country link such as the Eurostar network.

KENDRA YORK Indianapolis is the largest metropolitan area in Indiana and – as with any densely populated area – there is a need to provide efficient workforce mobility and enhance the quality of citizen's lives. The I-465 beltway around Indianapolis has undergone improvements to widen the road and replace bridges, which has had a significant impact on both commuters and industry by providing shorter travel times and fewer traffic delays.

ANNE KERR I live in Hong Kong which, in my opinion, is one of the world's best cities in

terms of the provision of infrastructure with reliable, affordable, safe and convenient transportation options. I believe that is because our city planning has focused on mass transit and a rail-based network with planning parameters (strategic and development plans) developed over a 20 year period. ■



Tassos Christakis

InfraMed Infrastructure

Tassos Christakis is a Director at InfraMed Infrastructure, a long-term investment vehicle launched by five major institutional investors. Prior to joining InfraMed, Mr. Christakis served as an Investment Director with Barclays Private Equity, where he originated and executed investments in infrastructure assets in Western Europe. Mr. Christakis also served as an Associate Director within the Infrastructure Finance Unit at DePfa Bank focused on transactions in both economic and social infrastructure, as well as the renewable energy sector. Mr. Christakis has held senior positions at Transport for London, where he managed the contractual issues for high-profile projects including two Project Finance Initiative (PFI) Docklands Light Railway transactions, the London City Airport contract and the Woolwich Arsenal extension contract. Mr. Christakis holds an MBA and an MSc in Civil Engineering from Imperial College London.



Joss Dare

Ashurst

Joss Dare is the head of Ashurst's regional Middle East practice, managing partner of Ashurst's Dubai office and leads Ashurst's energy, transport and infrastructure department in the MENA region. He has wide-ranging experience of infrastructure transactions in a great variety of industry sectors (including a number of flagship Project Finance Initiative (PFI)/ Public Private Partnership (PPP) projects). He has taken a leading role in advising public sector clients as well as sponsors, lenders and sub-contractors in the Middle East, the UK and elsewhere. Mr. Dare leads the development of Ashurst's transport and infrastructure practice in the MENA region and India/Pakistan. He was featured as one of six leading PPP lawyers in the Middle East (MEED, February 2011).



Malik Faraoun

African Development Bank

Malik Faraoun is currently a Principal Investment Officer in Infrastructure Finance within the African Development Bank's (AfDB) Private Sector Department. As such, Mr. Malik has extensive experience in the originating, structuring and execution of infrastructure projects and Public Private Partnerships (PPP) with a particular focus on the transport and power sectors. Before joining the AfDB, Mr. Faraoun worked with the International Finance Corporation (IFC) providing advisory services in the Middle East and North Africa Region. Prior to that, Mr. Faraoun spent a number of years working in the private banking sector and providing consulting services. Mr. Faraoun holds an MBA from EDHEC (France) and a Bachelor of Business Administration from Ecole Supérieure de Commerce (Algeria).



Adel Mohammed Al-Roumi

Partnership Technical Bureau (PTB) – Kuwait

Middle East & Africa panel Chair

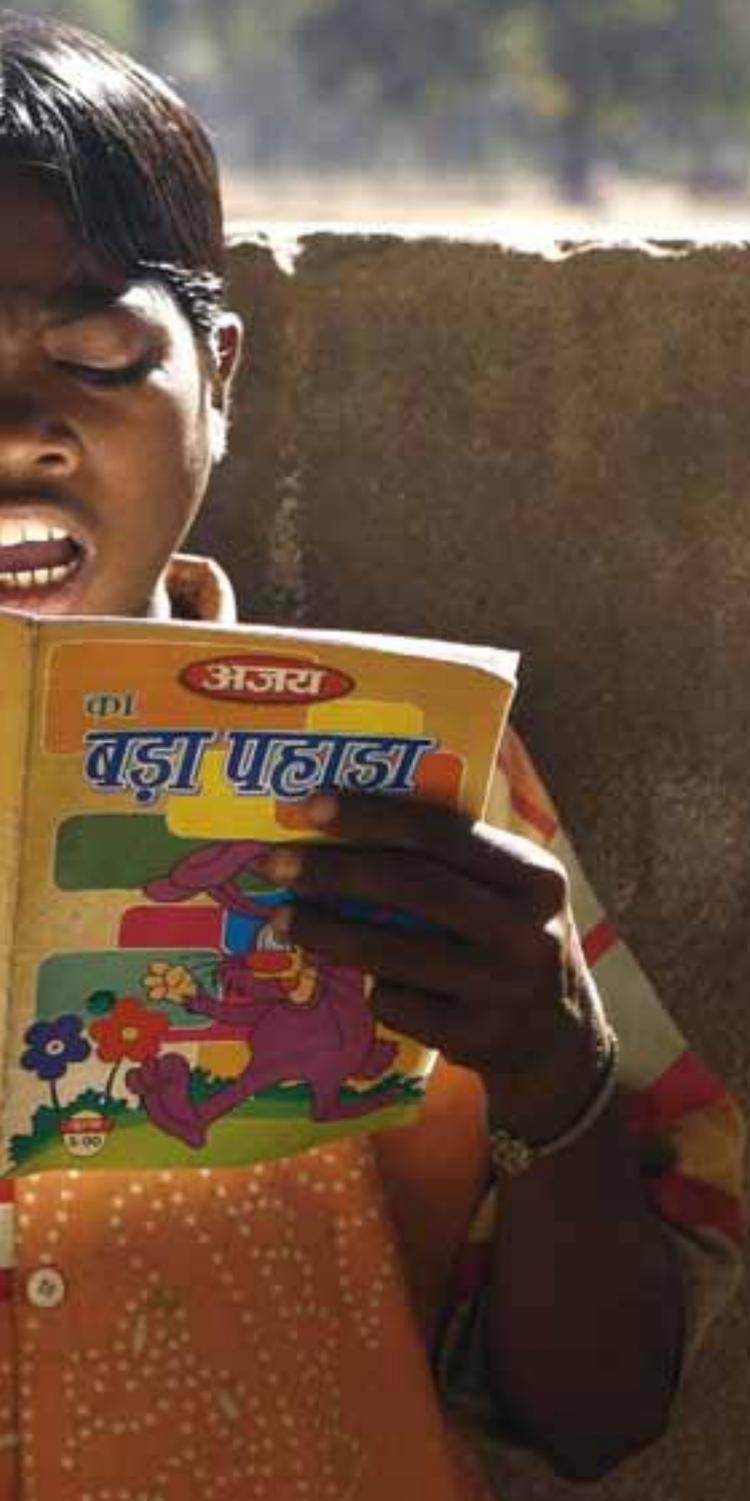
Adel Mohammed Al-Roumi is the head of the Partnership Technical Bureau (PTB) in Kuwait, responsible for operating Kuwait's PPP program, and is the current chairman of VIVA Telecommunications Company. Mr. Al-Roumi has held a number of roles in the Kuwait Investment Authority, in New York and London, where he was the Senior Vice President and Director of Asian Investments. Mr. Al-Roumi served as the Director of Institutions and New Investments at the Kuwait Investment Authority. Mr. Al-Roumi was instrumental in establishing the Kuwait Small Projects and Development Company to oversee the development of the small to medium enterprise sector in Kuwait. Mr. Al-Roumi holds a bachelor's degree and various post-graduate degrees from Harvard School of Business, Northwestern University and the London Business School.



Education



A	B	C	D
A	B	C	D
E	F	G	H
E	F	G	H
I	J	K	L
I	J	K	L
M	N	O	P
M	N	O	P
Q	R	S	T
Q	R	S	T
U	V	W	X
U	V	W	X
Y	Z		
Y	Z		





Featured Project

Princess Nora Bint AbdulRahman University for Women Saudi Arabia



By **Sakshi Sharma**, Infrastructure Journal

The Princess Nora Bint AbdulRahman University for Women in Riyadh, Saudi Arabia, is an outstanding example of an integrated infrastructure project that is expected to have a huge social impact. The university not only furthers the cause of advancing education among Arab women but it also sets new standards for built infrastructure in the education sector globally.

While the Arabian Peninsula is no stranger to mega-projects in the urban environment,

the university stands out for its sheer size and scope. It is possibly second only to another Saudi Arabian education project featured in the first edition of the *Infrastructure 100* – The King Abdullah University of Science and Technology (KAUST), which was unveiled by King Abdullah bin Abdulaziz Al Saud in September 2009. Another construction marvel, KAUST is spread over 36 million square meters and is located in Thuwal, north of Jeddah.

The Princess Nora Bint AbdulRahman University, which was inaugurated on 15 May 2011, is located on the King Khalid International Airport Road in north Riyadh. The project is spread across eight million square meters and has been built with a total investment of £11 billion.

Breaking new ground

The university’s sprawling campus is something of an ‘education city’ in and of itself. It houses 15 colleges and covers almost all major disciplines. It has been aptly named after Saudi Arabia’s founder King Abdul Aziz’s sister, who is said to be known for her outspokenness, progressive mind and faith.

Princess Nora is one of the largest – if not *the* largest – women’s universities in the world, and a major landmark for a region

with strict gender segregation in the education system. The judges appreciated how the project addressed a problem whereby women either miss out on going to university or interact with limited participation. The Princess Nora Bint AbdulRahman University hopes to change that notion by providing world-class facilities.

The university will have the capacity to offer places to 60 percent of Riyadh’s female high-school graduates. It will offer degrees in medicine, pharmacy, management and IT – subjects which have typically been male-dominated and difficult for Saudi women to access. The campus will accommodate around 40,000 students and 12,000 employees. Transport within the campus will be provided by an 11.5 kilometer women-only light metro, with a total of 14 stations on a main loop, plus two branches.

Out of the 15 colleges situated on the campus, five are medical, supported by a 700-bed medical center and a state-of-the-art clinical research laboratory. The university also boasts a vast student sports center comprising a 7,000-seat multi-functional sports stadium. The on-campus residential quarters include 1,436 villas and apartments which will accommodate faculty and have the capacity to house 12,200 students.

Construction on the project began in early





“The university sets new standards for built infrastructure in the global education sector”

2009 and the entire university was built within a 25-month time frame. The massive project is said to have engaged around 75,000 workers, and was designed with the aid of architectural expertise from around the world, including Cairo, Beirut, India and the United States. The entire campus is LEED-certified and has kept environmental sustainability high on its agenda. The campus includes one of the world’s largest thermal solar power plants, a solid waste station, and a wastewater and water re-use treatment plant.

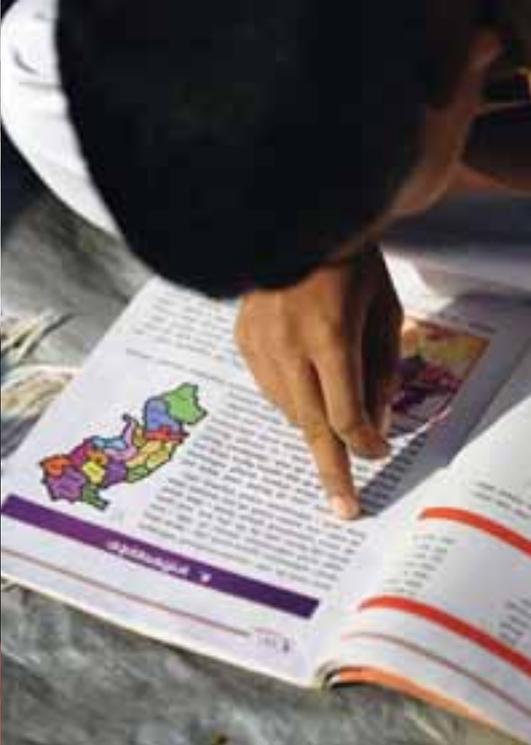
Feeling the heat

The university’s solar hot water system went into operation after a six-month trial period and

build-up. The solar system provides significant savings on fuel consumption while reducing carbon emissions. The plant uses 35,230 square meters of solar panels to feed solar energy into a district heating grid providing hot water and heat over the campus’ eight million square meter area and to its entire 40,000-student body. There are also six tanks of 150 cubic meters each to store excess solar heat at 110°C, as well as a dry cooling tower which will ensure the systems’ temperature stays below 120°C should an exceptional situation arise.

By combining all possible sophisticated infrastructure technologies and by building a state-of-the-art modern campus, the Princess Nora Bint AbdulRahman University wishes to become a medium for the advancement of research in the Saudi Kingdom and beyond. The university stands out as an example of Saudi Arabia’s commitment towards advanced education for its women in an environment that is intellectually enriching, environmentally friendly and sustainable both in its design and function. ■







Leaders in the field

Seats of learning

Although tall buildings, roads and power plants are impressive, schools and the enlightenment of a country’s youth are far more likely to shape its destiny. All of the projects submitted in this category had a great deal of positive social impact which made narrowing the final field very difficult.

What some submissions lacked in scale, they made up in ambition. From early-learning projects to world-class facilities of research and higher learning, measuring the impact of education infrastructure is a challenging proposition with different regions facing different challenges.

In the Middle East and Asia, new universities are being established to cater to a growing middle class while the importance of early childhood education continues to grow within the population. In parallel to this, universities and colleges in Europe and North America continue to expand at a rapid pace in order to keep up with demand and technology.

The **Princess Nora Bint AbdulRahman University for Women** in Saudi Arabia was widely lauded by the judges and is considered a major step in obtaining equal education for women in the Middle East. The self-contained campus will cover 8 million square meters just outside Riyadh and accommodate 40,000 students. The university will have the capacity to offer places to 60 percent of the city’s female high-school graduates and will offer degrees in medicine, pharmacy, management and IT – which have typically been male-dominated subjects and sometimes difficult for

Saudi women to access. According to the judges, the project has a “generational theme” and its effect will ripple across the whole country for years to come.

Also set to bolster the growing reputation of the Middle East’s university sector is the **Paris-Sorbonne University Abu Dhabi** which will see a world-class university setting up a campus overseas. The project combines both academic excellence with cutting-edge infrastructure and architectural design. It is also a strong example of participation between private and public sectors, being developed as a Public Private Partnership (PPP) with a long-term build-own-operate-transfer (BOOT) structure. The university provides courses in arts, languages and political sciences, all being taught in French.

Western universities like the Paris-Sorbonne expanding campuses into Africa and the Middle East is a growing trend and earned an honorable mention for the **Carnegie Mellon University** in Rwanda. Judges thought this project represented positive strides for an African state recovering from internal strife. It is believed to be the first time an international university has set up a full campus in Africa.

Two impressive ‘Education Cities’ being built in India and Bhutan also came up on the judges’ radar. **Education City Dantewada** in Chhattisgarh, India is being developed to provide an education that aligns skills with opportunities – giving young people an alternative to violence caused by socio-political unrest in the state. The project in Dantewada will provide a polytechnic, a

The projects

Princess Nora Bint AbdulRahman University for Women
Saudi Arabia

Paris-Sorbonne University Abu Dhabi
United Arab Emirates (pictured top left)

Education City Dantewada
India

Education City Bhutan
Bhutan (center left)

The Yonkers, New York Schools PPP
United States of America (bottom left)

Schools for the 21st Century
Puerto Rico (top right)

Belo Horizonte Schools PPP
Brazil

Southern Alberta Institute of Technology’s Polytechnic Trades and Technology Complex
Canada (bottom center)

UWE Bristol Campus
United Kingdom

Toulouse University
France



“Western universities expanding campuses into Africa and the Middle East is a growing trend”

middle school, a sports complex, an industrial training institute with workshops and residential quarters for staff and students.

Education City Bhutan, in the eastern Himalayas, which is set to cost between US\$500-600 million, involves the design, build, finance, operate, own and transfer of the educational city on a 1,000-acre campus with a lease of 90 years. The project will not only help Bhutan develop its own education sector but could attract international students – particularly from neighboring India – providing an external source of revenue. The judges recognized this project for being an ambitious challenge in a poor area in need of development.

Investment in early learning and primary education is paramount in almost every society of the world. Projects to support our youngest minds – and ranging from the United States to Kazakhstan – were carefully considered.

The Yonkers, New York Schools PPP – described as “gutsy” by one of the North American judges – is the first social infrastructure PPP for a public school district in the United States. It will involve the upgrade of 38 schools for the Yonkers Public School District. The US\$1.7 billion project is truly unique in the United States, and if implemented correctly could be a real pathfinder for American education in an era of increasingly constrained public finances.

Schools for the 21st Century in Puerto Rico is a comprehensive school modernization program that aims to invest US\$756 million to transform more than 100 schools in an effort to deliver a high-quality learning environment that provides students with modern skills to meet the needs of modern employers. Led by Governor Luis Fortuño, the project is developed as a design-build-maintain PPP that prioritizes teaching and learning outcomes, improves parent participation and raises the profile of each school as an important and valued asset for the entire community. Judges

liked the renovation aspect of the project and how it creates a better environment for learning by examining people and the spaces they inhabit in order to better understand the connections between the built environment and human psyche. The idea is to shape the facilities in which we learn so that they are truly the most visible manifestation of our future aspirations as a society.

Like the project in New York, the **Belo Horizonte Schools PPP** is also Brazil’s first education PPP and will fill an urgent need for kindergarten school places in the capital and largest city in the state of Minas Gerais. Similarly, an honorable mention in this category was made by the Asia Pacific judging panel for the **Karaganda Kindergartens PPP** in Kazakhstan. The small US\$34 million project garnered support for addressing a desperate need for early-learning facilities and for potentially being the country’s first PPP.

Moving away from social impact, universities in Europe and North America continue to improve their standing internationally by expanding on already impressive facilities. In Canada, **Southern Alberta Institute of Technology’s Polytechnic Trades and Technology Complex** is set for completion this year and will bring 740,000 square feet of additional training space for one of the leading training centers in energy, construction and manufacturing. Judges liked the emphasis on vocational training.

Expansion and improvement of facilities are also surging ahead at the **UWE Bristol Campus** in the United Kingdom and **Toulouse University** in France. The UWE is one of the largest university expansion projects underway in Europe with a 70-acre site being acquired for a new students’ union, media hub and faculty of arts. Toulouse University is in the middle of the first of two PPP projects to redevelop its teaching and research facilities. Among the innovative developments taking place is the building of a new 11,000 square meter training center and a 1,250-meter wind tunnel for the aeronautics school, a 2,600 square meter biosciences center at Auzeville and another 4,050 square meter facility at Castanet. ■

KPMG's view

New terms for schools

By **Bob Griggs**, KPMG in the UK

The landscape for education infrastructure is shifting: governments and school boards are rethinking their facilities needs, bank financing for education continues to be short-term, higher education institutions are looking for new markets and technology is altering the very fundamentals that, until recently, underpinned the delivery of education in mature markets. Change affects all sectors in the 21st century and education is no different. The good news is that education is such a cornerstone of social infrastructure policy (for most governments) that there will always be a need for investment and that will produce infrastructure/investment opportunities going forward.

Much of this change is related to the global financial crisis. Indeed, given the focus on fiscal restraint in government, many jurisdictions have started to rethink the way they approach social infrastructure. In the UK, for example, the government has stopped their £45 billion BSF school investment program, to focus on a much smaller program that still uses Public Private Partnership (PPP) methodology. They have also switched from a more planned economy for local schools using an education partnerships' approach, to instead free up schools from local government control, allowing for much more autonomy. As a result, we have seen a significant increase in the number of local academies and 'free schools' across the country.

At the higher education level, the financial climate has forced many institutions to refocus their priorities towards new areas of growth. In response, many higher education institutions are now looking to expand transnationally in an effort to grow their revenues in overseas markets. In some cases, these institutions are developing foreign satellite campuses to serve new markets (such as the Paris-Sorbonne University campus being developed in Abu Dhabi); in others, they are developing partnerships with existing overseas institutions to create jointly run ventures.

Change in the classroom

New innovations in technology are also changing the way that education is provided in many sectors and geographies. Distance

“The financial crisis has forced many institutions to refocus their priorities towards new areas of growth”

learning and online programs are encouraging schools and universities to rethink their operating structures and their facilities. What is the optimal classroom size? Do higher education institutions still need residences? How does location relate to the ability to recruit students? Social infrastructure is often closely allied to regeneration objectives and both the repurposing of existing buildings into education facilities and targeted investment in more depressed urban locations are trends we can expect to see going forward.

Education and the economy

Shifting demographics have also played a part in the current transformation affecting the education sector. In the developing world, the increasing pace of urbanization has created massive demand for urban schools, while high rates of youth unemployment are adding to the pressure on governments to deliver more efficient and effective educational services. In response, we are starting to see renewed activity in the education sector in places like China, India and Brazil (take, for example, the Belo Horizonte Schools PPP project highlighted on page 22).

Emerging economies have also started to recognize the link between education infrastructure and economic growth. Indeed, this edition of *Infrastructure 100* contains some wonderful examples of cities developed entirely around the provision of educational services. The Princess Nora Bint AbdulRahman University for Women in Riyadh promises to be the largest women's university in the world; Bhutan's Education City is envisioned to encompass more than 1,000 acres within the country's capital; the Dantewada Education City will bring major educational infrastructure to a particularly underdeveloped Indian state.

New take on old models

Another more obvious outcome of the financial crisis is that funding models for education have started to shift. In part, this is because long-term bank financing has all but dried up: where projects could once expect to receive 25-year terms, today we rarely see projects secure more than five/ten-year terms. But education infrastructure generally takes longer than this to pay for itself, meaning that project owners will likely be looking at several rounds of refinancing if the current environment persists. We have, however, seen some progress being made in attracting institutional long-term funds (from pension funds and insurance companies) into the market, and these sources of finance could be vital in future to providing longer term capital.

None of this is to say that PPP models are not still effective approaches to fund and operate education projects. The UK continues to follow a PPP model in financing its planned school investment program and universities often use PPP structures; the US is just starting to move forward with a raft of PPP projects in the sector (see The Yonkers, New York Schools PPP project highlighted on page 22); Brazil and Puerto Rico have also both recently announced new PPP projects.

Looking forward, it seems clear that – while some dramatic changes may be underway – the education sector will continue to provide opportunities: refocused schools and higher education projects in the mature markets; a steady growth in new school development in emerging markets; and even a number of significant new mega-projects in the form of new university campuses and education cities around the world.



Healthcare





Royal London
Hospital, United
Kingdom



Featured Project

Royal London Hospital

United Kingdom

By John Kjorstad, Infrastructure Journal



The 2012 summer Olympic Games near Stratford, the Queen’s Diamond Jubilee celebrations along the River Thames, and the opening of the new Royal London Hospital at Whitechapel – London’s long-neglected East End is having a year to celebrate.

Steeped in history, the true grit of the British capital has been shaped by centuries of immigration. From French Huguenots in the 17th century to the Bangladeshi-Sylheti community in the 20th, new arrivals in the United Kingdom often find themselves living on the city’s eastern fringe, where the Royal London Hospital has been treating patients for more than 250 years.

While its age and history may be impressive, the Victorian-era hospital that began the new millennium 12 years ago has clearly struggled to cope with the demands and expectations of modern 21st-century healthcare. As a result, Barts Health NHS Trust initiated a £1 billion Public Private Partnership (PPP) that included upgrading two historic hospitals over a nine-year construction period.

Taking care

One of the judges familiar with the scheme mentioned that this huge project was quite controversial at the time it was mooted, because it was lumped in with the St Bartholomew’s Project Finance Initiative (PFI)

“The two-site redevelopment is arguably the UK’s largest and most complex PFI hospital project”

project. Having overcome some significant planning challenges, there is no question that the facilities at this historic hospital have now been brought up to a very high standard.

The £650 million redevelopment of the Royal London specifically, is an intriguing case study on preserving a long and illustrious past, yet delivering the kind of world-class facility one would expect from a leading global city. The hospital now occupies an area equivalent to 40 soccer pitches and its level of diagnostic care has been doubled. It is home to London’s air ambulance and a leading trauma and emergency care center. It also houses a range of specialist centers including one of Europe’s largest renal services and a dedicated Women’s Center and Children’s Hospital.



The sheer scale of the new Royal London Hospital (main picture) is evident as it dwarfs the housing around it, the Gherkin (below) in the distance, and (below left) the statue of Queen Alexandra (wife of Edward VII)

Capital Hospitals, a consortium owned by Skanska, investment group Innisfree and the Dutch Infrastructure Fund, won the concession in 2003 and financed the PFI in 2006. The two-site redevelopment is arguably the UK’s largest and most complex hospital project under the PFI, as well as one of Skanska’s largest construction contracts ever.

Social impact

The architecture features a cluster of interconnected blue, white and grey-colored contemporary glass buildings, including two 17-storey towers and one ten-storey tower. It is at once sympathetic to the hospital’s historic buildings, while adding to the modern architecture of an area that includes the iconic 30 St Mary Axe (designed by Sir Norman Foster and known locally as the Gherkin).

The new hospital opened its doors in March, but won’t fully be completed until 2015. The facility is totally sealed. Windows do not open, and it is fully ventilated with fresh air. This helps control infection and makes the hospital easier to clean. Patient areas are located on the outer side of the building to maximize light. Clinical functions are located in the center; offices and stores at the back.

Forty percent of the planned 990 beds will be single rooms with en-suite facilities. The remainder will be “light-and-airy” four-bedded bays. Friends and relatives of severely ill patients will be able to stay in

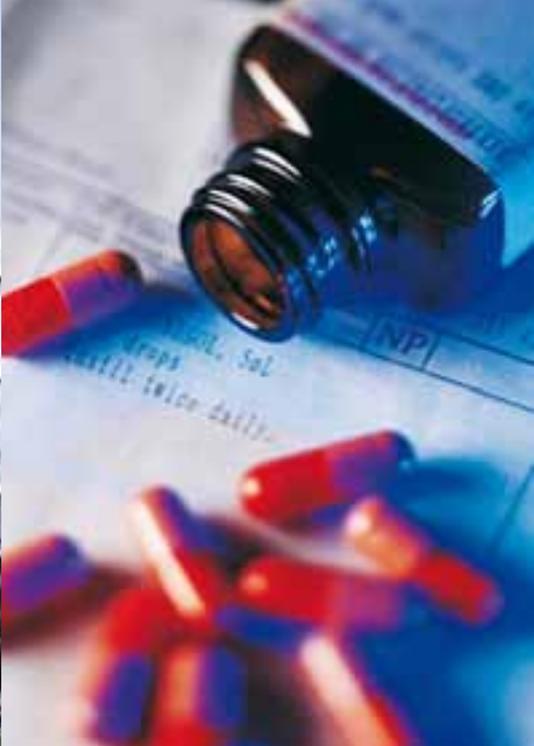
overnight rooms located close by. The 26 operating theaters are a third larger than in the previous facility, and a state-of-the-art cardiac center will open in 2014. Combined with the Barts Cancer Center at St Bartholomew’s (the second of the two hospitals being converted), the managing Trust will have converted two of Britain’s oldest hospitals into “cancer and cardiac centers of excellence” through a single PFI project.

While those reasons alone are enough to warrant the project’s inclusion in the *Infrastructure 100*, the hospital’s social impact

in an urban environment and the investment going into the East End also makes it stand out. The redevelopment has not only ensured that some of London’s most deprived communities have access to state-of-the-art healthcare facilities, but it will see 4,000 staff members move into the new building, providing an economic boost to the area around Whitechapel.

At the same time, the new Royal London delivers a hospital that the whole city can be proud of, and one that the whole of the south east of the country may benefit from. ■







Leaders in the field

Visions for provision

The changing nature of healthcare means that patients not only rely on skilled doctors and new technology for recovery, but providers are now acutely aware of the links between physical infrastructure, the built environment, psychology and healing.

Cities embracing public-private partnerships were endorsed by judges with a number of different projects being funded using this model. The **New Physical Medicine and Rehabilitation Hospital** in Kuwait, for example, was selected for being the country's first pilot healthcare Public Private Partnership (PPP) project. Financing the hospital is set to be a pathfinder transaction for a country increasingly turning to project finance to fund its growing public infrastructure needs.

The new physical medicine and rehabilitation hospital scheme involves a design-build-finance-operate-transfer model for a 500-bed hospital on the existing hospital site in the Al Andalus area in Kuwait City. Overall the project falls under the country's planned overhaul of the Kuwaiti healthcare system under a five-year development plan from 2010-2014.

Turkey is also getting in on the PPP action with its own pathfinder project in the industrialized central Anatolian city Kayseri. The US\$586 million **Kayseri Integrated Health Campus** will be the country's first ever healthcare PPP featuring a 1,048-bed general research and training hospital, a 200-bed rehabilitation hospital, a 200-bed

psychiatric hospital and a 100-bed high-security criminal psychiatric hospital. The hospital is being procured under the Turkish Ministry of Health's Health Transformation Program and is a welcome sign for a dynamic new and emerging market for PPPs.

Moving to Latin America, the new **Bahia Suburbio Hospital** in Salvador is also the first public-private partnership in the healthcare sector in Brazil. The PPP was enabled by the International Finance Corporation and the government of the state of Bahia to dramatically improve emergency hospital services in one of the country's most underserved urban districts.

Elsewhere in Bahia, the **Integrated Health and Water Management Project** supported by the World Bank was highly praised by the judges and singled out for critically addressing the need for clean water and sanitation. The impact of this project will be felt by at least 10 selected municipalities most affected by infectious intestinal diseases. Crucially, the project will vastly improve neonatal care in 25 hospitals reducing the infant mortality rate.

Another healthcare scheme that impressed judges was the US\$120 million **Queen Mamohato Memorial Hospital** in Lesotho, a small landlocked country surrounded by South Africa. This is a landmark healthcare project in Sub-Saharan Africa and was built to replace the deteriorating 450-bed Queen Elizabeth II Hospital in the capital city Maseru. Another torchbearer for PPPs, the scheme promises to transform healthcare services and will be the ►

The projects

New Physical Medicine and Rehabilitation Hospital
Kuwait

Kayseri Integrated Health Campus
Turkey
(pictured bottom right)

Bahia Suburbio Hospital
Brazil
(top left)

Integrated Health and Water Management Project
Brazil

Queen Mamohato Memorial Hospital
Lesotho

Victorian Comprehensive Cancer Centre Project
Australia
(center)

IIUM Teaching Hospital
Malaysia

Rush University Medical Center Transformation Project
United States of America

New University of Michigan C.S. Mott Children's Hospital
United States of America

The Royal London Hospital
United Kingdom



“Judges were impressed by large research hospitals that take healthcare to a different level”

country’s main public hospital with 390 beds and clinical and non-clinical services supporting two million people.

Beyond the provision of basic health services, judges were also impressed by large research hospitals that take healthcare to “a whole different level”. The US\$1 billion **Victorian Comprehensive Cancer Centre (VCCC)** in Melbourne, Australia will create an alliance of leading clinical and research organizations to drive the next generation of improvements in the prevention, detection and treatment of cancer. According to the judges, VCCC is to be praised for its innovation and leadership in cancer care. Once complete, it will become one of the main centers contributing to cancer research.

The Victorian Comprehensive Cancer Centre is set to have the largest concentration of cancer clinicians and researchers in the southern hemisphere, ranking it among the top 10 cancer centers in the world. It will be a center of excellence that facilitates the rapid translation of groundbreaking discoveries from ‘bench to bedside’, attracting the best and brightest researchers and clinicians, and drawing international investment and research collaborations.

Like some of the other inaugural healthcare PPP projects, Malaysia’s **IIUM Teaching Hospital** in the city of Kuantan on the coast of the South China Sea is another project that can be considered a pathfinder for the country to benchmark itself against the rest of the world. It combines the positive social benefits of basic healthcare provision with medical education. The hospital will offer treatment and teaching in a range of specialist areas, including cardiology, neuroscience, obstetrics, gynecology and oncology, among others.

In the United States, the **Rush University Medical Center Transformation Project** in Chicago and the **New University of Michigan C.S. Mott Children’s Hospital** are both extensions of existing facilities, but are

important as they represent the new approach to building care facilities with not just patient welfare in mind but also the environment.

The new 14-story Rush building – with a ‘green’ rooftop water harvesting system – has been designed by renowned Chicago-based architect Perkins+Will and is set to be the first healthcare project in the world to receive LEED gold certification. Another unique feature is the McCormick Foundation Center for Advanced Emergency Response – the country’s first facility for mass care of casualty patients in the event of a chemical, radiological, or biological disaster.

Across Lake Michigan, the new C.S Mott Children’s Hospital in Ann Arbor is offering the “same extraordinary medicine” in a “new extraordinary building” which has achieved LEED silver certification. The hospital already offers one of the country’s leading pediatric care facilities, the Von Voigtlander Women’s Hospital and a center for adult and pediatric bone marrow transplants.

The final project chosen by the judges is perhaps the most well known, if not politically controversial. **The Royal London Hospital** at Whitechapel in the United Kingdom is one of the oldest operating healthcare facilities in England. The Victorian-era hospital – often associated with the grittiness of the capital’s East End – was redeveloped and funded through a £1.1 billion PFI that has since put fiscal pressure on the local NHS Trust.

Following its redevelopment, the new hospital reopened its doors in March 2012 and is now one of Britain’s largest, most advanced healthcare facilities. The new hospital has 1,248 beds, an increase of 186 on the previous facility, with over 40 percent in single rooms with en suite facilities. Wards are light and airy with natural ventilation and separate areas for women and men, and the 22 operating theatres are one-third larger than their predecessors. ■

KPMG's view

Community matters

By **Matthew Custance**, KPMG in the UK

The world of healthcare infrastructure is evolving rapidly. In the developed world, we are witnessing a dramatic increase in demand for health services which is largely being driven by rising patient expectations, shifting demographics and aging populations. In the developing world, the combined forces of urbanization and a marked increase in universal health coverage are putting renewed strain on already-stretched health systems.

As a result, the health infrastructure sector is also encountering a significant change in both the type of projects and services being procured by health systems and, with it, their funding and financing structures.

Health system rebirth

Across the spectrum, healthcare infrastructure is experiencing somewhat of a rebirth and health systems around the world are now facing two distinct challenges: 'pains of old age' or 'growing pains'.

In the more mature markets of North America and Europe, the pressure of aging populations and demographic shifts has led many governments and health systems to focus either on the renewal of existing infrastructure or – more predominantly – the decentralization of healthcare delivery into the community. In part, this trend has been catalyzed by the recent introduction of new approaches such as telehealth or telemedicine which – enabled by cloud computing and IT advances – is fundamentally changing the existing healthcare delivery model.

As a result, some of the most significant infrastructure challenges in these regions relate to the need to rationalize many of the massive assets currently on the books, either by scaling them back or redirecting their use away from those services which can be better delivered in community-based facilities.

While the drivers for change in the developing world are somewhat different (rapid urbanization and the extension of universal healthcare), the change in infrastructure delivery is no less pronounced. Looking at recent announcements of planned hospital developments in areas such as the Middle East, Eastern Europe, Africa, Asia and Latin America, it seems clear that a massive program of development is now underway.

For example, Turkey plans to build between

“In the Middle East, Eastern Europe, Africa, Asia and Latin America, a massive program of development is now underway”

15 and 30 hospitals, some in excess of 1,000 beds; South Africa has more than five new replacement hospitals in the pipeline; Romania has six government-funded projects and up to 20 local government projects on the books. And programs currently being mooted in China and India may well dwarf these announcements by a long shot.

However, there are clearly signs that Public Private Partnerships (PPPs) in healthcare are moving from what has largely been a very well understood and defined procurement model with clear risk transfer approaches to instead embark on an era of locally-managed estates procurement that often embraces a new array of models such as joint ventures and leasing arrangements.

Approaches to health finance

The eventual success of many of these programs is going to be entirely dependent on the ability of governments and system administrators to find sustainable sources of long-term finance. It is clear that the global financial crisis and in particular the current European Sovereign crisis is putting a huge strain on the project finance bank market which is under regulatory pressure and may prevent long term lending (for example above 10 years). In turn, this will start to influence the way policy makers approach healthcare funding, with some now exploring the potential of offering some form of value/debt underwrite or other medium-term assurance that can unlock the bank's ability to offer shorter-term funding that can be more easily refinanced at a later time.

With public-private partnership models coming under greater pressure and scrutiny in the sector, we have started to see a significant move towards new approaches. For example, there has been a growing interest in structures that essentially wrap together infrastructure with clinical services to increase innovation,

cooperation and accountability between the construction contractor and the operator (Portugal, for one, has evidence of success in this area).

However, this approach, which makes sense in terms of delivering value, may be derailed by the growing risk aversion of funders (principally banks). With banks facing increasing pressure from regulation and restrictions on risk, bundling the risk of operations into construction risk will raise project risk profiles above the long-term funding appetite for most banks, regardless of the value delivered to governments and investors.

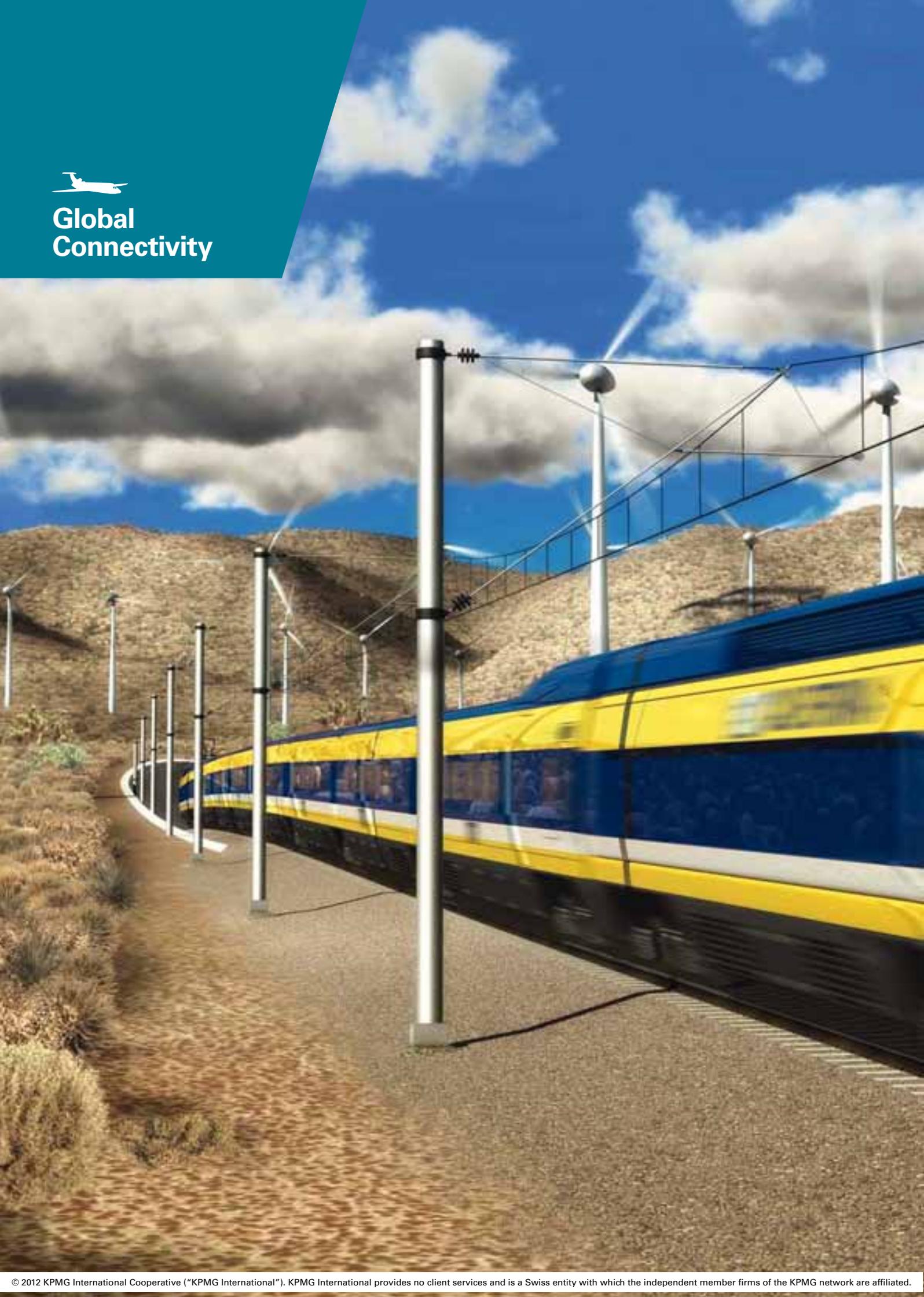
Of course, a number of governments, particularly in the emerging markets in the Middle East and Asia, are choosing instead to fund fully the development of health facilities without the assistance of international investment or private finance. Eventually, China will likely lead this trend as the country strives to bring basic health services to large swaths of previously under-served populations, even while Royal or Government-backed funds are largely financing developments in places like Saudi and Jordan.

Taken together, these rapid and transformational changes in the health sector have led to a turbulent yet exciting time for the infrastructure development community as growth moves into new markets, redevelopment takes hold in more mature jurisdictions and finance continues to muddle on in the face of increasingly restrictive regulation.

What is clear is that – while opportunities certainly exist in markets around the world – infrastructure developers, governments and system administrators will need to change their approaches to infrastructure development dramatically if they hope to meet the growing demand for health services.



Global Connectivity







Featured Project

Delhi-Mumbai Industrial Corridor India

By **James Kenny**, Infrastructure Journal

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With an exploding population of around 1.3 billion, India is becoming increasingly reliant on large-scale transport. In addition it is becoming increasingly clear that the country needs to spread out its economic activity to shoulder the weight.

The Delhi-Mumbai Industrial Corridor is the largest infrastructure project India has ever undertaken and is influenced by the Chinese model of transit-orientated activity. The corridor will cut across the country, linking the nation's capital Delhi with the financial capital Mumbai. The project has an influence area of 320 million people, with plans to include a high-speed rail line for freight, a six-lane expressway and a 4,000MW power station. The long-term aim of this strategy is to develop centers of industrial production along the length of the corridor, including nine industrial zones and 24 new cities.

At an estimated cost of US\$90 billion, the vision is to create a globally competitive



“The long-term aim is to develop centers of industrial production along a corridor, including 24 new cities”

with the towns alongside the corridor being built in as environmentally friendly a way as possible. It is also hoped that the corridor will strengthen the country’s utilities; electricity and water shortages are among the biggest problems facing India. Green cities will have optimized power supplies and 24-hour access to water. They will also have waste and water recycling plants. Japan is expected to provide energy-efficient technologies and expertise to help make the cities as sustainable as possible. Preparatory work for seven of the 24 cities has already begun, with Gujarat set to be the first state to undergo an eco-upgrade.

However idealistic its many goals, the project is not straightforward and many challenges do exist. The landscape and structure of India are incredibly complex. Building the corridor will confront many problems from economic and design perspectives, especially as the corridor will be constructed across arid, water-deficient and agriculture-dependent areas.

It will be the first time that the country has built a new city from scratch since the creation of Chandigarh in the 1950s. This is a daunting and difficult task to get right, as similar developments around the world have resulted in ghost towns with low occupancy.

However, India needs urban expansion. A massive rural-urban migration is changing the face of the country’s cities, which are currently bursting at the seams. The problem is likely to escalate, with an estimated 350 million people moving to urban areas over the next two decades.

Employment revolution

The lasting impact that a successful industrial corridor would have on the country could be as significant as the development of the Interstate Highway System in the United States or the Trans-European Rail Network in Europe. Global connectivity is about facilitating trade and commerce, making this project vital for India and its future.

This is what truly impressed the judges the

most, with one remarking that the: “sheer size of the project and the impact it will eventually have cannot be imagined right now. The kind of urbanization India is going through is massive, with almost 400 million people expected to move to urban centers in the next 35-40 years. It’s a huge migration and the existing cities and towns are already overloaded, so the creation of new cities and neighborhoods are very important.”

“Along with this is the need to create 300 million new jobs in the next 25 years,” he added. “The corridor addresses these challenges in an elegant way so that both a place to live and work is created.”

In essence, the Delhi-Mumbai Industrial Corridor is all ten sections of this publication combined into a single, highly ambitious effort. If the country can deliver, it will be an impressive achievement. ■

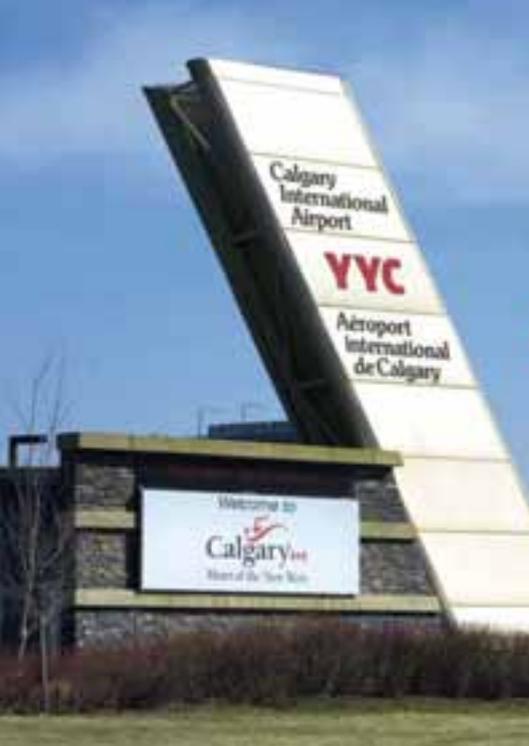
business environment with state-of-the-art infrastructure that will facilitate both local commerce and foreign investment. The corridor has already received a boost from Japan, which has inked a deal with India to invest US\$4.5 billion. As its top three goals for the corridor, India hopes within five years to double employment potential, triple industrial output and quadruple exports from the region.

Massive migration

Logistically, the project will pass through six states – Uttar Pradesh, the National Capital Region of Delhi, Haryana, Rajasthan, Gujarat and Maharashtra – with terminals at Dadri in the National Capital Region of Delhi and Jawaharlal Nehru Port near Mumbai. The corridor will be equipped with an array of infrastructure facilities such as a dynamic power grid and rail connectivity to ports.

As well as its more practical elements, the project is also aiming to be completely green,





Leaders in the field

Joined-up thinking

Global connectivity encapsulates transport infrastructure that allows cities to link and interact with each other through road, rail, sea and air travel. More and more, these projects have a major economic as well as social impact on the cities and regions in which they're based.

The **Ethiopia Djibouti Railway** is part of Ethiopia's ambitious plans to develop national railway infrastructure and is notable for its sheer scale and for the significant positive impact that it could have on economic growth in the Horn of Africa. The 656 kilometer line will connect Addis Ababa, the Ethiopian capital, with the tiny Red Sea state of Djibouti. The US\$1.2 billion project would have huge economic significance for landlocked Ethiopia as Djibouti represents the country's only seaport access and would considerably reduce goods transportation costs.

Another project due to make a major impact on a country is the **Delhi-Mumbai Industrial Corridor** in India. The US\$90 billion project will stretch across seven states and link the nation's capital, Delhi, with the financial capital, Mumbai. The sheer scale and far-reaching impact of the project impressed the judges with plans including a high-speed rail line for freight, a six-lane expressway and a 4,000 megawatt power station. The ambition – which mirrors proven Chinese development models – is to develop centers of industrial production along the length of the corridor. The project plan includes nine industrial zones and 24 new cities. Although there is limited information

about how the corridor will be fully funded, judges viewed it as a unique and ambitious project working towards the twin goals of fostering economic development and generating new centers for urban life.

From new city centers to re-establishing old ones, the next project was described by one judge as a “one in 100 year transformative event” that aims to rethink urban planning and the use of the automobile in a country and state that epitomizes car culture. **California High-Speed Rail** in the United States will reconnect major city centers with point-to-point travel that aims to reduce congestion on roads and at airports. Despite difficult public finances, California is hoping to move ahead with the US\$68 billion project as Governor Jerry Brown's number one infrastructure priority. Once built, trains capable of reaching speeds up to 220 mph will link San Francisco and Los Angeles in as little as two and a half hours.

Equally as important, city centers along the route will be regenerated with an emphasis on public transport. San Francisco's planning commission has approved plans for an ambitious Transit Center District to revitalize the area surrounding the city's proposed Transbay Terminal, which would include a new bus terminal, an extension of Caltrain to accommodate high-speed rail, and a 1,070-foot office tower. Housing is also planned at all levels of affordability, which coupled with new downtown parks and graciously designed streets will shape the future of urban living in the city. The district aims to be a model of ▶

The projects

Ethiopia Djibouti Railway
Ethiopia

Delhi-Mumbai Industrial Corridor
India

California High-Speed Rail
United States of America
(top left)

Medina Airport
Saudi Arabia
(center right)

Pulkovo Airport PPP
Russia
(bottom center)

Calgary International Airport
Canada
(center left)

Embraport Project
Brazil

Bioceánico Aconcagua Corridor
Chile/Argentina

Trans-Sumatra Toll Road
Indonesia

Fehmarnbelt Crossing
Denmark/Germany
(bottom right)

“These projects aim to unlock barriers to trade through new regional economic connections”

sustainability, and a guide to sound economic and job development. Similar schemes are proposed for other major California cities along the planned high-speed route including Sacramento, San Jose, Fresno, Bakersfield, and San Diego.

The growing importance of airports was also highlighted during the judging process. The construction of a new terminal and extension of the existing runway at **Medina Airport** in Saudi Arabia will greatly improve the transportation experience for thousands of religious pilgrims visiting one of Islam’s most important holy cities. From a financial perspective, judges liked that the expansion – which will double capacity from four million people per year to eight – was being project financed through a public-private partnership as it could become a beacon for what the model can achieve with Islamic finance in the Middle Eastern infrastructure market.

Another pathfinder singled out by judges was the US\$1.4 billion **Pulkovo Airport PPP** in St Petersburg, Russia. The project was launched off the back of a new law enabling Public Private Partnerships (PPPs) with a 30-year concession covering the building, financing and operation of airport facilities – including a new international terminal and modernization of the domestic terminal. “As well as being a leading project in Russia,” one judge remarked, “it is also important in that its progress will be keenly watched and its delivery will open up the country for further developments.”

In North America, the US\$1.95 billion expansion of **Calgary International Airport** in Alberta will more than double the size of the airport, and is part of the Canadian government’s strategy to dramatically improve the province’s infrastructure to accommodate recent and anticipated economic growth. The project includes a new 14,000 foot runway (the longest in Canada), an aircraft parking apron, taxiways, a central de-icing facility and an

international concourse that incorporates sustainable design principles.

The only seaport to make the global list was the US\$1 billion **Embraport Project** in Brazil. Based in the city of Santos in São Paulo, the privately-owned port with incorporated road and rail infrastructure is located away from the downtown area. Together with the São Paulo Ring Road project (given honorable mention in the Urban Mobility chapter), the two assets will have a considerable impact easing traffic congestion on land and sea. This will reduce delays and help cargo move more efficiently. Once complete, it will be the largest-ever port project financing in Latin America on a limited-recourse basis.

The final three projects in this section aim to unlock barriers to trade through new regional economic connections. The aspirational **Bioceánico Aconcagua Corridor** project between Argentina and Chile could potentially be a game changer for South America. Considered by some judges to be the region’s most important development in 100 years, the project aims to link the Atlantic and Pacific oceans via Argentina and Chile with a 52 kilometer low-base tunnel through the Andes. The project includes a high-cargo-capacity electrical railway connecting main cities and the major industrial and trade centers of both countries.

Located on the Indonesian island of Sumatra (which was badly damaged during the 2004 Indian Ocean earthquake and subsequent tsunami), the **Trans-Sumatra Toll Road** is a 2,509 kilometer north-south route connecting Banda Aceh to Bandar Lampung. A road traversing the island is urgently needed to boost economic activity. The project will pass through several major cities, including Medan and Padang, and is part of the government’s long-term economic plan which divides the country into six economic corridors; Sumatra will specialize in agriculture and energy.

The 18 kilometer **Fehmarnbelt Crossing** represents the final missing link connecting Scandinavia to mainland Europe. Construction of the crossing is considered one of the European Union’s 30 most important traffic projects and forms part of the Trans-European Transport Network. The preferred crossing is an immersed tube tunnel with an electrified dual-track rail line and a four lane motorway. Like the Bioceánico Aconcagua Corridor, this project will not only improve transport congestion but significantly bolster the economic capabilities of 18.6 million people living in the region. ■

KPMG's view

Networking nations

By **Graham Brooke**, KPMG in Australia

As the world becomes increasingly global, it is clear that cities must offer their citizens and businesses greater connectivity to the outside world. Indeed, the ability to create effective and sustainable global connections is critical to enhancing a city's productivity and competitiveness within today's marketplace.

As can be seen by the list of projects identified in these pages, there continues to be significant activity in the airport sector with a number of new regional airports currently under development. We have also witnessed a marked increase in the quantity of airport privatizations over the past few years as governments look to 'recycle' their capital out of these assets to shore up sagging balance sheets or fund new connectivity projects.

However, airports have also come under significant pressure of late. In London and Sydney, for example, local government clearly recognizes the need to add incremental capacity to its airports but is increasingly being stymied by local populations who are justifiably concerned about the increase in noise, air pollution and traffic related to expanded or new airports.

For its part, port traffic has recovered significantly from the low-tide of the global financial crisis and, today, we are starting to see renewed activity in the sector. Much like the airport sector, many ports are currently in the process of being privatized or refinanced and – in some cases – concessions are coming to the end of their lifespan, resulting in important renegotiations.

But while many ports are feeling the pressure of capacity constraints, it must be noted that these challenges often have more to do with their supporting infrastructure than the need to expand the port itself. City governments will therefore need to place increased focus on the interconnections between their ports and their cities to effectively enhance capacity and throughput. As a result, we will likely start to see a much greater focus being placed on the development of intermodal terminals on

“The adoption of high-speed rail networks will bring about some of the most important changes in global connectivity”

the periphery of both ports and cities. In this regard, global connectivity will be driven by an individual cities' ability to deliver local connectivity.

While there are also a number of impressive railway projects currently under development around the world, it is the adoption of high-speed rail networks that will bring about some of the most important changes in global connectivity within the urban setting. Having proven itself as a viable technology in Europe and Asia, high-speed rail projects are now underway in almost every corner of the world from the Americas to Africa.

High-speed rail also offers cities a practical alternative to building or expanding airports and – in a growing number of cases – city governments have opted to link to airports or ports in neighboring cities using high-speed rail rather than develop duplicate assets within their own jurisdictions.

Challenges ahead

As governments and private enterprise look to improve their cities' global connectivity, there are a number of looming challenges on the horizon that must be overcome. For one, planners must recognize the potential for ongoing economic turmoil in global markets. Given that most airports, ports and railways require high levels of throughput to be cost-efficient, the potential for economic slowdowns must be factored into the cost calculations of any given project.

The need for integrating planning and funding for the various primary and support assets must also be well understood. Indeed,

there is little point in developing plans for a new airport or port without first gaining a clear view of how other connecting assets such as roads or railways are impacted. So, for example, while a port operator may want to expand its facilities, it would need to work closely with the related road and rail owners to ensure that capacity is increased in step, which often leads to complex funding challenges (particularly in instances where one or both are privatized).

Likely the biggest challenge, however, relates to the introduction of carbon pricing in many jurisdictions. On one level, the impact of a carbon price may very well change the economic viability of both ports and airports which tend to emit a significant amount of carbon in their operations. However, on another level, the resulting change in energy sources may also have a massive impact on ports which – in many jurisdictions – are driven by imports and exports of fuel such as coal and oil and the loss of this inbound or outbound traffic may change the economics of ports entirely.

However, regardless of these challenges, the outlook for global connectivity infrastructure looks fairly strong in the medium to long-term. And while much will depend on the aspiration and vision of local and national governments, it seems fairly clear that – to remain competitive and productive in global markets – activity in this sector will continue to grow.



New and Extended Cities





Tianjin Eco City, China



Featured Project

Tianjin Eco City

China

By **Sarah Tame**, Infrastructure Journal



The Tianjin Eco-city in northern China wouldn't be out of place in a sci-fi film predicting a utopian future; man-made boulevards lined with trees, an advanced light rail system connecting the city, its very own solar energy zone, and thousands of jobs on site for its new residents. A city providing a more "liveable" alternative to China's polluted megacities.

As mythical as it sounds, this is no fantasy – the Tianjin Eco-city is under construction and scheduled to be complete by 2020, with the first phase "start-up area" due to be finished in 2013.

The Sino-Singapore Tianjin Eco-city, to give it its full name, is a collaborative effort between Singapore and China, the second government-to-government project between the two countries after the Suzhou Industrial Park. Chinese Premier Wen Jiabao and Singapore Prime Minister Lee Hsien Loong signed a Framework Agreement for the two countries to jointly develop Sino-Singapore Tianjin Eco-city in November 2007.

The idea for the project was originally conjured up earlier the same year as both governments sought to tackle rapid urbanization and increasing global attention on the importance of sustainable development.

Tianjin was one of four sites considered for the project, which the Chinese government required to be built on non-arable land and close to an area facing water shortage. The other possible locations for the project were

in Baotou (Inner Mongolia), Tangshan (Hebei province), Tianjin municipality and Urumqi (Xinjiang).

Greener communities

The site for the Tianjin Eco-city is located 45 kilometers from Tianjin city center and 150 kilometers from Beijing, within the Tianjin Binhai New Area – one of the fastest-growing regions in China. The planned Eco-city has a total land area of 30 square kilometers and when fully completed it will accommodate 350,000 residents. Prior to the development of the Eco-city, the site comprised mainly salt pans, barren land and polluted water bodies, including a 2.6 square kilometer wastewater pond, which will be turned into a lake.

The Tianjin Eco-city is a project driven by strong economic fundamentals and has attracted over 600 companies, including large multinational corporations and Singaporean companies, with registered capital of over RMB 50 billion. The Eco-city aims to be a fully functional community with amenities and jobs located close by. Local and centralized facilities are provided to serve the needs of residents in each neighbourhood and each district will be served by urban centers. The entire Eco-city will have access to key infrastructure services, such as recycled water, gas, broadband, electricity and heating by 2013. At least 20 percent of housing initially available in the Eco-city will be in the form of subsidized public housing.



Tianjin will blend major construction projects with a city-wide focus on sustainability, such as prominent solar power installations (below)

“The Eco-city incorporates extensive vegetation and waterways, forming green corridors around the city”

Business Parks are located close to residential areas to provide employment within easy access of residents’ homes. At least 50 percent of the employable residents should be working in the Eco-city by 2013.

In order to provide a more “liveable” alternative to China’s polluted megacities, the Eco-city has a mandate for “green-ness”. To achieve this, the project’s master planners have requested that green space in the city must equate to 12 square meters per person by 2013 and 20 percent of the total energy on the site must be renewable. The city will have its own solar energy zone and a smart grid test-bed. The design of the Eco-city also incorporates extensive vegetation and

waterways forming a network of green corridors and water bodies around the city.

Tackling transport

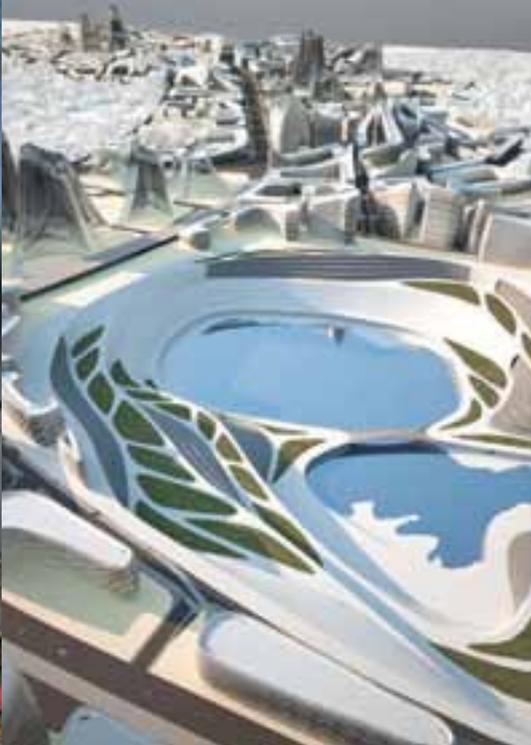
The emphasis on green transport is another key feature in the transport planning of the Eco-city. The aim is to encourage residents to use public transport, bikes or walk when trying to get around the city. Non-motorized and motorized networks will be separated, and priority will be given to pedestrians, non-motorized transport and public transport. The masterminds behind the Eco-city aim for at least 90 percent of trips within the

Eco-city to be in the form of green trips by 2020. The city’s public transport network will include an advanced light rail system.

Rapid urban growth and industrialization in China’s megacities has contributed to a serious air pollution problem in the country. Despite recent improvements, particulate matter is still over five times the levels considered safe by the World Health Organization. The air quality in the Eco-city will aim to meet China’s National Ambient Air Quality Grade II Standard for at least 310 days, and the carbon emission per unit GDP in the Eco-city should not exceed 150 ton-C per US\$1 million. ■



Above: solar panels along Central Avenue, generating renewable energy for the Eco-City





Leaders in the field

Cities of tomorrow

Hoping to rectify the mistakes of old, new cities being built and extended are planned with more care and concern for the surrounding environment. Architects, planners, politicians and economists can now all work together to deliver spaces that promote better urban living for inhabitants.

Located just 20 kilometers north of Doha International Airport, **Energy City Qatar** is a new Middle Eastern business center catering for the commercial, technical and human resource needs of the global hydrocarbons industry. It is set to be the region's first-ever fully integrated business hub for the energy sector. The city has been constructed with sustainability in mind, including solar PV panels, wind towers and passive solar shading. It aims to be the world's first entirely LEED-certified development.

Qatar has stiff competition from its neighbor across the Gulf. **Masdar City**, under development in Abu Dhabi, focuses on sustainability with an ambition to be powered entirely by renewable energy. The city, located in the United Arab Emirates, could be a model for the future. It will host the headquarters of the International Renewable Energy Agency and be home to 1,500 businesses, focusing on low-carbon and sustainable technologies. The city has been designed by British architects Foster + Partners and aims to be the world's first city with zero-carbon emissions, and 80 percent of water recycled.

In the Far East, judges were also impressed with **Tianjin Eco-city** being developed with "practical" technology on challenging arid

terrain in northern China. The city is an ambitious economic collaboration between China and Singapore to pilot a more liveable alternative to some of the country's polluted megacities. Employing an advanced light rail system, solar energy and smart grid technology; promoters of the project hope that Tianjin Eco-city will stand in stark contrast to alleged "ghost cities" – such as Ordos in Inner Mongolia and Zhengzhou New District – that have been rapidly built, yet remain largely uninhabited.

Staying in north Asia, **Fujisawa Smart Town** is a large-scale demonstration project in Japan that could also be a test-bed for future urban living. The town will consist of 1,000 'green homes', with each being equipped with solar power units and fuel cells. Houses will be connected to a smart grid to manage supply and demand with an aim to reduce greenhouse gas emissions by 70 percent compared to a typical Japanese town.

Judges chose to give honorable mention to another Japanese development, the Integrated Resort, Tourism, Business and Backup City. Following lessons learned from the earthquake and tsunami in March 2011, IRTBBC would provide an alternative capital should Tokyo be badly damaged by a similar disaster. The city would incorporate all vital functions of government with duplicate facilities for parliament and ministries as well as commercial and residential properties.

Across the Pacific, **Valle San Pedro** is a charter city and sustainable housing project being built near Tijuana, Mexico. The epic 13,000 hectare project developed by Urbi ▶

The projects

Energy City Qatar
Qatar
(pictured top left)

Masdar City
United Arab Emirates

Tianjin Eco-city
China

Fujisawa Smart Town
Japan

Valle San Pedro
Mexico

Ciudad Verde
Colombia

Tyson's Corner
United States
of America
(bottom right)

Detroit Works Project
United States
of America
(top right)

Kartal Pendik Project
Turkey
(top center)

Kronsberg
Germany



plans to house one million people by 2030. The city is the first certified Integral and Sustainable Urban Development (DUIS) project in Mexico. It claims to be different in that it puts the family at the center of the planning and urban design process.

In South America, **Ciudad Verde** in Colombia should have a major social impact and could be adopted elsewhere if successful. The development involves launching a housing model called *macroproyectos*, which aims to create small cities outside large urban developments – in this case the country’s capital Bogotá. Developers will build 350,000 social housing units in the town of Soacha ranging in cost from US\$20,000 to US\$35,000 each and aiming to accommodate the *desplazados* – a term used to refer to people displaced from rural towns located in conflict areas. Newcomers will have access to a social reintegration program, while the development’s infrastructure includes hospitals, schools and hydroelectric power sources funded through public-private partnerships. Another “very important” aspect for judges is the integrated transportation link connecting residents to Bogotá via the TransMilenio bus rapid transit system.

In the United States two transformational projects were singled out for reinventing existing cities. **Tysons Corner** in Virginia was a sprawling office and retail suburb near Washington D.C. It has been transformed into a green city with revived neighborhoods, sidewalk culture, local employment and local arts. The project evolved from a typical car-dependent, land-consuming suburb to a new urban centre supported by non-motorized and public transportation. Smart land use will help planners reconfigure the city of 17,000 to support as many as 100,000 in years to come.

Once upon a time, Detroit was one of America’s leading cities. With businesses such as General Motors and Motown Records, Michigan’s largest city could pride itself on being a titan of both business and culture. However, a steady decline of its industrial base has burdened the proud city with various social and economic problems – leading to unique infrastructure and municipal services challenges. While most cities in this category are trying to manage growth, Detroit is uniquely trying to reverse its decline.

The **Detroit Works Project** is both a short and long-term planning initiative launched by Mayor Dave Bing to create a blueprint that redefines the physical, social and economic landscape of the city. The project blends the expert analysis of urban planners, economists

and architects with the expertise and ideas of Detroit stakeholders to create a strategic framework for the city that will be used to generate sustainable economic growth, better land use policies, thriving neighborhoods, a healthier environment, improved city systems and infrastructure and increased civic capacity. The strategy focuses on attracting target clusters that bring new job opportunities for residents; zoning reforms that accommodate modern and innovative land uses; and a land use and infrastructure framework for making smarter, more efficient and sustainable investments that help to stabilize and grow neighborhoods and employment centers. The project also seeks to achieve immediate results in three specific pilot areas. Judges recognized the determination and courage of those involved and the work they’ve already done.

In fast-growing Turkey, the **Kartal Pendik Project** will develop a new ‘city center’ east of Istanbul on an abandoned industrial estate. The development, designed by Iraqi-born architect Zaha Hadid, will feature a business district, residential component, retail and a cultural center. The buildings will be designed in Hadid’s distinctive ‘organic architecture’ style, promoting harmony between the natural world and the built environment.

The **Kronsberg** district in Hanover, Germany is a sustainable community that emerged in the late 1990s in connection with the EXPO 2000. It presents a comprehensive example of visionary urban planning and construction. The city has high ecological standards, with buildings offering above-average quality of accommodation and semi-natural open space design. The district represents one of the most advanced settlement programs of its kind in Europe.

Portugal’s PlanIT Valley earned an honorable mention in this category for its ambition to build a sustainable smart city to house up to 250,000 people in Parades, east of Porto. The 17 square kilometer site would serve as a test-bed for sustainable urban technologies – a key feature being an Urban Operating System that receives real-time data throughout the city to manage the optimal and efficient use of resources. ■

KPMG's view

Building smarter

By David O'Brien, KPMG in Canada

Today's urban populations are growing at an astounding rate. By 2050, it is estimated that more than 70 percent of the world's population will live in cities, resulting in an influx of more than three billion people over the next four decades.

Clearly, the world's established cities cannot even begin to absorb this exponential growth without significant change. Indeed, for most cities around the world – particularly within emerging and developing markets – existing infrastructure is already strained to the point of collapse.

In response, many jurisdictions are thinking seriously about how they might either extend their existing cities, or build entirely new urban areas to support the needs of the masses of aspiring urbanites. In India, for example, around 500 new cities will need to be developed over the next four decades, just to keep up with the anticipated rates of urbanization.

Recognizing that cities are key economic drivers for national economies, a growing number of jurisdictions are also focused on developing Special Economic Zones; purpose-built cities designed to service the needs of one or two specific industries in order to create a 'business cluster' that will drive national innovation, enhance employment and attract foreign investment.

But building an entirely new city or extending existing urban areas is a notoriously difficult and complex proposition. Getting it right involves the coordination and planning of tens of thousands of integrated pieces that must be joined together to create a single holistic plan. It is not simply a matter of dropping down roads and sewage pipes and hoping for the best; today's city planners must balance a host of critical components such as infrastructure, services, culture, interconnectivity, transit, energy and employment, in order to create a city that can withstand the growing expectations of an ever-expanding population.

Master planning and keen vision, therefore, are critical. Planners must not only carefully

“In India, 500 new cities will need to be developed over the next four decades just to keep up with the rate of urbanization”

consider and align multiple interdependent requirements, but must also be able to forecast what the city may need 50 or even a hundred years into the future to ensure that the urban landscape is expandable and adaptable to future innovations.

Central to this will be the incorporation of technology into the new city environment. Already, we are seeing the emergence of 'smart cities' that leverage purpose-built technology platforms to achieve greater efficiency and administrative capability. From street lighting and local security to waste water management and power distribution, cities will increasingly leverage new technology to create more livable and environmental ecosystems in which people will want to live and work.

One of the most significant challenges for planners of new cities is creating the optimal balance between employment opportunities and residential development. The simple truth is that people tend to migrate into urban areas to find gainful employment and therefore planners must spend some time understanding how their city might attract the quality and quantity of businesses that would provide an optimum work/live environment.

To achieve this, many local and national governments have started to examine how they might best incentivize business to relocate or start-up within their urban areas. In large part, this is often related to the strength and availability of infrastructure. Manufacturing, for example, requires ports and airports to move their products to market; reliable electricity and water systems to operate their factories; skilled and accessible labor markets to drive productivity; and competitive tax and

regulatory regimes to facilitate market growth and stability. Each of these components must be considered, developed and promoted in order to secure business investment.

Of course, building a new city from scratch, or redeveloping a declining city, requires significant funding to ensure that all of the critical components can be developed according to planning timetables. The involvement of the private sector will be key to this success, as national and state levels of government are themselves financially strained.

The development of new cities carries a sizable demand risk that will require governments to pay considerable attention to how they structure and attract private investment in infrastructure development. In some cases, governments may need to not only offer implicit support to catalyze private investment, but may also need to take a larger role in the development of trunk infrastructure or fully finance certain components that may be economically inviable for private organizations.

Looking ahead, it seems fairly clear that hundreds – if not thousands – of new cities will need to be developed around the world over the next century. Success will largely depend on the ability of city planners to integrate lessons and best practices from existing cities and learn from the mistakes and triumphs of their peers.

In support of this demand, the *Infrastructure 100* is a significant asset: one only need look at inspirational projects cited in this chapter to recognize that the new and extended cities being developed today will almost certainly change the way that people interact with the world around them.



Urban mobility







Featured Project

East Side Access United States of America

By **James Kenny**, Infrastructure Journal



The East Side Access project in New York City is one of the largest public works projects ever undertaken and is set to dramatically change the lives of millions of people upon completion.

The project is the first Long Island Rail Road (LIRR) expansion in over 100 years and will connect its Main and Port Washington lines in the borough of Queens to a new LIRR terminal beneath Grand Central Terminal in Manhattan (at present trains run across town to Pennsylvania Station.) The new connection will not only increase the LIRR's capacity into Manhattan, but dramatically shorten travel time for Long Island and Queens commuters traveling to the east side of Manhattan.

The daunting scale of the project is clearly apparent, with the development including seven miles of tunnels and 24 miles of new track as well as tunnelling and blasting in two boroughs roughly 15 stories beneath Grand Central Terminal. The city's Metropolitan Transportation Authority has taken the lead on the project. Also included in the final plans will be the opening of new stations at Queens Boulevard and Skillman Avenue in Sunnyside.

For many people, nothing is more precious than time and with 160,000 people using the LIRR daily it is expected that East Side Access could end up cutting commuters'

daily journey by up to 30-40 minutes. All of the North America panel judges were aware of the project, with some having personal experience of making the journey into Manhattan from Long Island. One judge exclaimed: "With East Side Access, it is so complex and in such a congested area, it takes guts to build this project.

"Its impact cannot be measured," he added. "If you can shave 40 minutes off people's journey time we're talking about a major breakthrough and it is no longer just transport but a quality of life issue."

Relieving pressure

The project will not just affect commuting patterns, but will also make access to central Manhattan from JFK airport much easier. However, many pundits are concerned that the increased passenger loads will overwhelm the existing IRT Lexington Avenue Line and surface bus routes on the East Side. As a result, city administration has recommitted to resuming construction on the Second Avenue Subway which – it is hoped – will eventually reduce the congestion emanating from Grand Central Station. The East Side Access project is also anticipated to lessen the overcrowding on the E Line service between Pennsylvania Station and Midtown East.



The East Side Access project will relieve pressure on trains into Manhattan. A new terminal below Grand Central (main picture) will echo its stylish passageways (below) and offer extra exits at street level (below left)

“If you can shave 40 minutes off people’s journey time, it is no longer just transport but a quality of life issue”

Having anticipated the eventual need for this project, prefabricated sections of the tunnel had already been put in place back under the East River in the 1970s. However, having faced an earlier financial crisis in the 1980s, the city had stopped work on the extension at 21st Street in Long Island City, Queens. But in the late 1990s, the 63rd Street subway was eventually completed to the Queens Boulevard train connector, paving the way for the LIRR to be extended under 41st Avenue to the west side of Northern Boulevard in Queens.

Working with the community

As is the case with many projects of this size and scope, the plan has raised public concern and anxiety. In particular, the Catholic Diocese had cited the tunnelling work as a potential detriment to the stability

of St. Patrick’s Cathedral. To assuage these fears, the planners adapted the plan to add air vents just south of the Cathedral which has allowed the plan to move ahead.

There have also been significant concerns about the spiraling cost and timescale of the project. It is now estimated that the city will have spent US\$8.24 billion by completion in 2016. This is up from a 2006 estimate of US\$6.3 billion by completion in 2013.

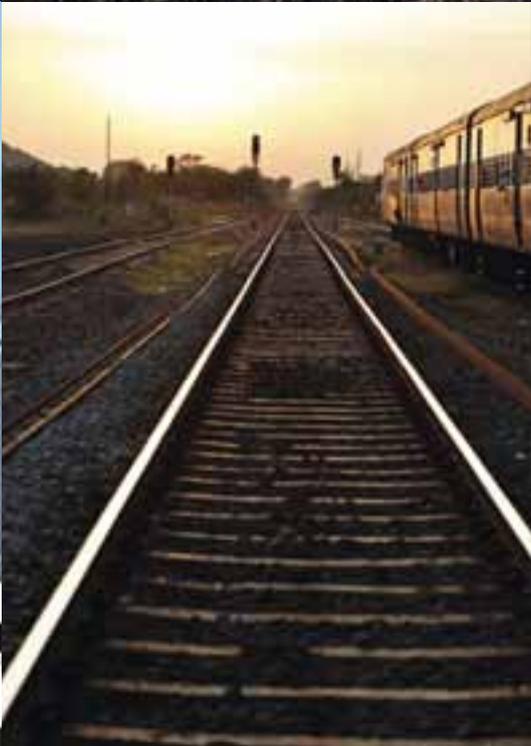
While it is mainly the civil work and digging that has been delayed, progress has been made in other areas with the finalizing of the design for the equipment such as the signal and ventilation system. The floor materials, walls and ceilings have all been carefully chosen in order to make the project cosmetically appealing to customers as well as maintainable and easy to repair.

The days of overspending on infrastructure



in New York, however, have been consigned to the past – in theory anyway. “The era of underestimating the cost of big projects is over,” declared MTA Chairman Joseph Lhota in May 2012. “We will stay on budget.”

Wary New Yorkers will wait and see, but the overall benefit to them of enhanced urban mobility once the East Side Access project is complete will be immeasurable. ■





Leaders in the field

Cities in transition

As the world's populations swell, the need for efficient, cost-effective and green forms of urban transport is a paramount requirement for the smooth running of cities.

The US\$1.1 billion **Bosphorus Tunnel** – or Eurasia Tunnel as it is also known – is an ambitious project being developed as a public-private partnership to connect both sides of Turkey's capital, Istanbul, via a 5.4 kilometer twin-deck tunnel beneath the seabed. What impressed judges most was the asset's aims to ease congestion, cut journey times and stimulate economic growth in the dense environment of one of the world's oldest cities. In addition, the historic project also brings Asia and Europe just a little bit closer together.

In contrast, the **Mersey Gateway** in the United Kingdom doesn't connect continents but offers an equally impressive and desperately needed solution improving mobility and economic growth throughout the Liverpool city region, north Cheshire and the north west of the UK. The Public Private Partnership (PPP) comprises construction of a new 3x2 lane cable-stayed toll bridge with a one kilometer span over the River Mersey between the towns of Runcorn and Widnes. The concession includes construction of associated link roads and the upgrading and tolling of the existing Silver Jubilee Bridge.

In preparation for the 2014 World Cup and 2016 Olympic Games, Brazil is undergoing a huge transformation. **Transolímpica** is

one of the key projects Rio de Janeiro is undertaking to improve the city's public transportation for the Olympic Games. The project involves a 23 kilometer highway with six lanes – three in each direction – connecting the neighborhoods of Barra da Tijuca (home of the Olympic complex) to Deodoro. Two of the tracks will be used exclusively by buses through a Bus Rapid Transit scheme with 18 stations – an affordable transport solution which judges thought could be replicated in other parts of Latin America. Elsewhere in Brazil, Line 4 of **São Paulo's Metro** was the first public-private partnership signed by the state. The new Yellow Line will carry nearly one million people per day. The first section, with six stations, is already operating. When it is fully up and running, the line will be 12.8 kilometers long, with 11 stations connecting Luz downtown with Vila Sônia on the west side.

The **Blue Line of the Lagos Rail network** in Nigeria is another groundbreaking PPP. The project was chosen by judges as not only does it fill a serious gap in transportation infrastructure in the city, but it also displays innovation in its financing structure. Track and station infrastructure is being constructed under design-build contracts funded by the Lagos state government; while trains, control systems, and fare collection will be provided by Eko Rail under a 25-year equip-operate-maintain concession.

Kuwait Metro is a similar PPP that fills an urgent gap in the market. Kuwait City has limited public transport and an overreliance ▶

The projects

Bosphorus Tunnel
Turkey
(pictured bottom right)

Mersey Gateway
United Kingdom
(top center)

Transolímpica
Brazil
(bottom left)

São Paulo Line 4
Brazil
(top left)

Blue Line of the Lagos Rail network
Nigeria

Kuwait Metro
Kuwait
(center left)

Gold Coast Rapid Transit
Australia
(top right)

Jakarta Rapid Mass Transit System
Indonesia

East Side Access
United States of America

Port of Miami Tunnel
United States of America
(bottom center)

Bottom center: view from inside the tunnel



“In preparation for the World Cup and Olympics, Brazil is undergoing a huge transformation”

on automobiles, leading to congestion. The first phase of the US\$10 billion greenfield project includes 50 kilometers of track with 28 new stations. It will be procured in six packages (one for rolling stock, four for infrastructure and one for operations) and have a significant social impact by reducing air and noise pollution. Following subsequent phases, the completed project will traverse 160 kilometers through 69 stations.

In Australia, the US\$1 billion **Gold Coast Rapid Transit** development in Queensland is being watched with great interest. Creatively financed, the scheme is a complex transport PPP that interlocks federal, state and local council funding. To maximize opportunities for local involvement, the project developed a two-stream delivery structure, providing the market with the big PPP it desired and a government-funded early works package underpinned by a series of smaller contracts that could be rolled out quickly to kick-start the struggling local construction industry and inject some much needed capital into the local economy. Stage one consists of 13 kilometers of light rail servicing 16 stations with 14 trams at peak hours.

According to The Brookings Institution, Jakarta ranked 17th among the world's 200 largest cities in 2011; a significant jump from 2007 when it was ranked 171st. The city has seen more rapid growth than Kuala Lumpur, Beijing and Bangkok. With this in mind the judges chose to support the **Jakarta Rapid Mass Transit System** in Indonesia, which is being funded by the Japan Bank for International Cooperation. Although there are several challenges yet to be overcome (and some doubt about the ambitious timelines), the light rail project – being developed in two stages – is so badly needed that, if the current situation persists, the city will come to a standstill by 2020.

In the United States, the US\$8.24 billion **East Side Access** project in New York City

was also held in high regard by the judges and singled out as a project that will not only improve chaotic traffic into Manhattan but also benefit the lives of thousands of commuters as it will shave as much as 40 minutes off daily travel time. The project will route the MTA Long Island Rail Road through new track connections in Queens, new tunnels under Sunnyside Yard, and through the existing 63rd Street Tunnel under the East River to Second Avenue in Manhattan, where new tunnels will curve south under Park Avenue and enter a new eight-track LIRR terminal beneath Grand Central Terminal.

Congestion in the city of Miami, Florida helped spur the over 30-year development of the **Port of Miami Tunnel**. The US\$607 million project was designed to alleviate pressure on the Port Boulevard Bridge, which was the only access route for heavy commercial vehicles using the container shipping terminal. The tunnel is a mixed-use facility, accommodating cruise and cargo traffic and provides a direct interstate connection to and from the Port, reducing travel times and alleviating congestion by diverting traffic away from city streets. The project's construction and eventual delivery is being heralded as a triumph of engineering and city planning, as well as for the successful use of an availability payment PPP procurement model on such a technically complex project.

Another road linked to a port, the **São Paulo Ring Road** (also known as Rodoanel Mário Covas) in Brazil, was given an honorable mention in this category for similar reasons. The project will alleviate pressure in the city center allowing heavy vehicles accessing the port of Santos to navigate around the perimeter, eventually connecting with the Embraport Project mentioned in the Global Connectivity chapter of this edition of the *Infrastructure 100*.

Two more honorable mentions round out this category. **Mecca Mass Transit** in Saudi Arabia and **Florence Tram** in Italy represent two light-rail PPP projects attempting to alleviate traffic and improve access to historic sites. Both projects have to account for dense populations and sensitive archaeology. Phase one of the Florence project is already operational, while Mecca Mass Transit is still in the development stage. ■

KPMG's view

The taming of traffic

By **Mauricio Endo**, KPMG in Brazil

How long do you spend in traffic each week? Almost regardless of where you live or work, there is a fairly good chance your personal urban mobility is constricted by congestion. Road congestion is not only frustratingly inconvenient, but also hugely expensive. By 2025, the UK is expected to lose US\$36 billion in productivity each year due to traffic jams; the US already loses almost twice that amount.

Of course, urban congestion is about much more than just economic 'opportunity costs'. It also has a massive impact on both the quality of life for urban dwellers and the environment in which they live, work and play. As a result, urban administrators and planners around the world are keenly focused on enhancing urban mobility through a range of mass transit solutions.

But urban transportation projects are notoriously difficult to plan and execute. They have long lead times, face huge planning issues, are complex to procure, challenging to operate and usually exceedingly expensive. They promise to make a difference to the lives of millions of people, but they come with the scope to go seriously wrong and potentially even bankrupt a city.

Understanding the cost

Likely the most significant consideration relates to cost. Facing constrained government budgets and competing priorities, many city administrators and infrastructure developers are now exploring a variety of innovative funding approaches. In London, England, for example, the local authority has raised more than £4 billion to fund the new Crossrail initiative through a supplemental business tax. In other cases, governments are developing Private Public Partnerships (PPPs) where the authority procures the infrastructure and underwrites part of the demand risk and private sector partners contribute funding, expertise and operational experience.

However, governments and urban planners must carefully consider the implications of

“Urban transport projects promise to make a difference to the lives of millions, but they come with the scope to go seriously wrong”

their financing choices. The simple truth is that few people are willing to spend a larger proportion of their personal budgets on daily transport, so any mass transit solution must stay focused on providing a financially competitive alternative to car and road use.

Planning authorities may also find that their choice of potential urban transport projects is limited by two other important factors: land and time. Land acquisition is a frequent challenge for established cities as the development of new mass transit systems often involves protracted negotiations to secure appropriate land usage rights.

Another challenge relates to the long lead times required to develop many mass transit solutions such as metros or light rail projects, which can often take up to a decade to fully execute. As a result, there is significant interest in solutions that can be quickly brought to fruition such as Bus Rapid Transit systems which, by making better use of existing road infrastructure, can often be deployed in a matter of months rather than years.

Building a value network

Another key success factor for urban mobility projects is their ability to interconnect with alternate forms of transport that, together, can provide 'door-to-door' service to local residents. For example, the São Paulo Metro PPP plans to integrate into the regional and intercity bus terminals to effectively extend the footprint of transit options across a wide region. The Gold Coast Rapid Transit project in Australia also envisions a complex set of interconnections with roads, pedestrian walkways and other forms of public transport.

Similarly, urban planners will want to ensure their mass transit systems interface with available global connections within the city such as airports, high-speed rail or regional railways. This will not only enhance the value of the system to the city's inhabitants, but will increase the individual value of each infrastructure asset connected into the network by enhancing usage and – as a result – revenues.

Focusing on connectivity

Recently, a small but growing number of cities have begun to look at their urban transport plans through a different prism that starts with the recognition that the way that mass transit delivers value to a city is through creating more efficient connections between business, labor markets and consumers. And as a result, these cities are now taking a much wider view of the value of mass transit which, in turn, is radically changing the way they prioritize and select their transit options.

Take, for example, a roads project that connects an industrial development to a new port project: viewed as an isolated project and measured solely by time saved in traffic, the road would be hard to justify. But when one combines the economic benefits of delivering products to export markets with the increased throughput of the port and the potential for job creation, it becomes blatantly clear that the road actually provides exceptional value.

Looking ahead, it seems that the sector can anticipate significant growth in the market as more and more cities start to look at urban transit as an economic, environmental and cultural priority rather than simply a set of roads projects.



Urban Regeneration







Featured Project

Oresund Regional Development

Denmark and Sweden

By **René Lavanchy**, Infrastructure Journal



The Oresund region comprises the Danish island of Zealand, home to the capital Copenhagen, and the Skåne region of south-western Sweden, home to its third city, Malmö. It contained 3.7 million inhabitants, over one-fifth the combined populations of the two countries, in early 2010.

In the 1990s, mainly led by the administrations of the Copenhagen capital region and the city of Malmö, it was recognized that the region makes sense as an economic proposition. A regional political association for collaboration – known as the Oresund Committee – was set up to support development and regeneration of the region, specifically of a joint multi-nodal employment district, a research and education centre, and a transport hub.

Improving connectivity via transport is central to enabling the Oresund Committee's regional development plans. In July 2000 the Oresund Bridge was opened – a permanent link across the Sound of Denmark and Sweden. Traffic figures for the bridge are impressive and indicate there may be strong demand for additional regional infrastructure development programs that support more integrated lives – combining improved access to work, culture, nature and social services – for citizens on both sides of the Sound. Sweden and Denmark have a combined population of 15 million, but the number of travelers across the Oresund has risen from just over 25 million in 2001 to 35.6 million in 2009, according to data compiled by the public sector-funded Oresund Trends

agency. Of this, passenger rail traffic across the bridge more than doubled from 4.9 million to 11.1 million. This traffic demand is particularly important if future crossings, like the Oresund crossing, are to be funded through user charges.

The next confirmed major infrastructure project to benefit the region will be the Fehmarn Belt Fixed Link. This planned tunnel will link Zealand to the German mainland via the Danish island of Lolland and the German island of Fehmarn, by means of the world's longest immersed tunnel: 19 kilometers long, of which 17.6 kilometers will be underwater, carrying a four-lane motorway and two-lane railway in two separate tubes.

The project is expected to cost US\$6.9 billion in 2008 prices and will be undertaken by the Danish government-owned company Femern A/S, with debt guaranteed by the government and funded through tolls. Procurement of construction is expected to begin in September 2012, in parallel with the Danish environmental impact assessment process and after parliamentary approval. When the link opens, an average of 8,000 vehicles a day are expected to use it in the first year, rising to 10,800 in year six.

Future proofing

In the next 20 years, the Oresund Committee wants to see further regeneration of the region through improvements in connectivity. Rail connections will play a central role. One of the key pieces of infrastructure to open the region

Construction in Copenhagen (main picture) is inspired by recent projects in Oresund including Copenhagen Opera House (below) and the Turning Torso skyscraper in Malmö (below left)



“Infrastructure has created a genuine cross-border economy and placed many more people in reach of public transport”

to the Danish and Swedish national rail networks has been the US\$1.16bn Malmö City Tunnel, which finally opened in December 2010. This tunnel, and the accompanying rail links, have transformed Malmö’s central station from a terminus to a through station and allowed an entirely new underground station to open at Triangeln. The cross-Oresund rail line is now better connected to lines south of Malmö, the city’s rail passenger capacity has increased and Triangeln station has made the city center more accessible to the regions.

The IBU-Oresund project, launched by the Oresund Committee and working in partnership with local and regional administrations, presented a series of recommendations in a 2010 report which have generally been accepted by the committee and for which it is now trying to attract support from all levels of government.

The report particularly highlighted rising traffic levels on the Oresund crossing, which have put its capacity under strain within a decade of its opening. Passenger trains are expected to run every ten minutes, but freight traffic has been

on the rise. The solution proposed is a fixed road and rail link between Helsingborg in Sweden and Helsingør on Zealand, about 40 kilometer north of Copenhagen. The project could help to redress the balance between rail and road freight: despite the Oresund crossing, 75 percent of all freight through the region was transported by lorry in 2010, according to IBU-Oresund. The Swedish government and regional governments on both sides are thought to strongly support the fixed link.

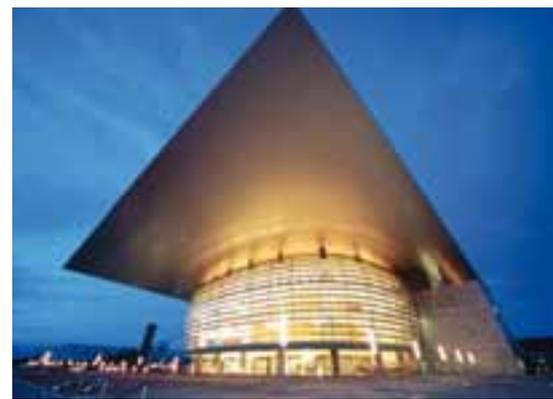
Other, longer-term projects being lobbied for are the development of Copenhagen Airport into an international hub so that it can act as the center of a high-speed rail network through the region; the establishment of multi-modal freight terminals through the region, starting with the main ports (Copenhagen-Malmö, Trelleborg, Roskilde, Køge) and a metro link between Copenhagen and Malmö.

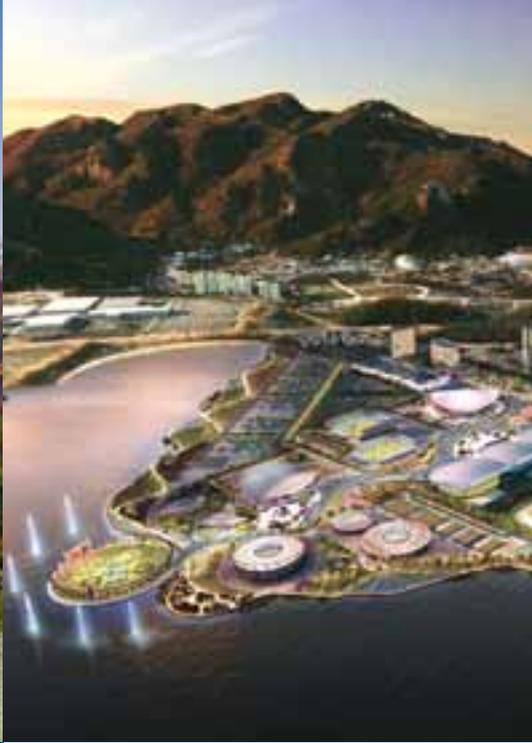
Coming together

Infrastructure developments to date in the Oresund region have created a genuine cross-border economy and placed much greater

numbers of people within easy reach of public transport. The number of commuters between Denmark and Sweden has risen from 2,000 a day to 20,000 in the decade since the crossing opened, and 10,000 Danish citizens now live in Malmö. Copenhagen’s large service industry has absorbed eight percent of all Swedish young people aged 18 to 24.

The joint harbor board of Malmö and Copenhagen has performed better since its formation in 2001 than its predecessors did separately. In 2013, construction will begin on the European Spallation Source, a neutron scattering laboratory to be sited in Lund with data processing facilities in Copenhagen. Joint support from both countries led the Swedish bid to prevail in 2009. The US\$1.9 billion project will help to establish the Oresund region as a center of cutting-edge scientific research. ■





Leaders in the field

Designed for living

The regeneration of cities and creation of green spaces to offset hectic urban living is an extremely important issue and one that is being embraced worldwide. From well-known public spaces such as the World Trade Center in New York City to small local communities in England, the projects in this sector were diverse in their attempts to create more tranquil living conditions and regenerate what was once in a state of disrepair.

The two North American projects chosen by the judges were each unique in their own way, one capturing the sober emotion of tragedy and the other impressing with its sheer scale. The **World Trade Center Redevelopment** in the United States involves the regeneration of Ground Zero and reconstruction of the World Trade Center in the aftermath of the 9/11 attacks on New York City. The development has attracted controversy since its inception, with some people questioning if redevelopment of Ground Zero could, or indeed should, be attempted. Redevelopment is now underway, and is aiming to turn the 16-acre area into a vibrant commercial district and a memorial to those who lost their lives. The 104-floor skyscraper One World Trade Center is currently nearing completion, and three more commercial towers are planned.

The **Toronto Waterfront** project in Canada is a US\$17 billion development that has been planned for 25 years and is perhaps the largest regeneration project in North America. The revitalization is concentrated on

Toronto's central waterfront, an area of 800 hectares of largely underutilized land located steps away from the country's largest financial and cultural urban core. Once it is completed, the waterfront will include 40,000 new residences (20 percent of which will be affordable housing), 40,000 new jobs, new transit infrastructure and 300 hectares of parks and public spaces.

In the Middle East and Asia, where green space is at a premium, urban regeneration has become a key component for governments as they attempt to bring urban living into the modern age.

The **Abu Dhabi 2030: Urban Structure Framework Plan** is set to revitalize the city's Shahama and Bahia areas. It is possibly the largest and most comprehensive urban regeneration masterplan in the region, and it will ensure that Abu Dhabi's next phase of physical and economic growth takes place in a sustainable and competitive manner. The plan aims to turn the central district into a "liveable and modern Arab capital," which will encourage citizens to use public transport or walk rather than drive cars in what is already a heavily congested and polluted city. Seven axis corridors, each representing one of the seven Emirates, will lead into the central business district. Monuments and buildings of national importance will be built along these roads, and a federal precinct will be created to house national government buildings.

Not far away, the **Bahrain Social Housing** project is another pathfinder Public Private Partnership (PPP) for the country and the ►

The projects

World Trade Center Redevelopment
United States of America
(pictured bottom left)

Toronto Waterfront
Canada
(center left)

Abu Dhabi 2030: Urban Structure Framework Plan
United Arab Emirates
(top right)

Bahrain Social Housing
Bahrain
(center)

Sabarmathi Riverfront Development Project
India
(bottom center)

Gardens by the Bay
Singapore
(top left)

Rio Olympic Park
Brazil
(top center)

Porto Maravilha
Brazil
(center right)

Oresund Regional Development
Sweden/Denmark

Scotswood Urban Regeneration
United Kingdom

“Gardens by the Bay is part of a project to turn Singapore from a ‘Garden City’ to a ‘City in a Garden’”

wider Middle East. The development spans three sites and will involve the procurement of 4,100 units over a period of three and a half years. In a country recently scarred by violence and civil unrest, it is hoped that effective social housing can alleviate social tension as well as housing shortages to bring back some stability and balance to Manama.

In India, where waterfronts have been badly neglected, the **Sabarmathi Riverfront Development Project** is an urban regeneration and environmental improvement initiative currently under way in Ahmedabad, Gujarat. It involves the reclamation of a 10.5 kilometer stretch of the banks of the Sabarmathi River, creating a new public space for cultural and civic institutions. Along the river, space will be made for recreation use and markets. The aim is to transform the stretch of river from a geographical divider in the middle of the city to a focal point for leisure and recreation.

Singapore’s social values are as impressive as its civic works as the city ploughs time and resources into enhancing the greenery and flora of a city where land is both scarce and highly valued. The inspirational **Gardens by the Bay** is major urban development which forms part of the wider Marina Bay project, aiming to improve the quality of life for residents by providing green space within the city. Spanning 101 hectares, the project is an integral part of a strategy by the government to transform Singapore from a ‘Garden City’ to a ‘City in a Garden’.

In Brazil, the influence of the upcoming 2016 Olympics and the 2014 FIFA World Cup is felt in two of the country’s regeneration developments – both ambitious PPP projects that will not only enhance the country economically but also influence the quality of life for its residents.

The futuristic **Rio Olympic Park** in Rio de Janeiro will be the focal point for the 2016 summer games and involves an area of 1.6

million square metres. From a waterside park to the athlete villages, regeneration includes permanent and temporary facilities to support the Games. Controversially, the development will evict 4,000 people from Vila Autódromo, a decades-old squatter settlement on the site. As part of the deal for the development, the winning consortium will build new housing for the displaced with the aim of improving their living conditions; however, some resistance continues.

Also in Rio, the **Porto Maravilha** project has been mooted for more than 30 years and will redevelop large areas of the port district in time for the 2016 Games. Development will focus on residential and commercial properties, with the landmark Pier Mauá set to become the focal point of a major new leisure complex. Infrastructure improvements will include new sewage, water, electricity, telephone and piped gas networks. Transportation links will also be improved as tunnels, on-ramps, bike lanes and bus stops are constructed, and the Mount Providência rail tunnel will be expanded to include road traffic. The PPP contract will include maintenance and conservation services for the public roads over the next 15 years.

From one city with two major projects, to two countries focused on one shared vision. The **Oresund Regional Development** creates a cross-border economic zone between Sweden and Denmark, focused on Malmö and Copenhagen. The two cities are connected by an impressive new international crossing and share a considerable amount of physical infrastructure. The aim is to continue to foster growth and connectivity via the proposed 18 kilometer Fehmarnbelt Tunnel, which will bring Germany and Scandinavia closer together.

The final development the judges were keen to highlight was the **Scotswood Urban Regeneration** project in the United Kingdom. The project plans to regenerate a run-down urban area in the west end of Newcastle city center, creating a truly sustainable, new urban community. Once completed, it will deliver 1,800 new homes, schools, retail properties, leisure centers and community buildings. Roads, drainage and other infrastructure will also be upgraded. Regeneration work began towards the end of 2011 and it is expected to take 15 years to complete. ■

KPMG's view

Improving connectivity

By **Lewis Atter**, KPMG in the UK

Almost everywhere you look, there are signs of urban regeneration. From small-scale projects to revitalize a single neighborhood to massive developments aimed at overhauling large swathes of the downtown core, many civic governments are eager to regenerate their urban environments.

For some, changing economic and demographic patterns have turned large areas of prime real estate into a derelict wasteland. Those that remain in the downtown core are left to battle heavy traffic congestion and aging, decaying infrastructure built to reflect the needs of a bygone era. Even those cities where industrial activity and residential occupancy have remained steady are seeking to renew; many are looking to add more green space to reflect environmental demand, others are upgrading their mass transit systems and road networks to reduce congestion.

Community catalysts

This is by no means just a rich-world phenomenon. In the developing and emerging markets, urban renewal is equally – if not more – important. In part, this is because many cities in these markets have historically developed with little central planning and, as a result, suffer from high levels of traffic congestion, sparse green space, and little to no room for infrastructure expansion. In other cases, lack of affordable housing stock has combined with the incessant pressure of urbanization to form massive slums in downtown cores.

But while the symptoms may manifest themselves differently in each market and city, the underlying prognosis is remarkably similar around the world: economic decay. Recognizing this, many civic governments are now looking to infrastructure renewal as a viable way to revitalize their urban economies and, as a result, are avidly seeking new opportunities to create new jobs, increase tax proceeds and enhance productivity.

When viewed against those criteria, many jurisdictions are starting to rethink their traditional approach to the way that

“Manchester’s civic leaders began thinking about how housing, planning and transport could boost labor markets”

infrastructure delivers value to the economy. When examining the potential of mass transportation investments, for example, it becomes apparent that, rather than simply linking two points on a map, mass transit delivers value by connecting businesses to labor markets, businesses to businesses, or businesses to consumer markets. In other words, it’s about improving connectivity.

That awareness tends to lead civic leaders and planners to the recognition that there are other ways to improve connectivity. In the UK, the Greater Manchester region has led the charge towards a new approach that started with civic leaders thinking about regeneration programs as a way to improve business connectivity, and housing programs as a means to improve labor markets. So rather than simply building inter-regional transportation systems to reduce commuter travel times, they began to think more clearly about how housing, planning and transport can be improved to not only boost labor markets, but also to deliver a catalyst to communities that were less connected.

Bigger bang

Essentially, what it comes down to is the question of which investment will deliver the most potential for job creation and productivity. Suddenly, rather than deciding on the value of a single mass transit system, the scope is thrown wide open to include civic planning, housing projects, business promotion and a host of other approaches and investments that may deliver a bigger bang for the investment buck and – as a result – deliver economic renewal through urban regeneration.

There will be significant challenges for sure. Government departments will need to integrate their approaches to investment to rally around common objectives. Leadership will be required at the highest level to provide the political will to do what is best for the economy as a whole. New agreements and close co-operation must be adopted between civic, regional and national governments to drive balanced investments and benefits.

Co-ordinated masterplan

There is one rather sure-fire way to achieve a massive amount of urban regeneration and economic growth in a fairly short time: host a major international sporting event. London has revitalized entire neighborhoods and developed a massive amount of transportation infrastructure ahead of the 2012 Olympics. Brazil – which will host the 2014 FIFA World Cup and the 2016 Olympics – is virtually exploding with new infrastructure in almost every sector and (as evidenced by some of the projects included in this edition of *Infrastructure 100*) achieving significant urban regeneration at the same time.

For those civic governments unable to attract such major events – and that’s probably more than 98 percent of today’s cities – the path to urban regeneration will be somewhat longer. However, with time, they should be able to benefit from developing and executing a thoughtful and co-ordinated masterplan that accounts not only for the different types of funding required for each asset, but also how different streams of development interrelate in order to create real and lasting urban economic growth and productivity.



Water







Featured Project

Tuas II Desalination Plant

Singapore

By **Ivan Kovanovic**, Infrastructure Journal



Throughout history, people have settled near bodies of water; by rivers, lakes and on the coasts of the world's seas and oceans. Many of these settlements – taking advantage of the opportunities for trade and exploration that waterways provide – have grown into some of the world's most successful cities.

No such list of cities would be complete without Singapore. Thanks largely to its status as a center of trade, the small city-state located on several islands at the tip of the Malay Peninsula has experienced astounding growth – effectively becoming a leading global city in a single generation while tripling its population since the 1960s.

Nicknamed the 'Little Red Dot' for the way it appears on many maps, Singapore has used its physical limitations to its advantage. Much of the city's urban and industrial growth has been shaped by its access to key Southeast Asian trade routes.

Singapore's relationship with the water that has given it so many opportunities is not an unproblematic one. The country may be linked to the rest of the world by important shipping lanes but it has no natural aquifers or an abundance of land.

Closing the loop

Through integrated water management, Singapore's national water agency PUB has successfully closed the "water loop" and manages the whole water cycle, from

rainwater collection to the purification and supply of drinking water, to the treatment of used water and its reclamation into NEWater, Singapore's own brand of high-grade reclaimed water.

This has enabled it to put in place a robust and diversified water supply strategy known as the Four National Taps – water from local catchment, imported water, NEWater and desalinated water. NEWater and desalinated water will form the core pillars of the strategy, and are expected to meet 50 and 30 percent of the city's future water needs respectively by 2060.

Advances in technology have made it possible to use a process known as reverse osmosis to separate sea salt from water on an industrial scale. In normal osmosis, matter (for example salt) dissolved in a liquid will naturally flow through a suitable membrane towards areas where the concentration is lower, effectively equalizing concentrations on both sides of the membrane. In reverse osmosis, pressure is used to force the natural process of osmosis to work in reverse, concentrating the salt on one side of the membrane and leaving just pure water on the other. Reverse osmosis produces water of such purity it has to be re-mineralized and blended with treated water before it is supplied to homes and industries.

Because reverse osmosis relies on high water pressure, it is a complex and energy intensive process. Research and development



The Tuas II plant (below) aims to secure the future supply and distribution of water in Singapore (main picture), where desalination has emerged as the answer to a decades-long problem

“Planners aim to produce 30 percent of demand through desalination”

in this area has yielded innovations in energy efficiency, which –combined with lower prices for key technologies, such as the membranes used in the process – have made reverse osmosis economically viable on a large scale.

Water for life

Singapore’s first reverse osmosis desalination plant, the S\$200 million Tuas I facility, was completed in 2005. The plant produces 136,000 cubic meters of water per day, meeting 10 percent of the city’s water needs. The success of the first Tuas plant has led Singapore’s national water agency PUB to initiate a project for Tuas II.

Currently under construction, the S\$1.05 billion Tuas II facility will soon be Singapore’s largest desalination plant. When it is completed in 2013, it will be more than twice the size of Tuas I and will supply the city with 318,500 cubic meters of water per



day for a 25-year concession through to 2038.

Singapore’s planners now aim to produce 30 percent of total future demand from reverse osmosis desalination by constructing several huge plants like the Tuas I and Tuas II projects. Recalling Samuel Taylor Coleridge’s *Rime of the Ancient Mariner* – “Water,

water, everywhere, nor any drop to drink” – the country’s application of advanced technologies and willingness to invest in large-scale infrastructure have enabled it to transform the sea water that surrounds it into a key resource for everyone living and working in the city. ■





Leaders in the field

Global liquidity

Water is one of the world’s most valuable resources and politically sensitive issues. For any city to prosper and expand, it must have fully functioning and efficient water infrastructure – from supply access to sewage disposal.

In the Middle East, water resources are plummeting fast, according to water charity Just a Drop. While representing 5 percent of the world’s population, the Middle East & North Africa (MENA) region contains only 0.9 percent of global fresh water resources. As a result, judges in the region thought wastewater treatment should be a priority as it is likely to have the widest impact.

The **Muharraq Wastewater Plant** in Bahrain is a crucially important project in that it will not only enhance the country’s efforts to manage its scarce water supply, but it is also a landmark Public Private Partnership (PPP) for the MENA region. This project illustrates how – despite a challenging financial and political environment – the government and the private sector can still find a way to bring a much-needed urban infrastructure project to financial close.

Similarly, expansion of the **Umm Al-Hayman Wastewater Project** just outside Kuwait City is equally important: once completed it will be the largest in the Middle East. Kuwait has no lakes or perennial rivers of its own and is currently one of the most urbanized and water-scarce countries in the world. Around 98 percent of the population live in Kuwait City. The expansion will

increase its current wastewater treatment capacity of 27,000 cubic meters a day to around 600,000.

In Latin America, the judges were also impressed with the important work being done to facilitate basic needs for the most deprived populations. Proper sanitation is essential for communities and the **Water and Sewerage in Peri Urban Areas Project** in Bolivia was hailed by one judge because “not only will it have a huge impact and provide basic water facilities to local people, but it is extremely difficult to get any infrastructure work done in Bolivia so it’s an admirable project.”

The US\$100 million development is part of the Spanish Cooperation Fund for Water and Sanitation in Latin America and the Caribbean. Money will be used for four principle activities: construction of new infrastructure in un-served areas; completion of local water and sanitation masterplans; institutional strengthening of service providers and government authorities; and establishment of a full-time coordination unit to audit, evaluate and monitor project execution. As many as 500,000 people will benefit, with the peri-urban areas of El Alto, La Paz, Cochabamba, Santa Cruz, and Tarija all receiving funding.

In arid north-central Mexico, **Querétaro Aqueduct II** is the state’s largest water project since the Spanish built an original aqueduct in 1738. The project will transport drinking water 128 kilometers, from north west to south west, crossing through the basins of the Pánuco River and Lerma-Chapala watershed to supply more ►

The projects

Muharraq Wastewater Plant
Bahrain

Umm Al-Hayman Wastewater Project
Kuwait

Water and Sewerage in Peri Urban Areas Project
Bolivia

Querétaro Aqueduct II
Mexico
(bottom center)

Jakarta Urgent Flood Mitigation Project
Indonesia
(bottom left)

Tuas II Desalination Plant
Singapore

People’s Moss Desalination Project
United States of America

Torre Vieja Desalination Plant
Spain

Thames Tideway
United Kingdom
(center left)

+ Pool
United States of America
(top right)

“With no lakes or rivers, Kuwait is one of the most urbanized countries in the world”

than 700,000 citizens in the capital Querétaro. The project is imperative for the social and economic development of the city and will aim to distribute over 55,000 million liters of water every year. The judges were impressed by the scale and overall goals of the project.

Across the Pacific in Indonesia, it is not a lack of water that is the issue, but the fear of too much water that is driving investment in infrastructure. As one judge suggested, it's about confronting the issues of climate change by adapting rather than mitigating.

The **Jakarta Urgent Flood Mitigation Project** is an ambitious overhaul of the city's drainage system, which will involve the dredging of 67.5 kilometers of 11 key channels across the capital, plus the repairs of 42 kilometers of embankments and 65 hectares of four retention basins in order to restore their original operating capacities. While it is not a project that shows immediate returns, it is desperately needed. Jakarta is highly vulnerable to flooding, with 2.3 million people affected by the last major incident in 2007. The project is significant because it is a major infrastructural investment aimed at making a mega-city safer and more liveable.

In nearby Singapore, the **Tuas II Desalination Plant** will serve a vital function, delivering 318,500 cubic meters (70 million gallons) of water per day for a 25-year concession period from 2013 to 2038. Singapore currently relies on rainfall and imports from neighboring Malaysia for freshwater supplies. The wealthy city-state has made several investments in recent years to become more independent and meet the needs of an increasing population.

In the United States and Europe, two other desalination plants caught the judge's eyes; the **People's Moss Desalination Project** in California and **Torre Vieja Desalination Plant** in Spain.

Launched in 2004, the People's Moss Desalination Project is one of three proposed

desalination projects that could provide the Monterey Peninsula with an alternative freshwater source. Currently, the cities of Monterey, Carmel, and Pacific Grove rely heavily on the Carmel River. However, a state-wide water crisis has caused the California state government to demand a 70 percent reduction by 2014, with hefty fines and rationing if the target is not achieved by 2016.

The Torre Vieja Desalination Plant on Spain's south east coast is Europe's largest facility for converting seawater into fresh, and the second biggest in the world. After much political turmoil, the plant is finally about to begin production and will open in late 2012. It will have a capacity of 240,000 cubic meters per day.

The final two projects in this category are dramatically different, but both aim to clean polluted urban rivers. The **Thames Tideway** in the United Kingdom is a huge undertaking for London and privately-owned Thames Water. It involves the construction of a 30 kilometer-long tunnel, 70 meters under the River Thames. The controversial "super sewer" will run from west to east across London and is desperately needed due to the inability of London's current Victorian drainage system to cope with heavy rainfall.

+ **Pool** in New York is perhaps the strangest selection in this edition of the *Infrastructure 100*, but the project's quirkiness made it a fun favorite among the judges. Recreational swimming in North America's rivers was once a rite of passage: + Pool aims to bring back that simplicity with technology by developing a floating pool in the rivers of New York City. It was launched with the ambition to improve the use of the city's natural resources by providing a clean and safe way for the public to swim in city waters. The project, described as being "like a giant strainer dropped into the river," uses a complex filter system to remove bacteria, contaminants and odors. ■

KPMG's view

Bridging the water gap

By **Bastien Simeon**, KPMG in France

By 2030, one third of humanity will live in areas where water demand exceeds supply by more than 50 percent. This is not only a challenge to basic human rights; water scarcity is already fueling conflict and contributing to the pace of urbanization as more people relocate to cities in search of secure sources of potable water.

There are certainly signs that more effort and political will is being put towards solving the urban water challenge. All around the world, we have seen shiny new water treatment plants being built, adding more capacity to the system.

But while this may be a good sign for the future, the reality is that many – if not most – jurisdictions and urban areas are largely ignoring the bigger challenge that lies right under their feet: inefficient networks. Indeed, water leakage has become an endemic problem for many countries. In Brazil, almost 40 percent of water is lost through network leakage, Hong Kong loses more than 25 percent, while Singapore – widely viewed as possessing one of the most efficient water systems in the world – wastes only around six percent.

Indeed, there is a strong argument to be made that many of the world's urban water challenges could, in fact, be partly solved by improving the efficiency of existing networks and reducing both physical and administrative losses. Interestingly, there are signs that the recent global financial crisis has concentrated minds towards doing just that. Facing scarce financing for new (and expensive) water plants and a general reluctance on the part of governments to outlay more capital on big-ticket infrastructure items, many water utilities and urban governments have started to focus their efforts on bringing more efficiency to their networks in order to increase overall capacity and improve service to end users.

Tied to this is the growing trend towards waste water reuse. Whereas just 10 years ago, the overwhelming majority of sewage tended

“Urban areas are largely ignoring the bigger challenge that lies right under their feet: inefficient networks”

to be treated and discharged unceremoniously into lakes, oceans and deserts, an increasing number of jurisdictions are now actively capturing waste water and treating it to alleviate some of the pressure on resources by reusing it mainly for agriculture or industrial purposes. In many urban areas, treated waste water is being sold to industrial users, thereby reducing the demand for potable water and providing new sources of revenue for water utilities. In 2009, over 40 million cubic meters of sewage was already being recycled daily, with some locations – such as Windhoek (Namibia) and Singapore – even utilizing treated waste water for direct or indirect potable re-use.

Another encouraging development over the past few years has been the improved efficiency gains within many of the plants themselves. Desalination facilities, for example, which have traditionally been seen as a technology of last resort in water-scarce regions due to the high cost of operations and environmental impact, have become much more efficient and, as a result, much more popular. Indeed, desalination plants are now starting to pop up in non-oil producing countries where the cost of operations is multiplied greatly.

Of course, the enduring challenge of water tariff mismatches persists in most markets around the world and will continue to distort

the economics of water provision. Simply put, until the true value of not only the water being used, but also the capital costs of operating and maintaining water systems is reflected in urban water tariffs, the sector will continue to struggle to fund and finance the type of capacity change that will be required by our burgeoning cities. So while eliminating water subsidies may be extremely unpopular (particularly in traditionally water scarce countries), the reality is that governments and utilities will never be able to achieve the right balance between cost and demand while this mismatch continues.

With user fees barely covering operations and maintenance costs, most governments have been forced to either fund or underwrite the development of new plants and facilities by dipping into their budgets and tax revenues. In the developing world, this burden has largely been picked up by some of the multilateral development funds who are striving to solve both the water scarcity challenge and the public finance challenge through long-term loans and risk financing.

We have also started to see an increasing number of Public Private Partnerships (PPPs) emerge in regions with particularly unreliable or non-existent water infrastructure. In these cases, private industry (such as mining operations or manufacturing plants) have contracted with private developers to build and operate a local water and wastewater system capable of meeting and sustaining their water consumption levels.

There is little doubt that water will continue to be both a critical imperative and a significant challenge for urban governments going forward. Much will depend on not only the ability of administrators to bring greater efficiency to the system but the willingness of politicians to allow tariffs to reflect the true cost of what is clearly a scarce and valuable resource.



Urban Energy Infrastructure



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Featured Project

Cidade Inteligente Búzios Brazil

By Catherine McGuirk, Infrastructure Journal



Cidade Inteligente Búzios is a planned ‘Smart City’ initiative in Rio de Janeiro, Brazil, proposed as one of a few pilot programs worldwide to employ new and sustainable energy resources in urban areas. The premise of the project is to improve the environmental impact of cities through the sustainable reduction of energy consumption and CO2 emissions. In addition to the material aspects of the program, the developers want to provide consumers with information on the efficiency of their consumption, facilitating habit change.

Spanish utility Endesa has been working with the state government to design and develop a model for energy efficiency which could be emulated elsewhere in Brazil and Latin America. The project began in 2011 and aims to be fully operational within two years.

Green technology

The initiative involves development of urban photovoltaic solar and micro wind farms, as well as the installation of smart meters and a new computerized grid – technologies which Endesa has been developing and operating in other regions for some time. This includes the installation of LED lamps for street-lighting powered by renewable energy sources, increased energy efficiency measures in public sector buildings, and photovoltaic panels installed on rooftops across the municipality.

The project aims to convert and add to the

“The new pricing model could reduce electricity costs by up to 30 percent for around 10,000 customers”

existing distribution network to optimize use of energy by using automatic control systems. It will involve installation of three 15kV medium-voltage transmission lines over 67 kilometers, and 450 medium and low-voltage transformers. The aim is for energy to cost less for the end consumer, who will be able to control and monitor personal and household spending by phone and online, increasing choices based on cost, supply and demand.

Retail pricing for electricity will be based on the time of consumption, with consumers paying a premium for electricity supplied during peak hours. The aim of this part of the project is to reduce energy losses that occur in transmission, especially during peak periods, and to avoid the need to expand network



Residents of Búzios beach (main picture and below left) will benefit from cheaper off-peak energy. The initiative plans to minimize ecological impact to the stunning coastline, including Ferradura beach (below right)

capacity significantly. According to Endesa, the pricing model could reduce electricity costs by up to 30 percent for around 10,000 customers.

The program also includes incentives for greener transportation, including bicycle rental and ‘Intelligent Vehicles’. The latter phase of the program will include two electric cars and ten electric bikes for rental, two patrol cars and installation of one slow and one fast charging station.

The scope of the two-year project includes planning and design, procurement, installation, operations and management. Analytical studies are underway via a ‘Living Lab’ for tests and trials of new technologies and services. The developer will use this data to forecast possible opportunities to implement its plans to integrate the technologies into the project.

Smart thinking

The program is being carried out in four stages. The first involves measurement of the ecological impact of the proposals and their efficiency. The next involves assessing how best to manage efficient end use of energy systems via the internet and through other smart grid programming. The network is designed to be flexible, highly automated and fully integrated on all aspects of centralized control, diagnosis, repairing and remote meter reading for electricity, water and gas. This stage will include management of active demand in residential homes and in small or

medium-sized businesses. It will also involve strategies for applying the technologies to public sector enterprises.

The third tier of development will include self-generation possibilities and look at ways to store renewable energy. This phase will include utilization of photovoltaic solar panel technology, and transmission and storage of renewable energy to the electric vehicle charging points. The last phase will address the smart grid energy distribution network and its operation. It will aim to achieve efficient integration of clean generation to the existing grid infrastructure.

As part of the scope of the project, the developer has made a number of commitments

on how it will roll out its Smart City plans. The core aspects are viability for the region and customers, integration of technologies, scalability, robustness and ability to manage the flow of information, reliability of the network, multifunctional communication systems and security for the data network.

Rio de Janeiro wants to become a world leader by demonstrating that this type of smart grid technology and application is practicable and manageable. The developers believe that the Cidade Inteligente Búzios project will make the region a world reference in the use of clean technologies in an urban setting while also addressing the city’s energy and infrastructure requirements. ▀







Leaders in the field

The power to dream

Sustainable low-carbon infrastructure is the cornerstone of modern energy policy. For centuries, cities have been consumers and wasters of energy. With global populations rising and urbanization increasing, cities are at once the most difficult challenge and greatest opportunity for man and the environment.

Saudi Arabia is the poster child for a world fuelled by hydrocarbons. However, the **Princess Nora Bint AbdulRahman University Solar Heating System** in Riyadh aims to capitalize on the Kingdom's other abundant resource – sunshine. Impressively, the university distributes energy over eight square kilometers with a district heating grid supplied by thermal solar collectors and the world's largest solar hot water system.

In Sweden, a new district in Malmö hopes to become a global model for sustainable urban development. With up to 9,000 new homes planned to be built by 2030, planners have set an ambitious goal to power the Hyllie District with 100 percent renewable energy by 2020. E.ON and Siemens are working together to deliver the **Hyllie District Smart Grid**, a project that will feature a range of energy-saving technologies such as distributed energy storage and smart meters that allow end users to control consumption. The smart grid will allow for better management of peak load and overall greater energy efficiency.

Judges were also impressed by the **Jeju Smart Grid Test Bed**. The pilot project in Jeju City, South Korea precedes government plans to roll out smart grids across the nation by

2030 in order to meet carbon emission reduction targets. The project also puts consumers first, as end users will develop a greater awareness of and control over the energy they are using at home, saving money on their electricity bills. It also allows renewable energy from the island's numerous wind and solar sources to be consumed locally, reducing energy lost during transmission.

In the United States, a scheme in Charlotte, North Carolina was given an honorable mention for its attempt to change consumer behavior and achieve 20 percent energy use reduction by 2016. Launched in October 2011, **Envision Charlotte** is a unique public-private collaboration that will use real-time energy information and community support to achieve energy savings. Efforts are also underway to launch air, water, and waste programs.

Brazil is also at the forefront of intelligent energy systems with its impressive **Cidade Inteligente Búzios** project. The country's first smart city is being launched in Rio de Janeiro and will consist of the installation of smart meters and a new computerized electrical network. These new technologies aim to reduce energy loss, increase the quality of public services and maintain user safety. Among the benefits for consumers are the possibilities of having discounted energy prices dependent on time of usage, consumption control of household appliances, energy savings through the installation of new LED street lighting and increased energy efficiency in public buildings.

Another innovative project in South America is **Empresas Transoceanica**, an ►

The projects

Princess Nora Bint AbdulRahman University Solar Heating System
Saudi Arabia
(pictured bottom center)

Hyllie District Smart Grid
Sweden

Jeju Smart Grid Test Bed
South Korea
(bottom left)

Cidade Inteligente Búzios
Brazil

Empresas Transoceanica
Chile

Durban Waste to Energy
South Africa

UBC Bioenergy Research and Demonstration Facility
Canada
(top right)

Chennai Solar Economic Zone
India
(top center)

Exelon City Solar
United States of America
(bottom right)

Brixton Solar One
United Kingdom
(center left)



“If smart grids are the celebrities of urban energy, waste schemes could be the workhorses”

energy-efficient building in Santiago, Chile. Located in the capital city’s Vitacura neighborhood, Transoceanica uses geothermal energy and efficient design to achieve one-fifth to one-sixth consumption of the energy demanded for a traditional building. As the country’s first to achieve the LEED gold certification for a new building, it is considered a prototype not just for Chile but all Latin America. Transoceanica provides an inspirational centerpiece for a government eager to develop sustainable building standards.

If smart grids and efficiency are the celebrities of urban energy, waste schemes could be the blue-collar workhorses. In South Africa, the **Durban Waste to Energy** project is a model for the continent as it converts methane gas derived from household waste into electricity. Energy is transferred through the city’s existing grid, and supplies roughly 5,000 to 6,000 low-income households per day. It will generate money for Durban through the sale of electricity and carbon credits.

A biomass-fuelled heat and power research project at the University of British Columbia in Canada also impressed judges. The **UBC Bioenergy Research and Demonstration Facility** will be housed in a building designed and constructed using cross-laminate timber, a renewable alternative to steel/concrete construction. A collaboration between the university, Vancouver-based Nexterra Systems and General Electric, the gasification system aims to generate enough clean electricity to power 1,500 homes and reduce the university’s natural gas consumption by up to 12 percent.

Another honorable mention in this category was given to the **Ulaanbaatar CHP-5**, a combined heat and power plant in Mongolia. The project, being structured as a public-private partnership, is critical to the long-term economic growth for the capital and will address the urgent need for increased heat and power supply capacity.

Situated near Bangalore, India’s information technology hub, the **Chennai Solar Economic Zone** is a 312-acre site being developed by GMR Solar to provide a robust ecosystem for the solar industry and its supply chain. The zone is the first phase of an overall 3,700-acre development intended to attract high-tech investment to a growth corridor between Bangalore and Chennai. Overall, the project aims to provide world-class infrastructure and utilities to house all activities related to solar products, including research and development, manufacturing, services and training.

Solar power clearly has a lot of potential within cities. In the United States, **Exelon City Solar** in Chicago, Illinois claims to be the country’s largest urban solar plant. Located on a 41-acre brownfield site in the city’s West Pullman neighborhood, the 10MW array includes over 32,000 solar PV panels that can generate enough annual electricity to power 1,500 average sized homes.

Although small in scale, **Brixton Solar One** is another urban PV project that charmed judges with ambition and community spirit. Located on the Loughborough Estate – an economically deprived area of south London in the United Kingdom – the project will be Britain’s first community-run urban solar power plant. PV panels will be installed on the rooftops of the estate in order to generate clean energy for residents. The £75,000 project is being financed through a community share offer, in which local businesses and individuals can invest. It aims not only to generate steady returns for shareholders, but to make a lasting contribution to sustainability and quality of life in the area.

Finally, a carbon capture and storage demonstration project in The Netherlands also received an honorable mention. Located at **Maasvlakte** in Rotterdam, the project plans to capture emissions from a coal-fired power plant and transport them via a 25 kilometer pipeline network offshore for storage in depleted gas fields. As carbon is at the core of a global energy debate, some judges thought carbon capture and storage was perhaps a more realistic solution to fixing a very difficult problem. ■

KPMG's view

A low-carbon crunch

By Dr Timothy Stone CBE, KPMG in the UK

That the world is rapidly moving towards low-carbon energy generation should come as no surprise to anyone. Yet few seem to have truly understood the grand implications of this change. Indeed, it is not enough to simply add new energy sources into the existing grid without first thinking through the fundamental changes that will be required within the system itself.

The reality is that much of our existing energy infrastructure comes from a different era and is therefore rather old and fragile. And while – with significant investment – the age gap can likely be overcome, the more significant, yet often ignored, issue is that, in most cases, the cost of these assets has already been fully written-down. As a result, the energy price now being paid in many countries tends to have factored out the long-term costs of asset renewal and settled at a point that is way too low to support the type of reinvestment that will be necessary to evolve the system towards low-carbon sources.

Another challenge is timing. Simply put, almost every country and city around the world has suddenly and simultaneously awoken to the climate change imperative. And, as a result, a significant amount of activity in this space has all started to occur at once, which has put a severe strain on both the capacity of developers and the financing markets. This can only lead to two things: first, some people are not going to get what they want when they want it, and secondly, market prices are going to soar as demand outstrips supply.

The move towards low-carbon generation will also necessitate massive changes – likely even wholesale change – to existing energy systems. And while this may seem to be simply a problem of scale, the reality is far more complicated. For decades, governments and utilities have tended to think about changes to the system in terms of marginal growth. But within the next 30 to 40 years, the energy system as a whole will need to be very different if we ever hope to incorporate

“Governments, utilities and developers will need to work together if they hope to achieve the scale of change that is required”

the wide range of low-carbon sources now being commercialized.

In part, this is because many of the low-carbon sources will require a very different transmission system that cannot only effectively manage feed-ins from multiple generation sources, but also provide excess spare capacity to smooth out the peaks and valleys that come from the more intermittent sources such as wind and solar power.

The next challenge with system transformation is that of building up an adequate supply chain in time to deliver all of the required components. Building gigawatt arrays of wind turbines in the North Sea requires thousands of components – everything from gear boxes and blades through to the ships that are going to take them out there. Renewing the nuclear supply chain will be equally complex, not least because most countries have been out of the nuclear production business for a quarter of a century and – facing understandably high quality standards – governments are likely to struggle for some time to properly reignite the supply chain.

Then there is the system design itself, a competency that few companies around the world seem to have mastered. The reality is that designing an entire energy system is much more complex and intricate than building roads or a housing estate, particularly when the new system must be overlaid on top of an existing system within established cities. Governments, utilities and developers will therefore need to work together to develop this level of planning capability if they hope to achieve the scale of change that is required.

Taken together, it seems clear that we will eventually reach the point where the typical constraints that result from the scale of change that we are undertaking – supply chain constrictions, financing challenges, economic system cost issues and the like – will mean that it is going to be a much bumpier ride than most people realize. The reality is that those constraints cannot possibly be solved instantaneously by market forces alone. Rather, it will take the help and guidance of the utilities, regulators and governments working together to essentially become much smarter commissioners of the system.

Government, in particular, will need to place significant focus on reducing the market risk that accompanies this type of change. Some volatility can and should be expected, especially in price. But volatility in policy must be reduced (or, better yet, removed entirely) to encourage suppliers and utilities to make the types of investment – both in capacity and financing – that will certainly be required for the world's urban areas to achieve a low-carbon energy future.



Recycling and Waste Management





Deep Tunnel Sewerage
System, Singapore



Featured Project

Deep Tunnel Sewerage System Singapore

By **Olivia Gagan**, Infrastructure Journal



Urban sewer systems are never going to be the most glamorous of infrastructure projects. They are invariably expensive and fiendishly difficult to finance and construct, requiring not only billions of dollars of investment but the political and public will to get the work done – and that’s long before the technical challenges of drilling and constructing tunnels under heavily populated areas are addressed. But their impact on every strata of a metropolis cannot be underestimated: from encouraging investment, to improving the health prospects of its inhabitants, to boosting a nation’s industrial capabilities. In this age, decent sewage systems are non-negotiable if a country is to grow and compete on the international stage.

Key concern

Vast reboots of city sewer systems are taking place globally. In the United Kingdom, London’s Victorian water and waste system is currently being replaced at a cost of billions of pounds. Joseph Bazalgette, an English civil engineer, designed his sewers to last, and they have coped admirably with well over a century of waste, supporting decades of growth in the process, but the time has come when the demand for clean, treated water is outstripping supply.

Singapore is another water-stressed city. Water reclamation has become a key concern

in a city with a population of five million but no natural water sources. Dependent on water imports from neighbouring Malaysia, Singapore’s authorities are well aware that if its economy is to thrive, the basic infrastructure that underpins it must be fit for purpose.

Singapore’s US\$2.6 billion Deep Tunnel Sewerage System (DTSS) is a mega-project designed to be just as long-lasting as the Victorian sewers that still serve the streets, homes and businesses of London. The collection, treatment, reclamation and disposal of Singapore’s used water is set to be vastly improved by the replacement of the previous system of six sewage treatment works, one sludge treatment works and 139 pumping stations that are located throughout the city state.

The DTSS has been under construction since 2000 and is slated for completion in 2020. Phase One of the project was completed in 2008, and consisted of a new 48 kilometer-long deep tunnel sewer running from Kranji to Changi, where a centralized water reclamation plant was also built.

This, the Changi Water Reclamation Plant, is the heart of the system: a state-of-the-art used-water plant capable of treating 800,000 cubic meters (176 million gallons) or 320 Olympic-sized swimming pools of used water a day to international standards. The treated water is then discharged into the sea through deep-sea outfall pipes or channeled to the



Smart use of land and reclamation of water are essential for an island city with five million people but no natural water sources. The DTSS's tunnels and water-treatment system (below and left) are key to its prosperity

“The plant can treat 320 Olympic-sized swimming pools of used water a day”

NEWater factory on the rooftop of the reclamation plant. There it is further purified through advanced membrane technologies into NEWater, Singapore's own brand of reclaimed water.

The new system works entirely by gravity, doing away with the need for pumping stations and eliminating the risk of overflows of used water. The project frees up land for other developments, and employs advanced technology that in some cases uses only a third of the present system's footprint.

“One of the drivers was to reduce land take,” PUB assistant director Yong Wei Hin told *New Civil Engineer* magazine. “Singapore has only around 700 square kilometers of land.”

International accolades

The DTSS project is doing well so far. It has already won international accolades, scooping

Water Project of the Year at the 2009 Global Water Awards as judges recognized the ambition and scale of the project. It also received a Prestigious Engineering Achievement Award from the Institution of Engineers Singapore and an Outstanding Engineering Achievement Award from the Association of Southeast Asian Nations. The next phase of the DTSS, including another

deep tunnel sewer leading to the western end of the island with a second centralised water reclamation plant, is already underway.

Above ground, Singapore is rapidly growing, with the population projected to increase as the island nation becomes an increasingly powerful industrial force. It looks as if what is going on underground will be just as significant. ▀







Leaders in the field

Watching your waste

With so many people now living in cities, increasing volumes of waste are becoming a real headache for town planners, developers and local authorities alike. In order to combat this and continue the promotion and sustainable growth of cities, governments have to adopt more original thinking for the recycling and disposing of waste.

The **Askar Waste to Energy PPP** in the Kingdom of Bahrain has the potential to be a pathfinder for both the country and the region. As a Public Private Partnership (PPP), the US\$480 million facility is being commercially financed amidst a global debt crisis with uncertainty created by the Arab Spring and sporadic civil unrest. The need for the project is great as it aims to tackle the Kingdom's growing problem with waste management by providing capacity to treat 390,000 tons of domestic waste per year from Manama, the country's capital and largest city. In addition, the facility – located in the village of Askar on the south eastern coast – will generate 25MW of power fed into the grid.

A short distance away in the United Arab Emirates, the **Yas Island Waste Management System** in Abu Dhabi is set to revolutionize the country's recycling industry with its state-of-the-art vacuum waste management system. The system is capable of handling 40 tons of rubbish from 43 collection points transported through 5.3 kilometers of pipelines at speeds up to 75 kilometers per hour. The scheme will serve Abu Dhabi's popular tourist destination which includes

the artificial island's famous Formula One racetrack, nearby Ferrari World, the marina and seven hotels. The system will reduce the need for garbage trucks by as much as 90 percent, thus reducing traffic on the roads and cutting CO2 emissions.

The **Deep Tunnel Sewerage System** in Singapore has been under construction since 2000 and is scheduled for completion in 2020. The massive scheme has been designed to address all of the city-state's long-term needs for used water collection, treatment, reclamation and disposal. The award-winning system works entirely by gravity, thus eliminating the need for pumping stations and the risks of used water overflows as well.

Waste management in India is big business and of vital importance for a heavily populated country. In the city of Mumbai, where the population is reaching 14 million, there is an urgent need to find new ways of managing waste where previously it has struggled. Judges were impressed with the initiative being used in the **Gorai Dumping Ground Scientific Closure** to address a common challenge in the region. The unappealing but essential project is a PPP to renovate an area of Mumbai which had been used as a major dumping ground for waste. The site spans 19.6 hectares and has been operational since 1972. The closure has had a major social impact as the dump was located next to residential areas, posing health risks and contaminating local water supplies. Closure of the site in 2009 involved reforming the existing heap and sealing it off with ▶

The projects

Askar Waste to Energy PPP
Kingdom of Bahrain

Yas Island Waste Management System
United Arab Emirates

Deep Tunnel Sewerage System
Singapore

Gorai Dumping Ground Scientific Closure
India
(pictured bottom right)

Bordo Poniente Waste to Energy
Mexico

Bio-Cancun Project
Mexico
(top right)

The Energy Garden Project
Canada
(bottom left)

Durham York Energy Waste Project
Canada
(center left)

Zero Waste: Edinburgh and Midlothian
Scotland
(center)

Tonsberg Waste to Energy PPP
Norway



“A new waste-to-energy scheme that captures landfill methane will power 35,000 homes”

impermeable surfaces. There are now plans to install a power plant at the site which will run on methane gas generated by the decomposing rubbish.

Elsewhere in the country, the judges wanted to recognize foresight and long-term planning by giving an honorable mention to **AECOM's New Delhi Sewerage Masterplan**. The city's current sewerage system only connects 55 percent of its residents to the central network. To plan ahead, New Delhi has engaged with the private sector to audit the existing network and find a solution that encompasses the whole of the capital territory (1,500 square kilometers) and is both technically and financially feasible.

In Mexico similar problems caused by rising population are also becoming apparent. The government is actively taking action to put in place a number of waste treatment and recycling plants. Two projects that stood out were **Bordo Poniente Waste to Energy** and the **Bio-Cancun Project**. In December 2011, Mexico City closed the Bordo Poniente dump, one of the world's largest waste sites. Since 1994, it is estimated that 79 million tons of garbage were dumped in the landfill. Since its closure, a sizable waste-to-energy scheme has been developed to capture the methane gas produced by the landfill, which will be used to power as many as 35,000 homes when complete.

The **Bio-Cancun Project** on the Yucatán Peninsula is another waste-to-energy scheme developed through international cooperation which facilitates the transfer of technology. A combined effort in 2009 between the Canadian and Mexican governments, the project aims to divert organic matter headed for landfill sites in Cancun to a bio-digester for treatment. By-products of the scheme include fertilizers for agricultural use and biogas to generate power.

Canadians are also creatively working on their own waste solutions using high-solids anaerobic digestion technology. **The Energy**

Garden Project in Vancouver is the country's first high-efficiency system for producing renewable energy from food and yard waste. The US\$4 million project uses a number of different funding sources and will see up to 27,000 tonnes of food and yard waste per year diverted from British Columbia landfill sites. A demonstration plant will be built to generate enough energy to power up to 700 homes, while also producing high-quality compost.

Travelling east, the **Durham York Energy Waste Project (DYEC)** in southern Ontario is another world-class energy from waste facility being built in Canada. The DYEC will process remaining residential waste following Durham and York's aggressive composting and recycling programs, while also recovering materials and energy. Durham York Energy Centre will have a maximum capacity of 140,000 tons per year.

In Europe, two waste to energy PPP projects were selected for their ingenuity and ambition. The **Zero Waste: Edinburgh and Midlothian** project in Scotland impressed judges as the project has been developed in response to the Scottish Government's Zero Waste Plan in 2010. It aims to separate all food waste collections from regular rubbish by 2013 followed by a ban on recyclable waste in landfills by 2015. The project involves development of an anaerobic digestion facility to process 30,000 tons of waste per annum.

Across the North Sea, the proposed **Tonsberg Waste to Energy PPP** will serve one of the oldest towns in Norway. This project is another strong example of a city using a PPP to manage waste and put it to a productive use. The project will help Tonsberg and other municipalities in Vestfold County to convert sewage sludge, food waste, organic commercial waste and manure into biogas which will then be used for heating and electricity production. The council also expects to use it for running buses which currently use about four million gallons of gasoline/diesel per year. ■

The risks of recycling

By **Gordon Shearer**, KPMG in the UK

As countries and regions become increasingly aware of the need for more environmental approaches to waste management, we have seen dramatic growth in the development of recycling and waste-related infrastructure.

In large part, growth in the sector has been driven by regulation and tax. In Europe, for example, the EU has implemented stringent regulation regarding the disposal and diversion of waste that has catalyzed many EU member states to intervene in the market to better incentivize the development of new waste-treatment and recycling facilities.

More can be expected; by 2014, EU member states will face regulations for bringing about an end to landfills, accompanied by a cap on how much waste can be burned. If effective, the rules should further incentivize countries to seek more effective ways of waste avoidance and recycling. Many jurisdictions have also implemented a tax on landfills that essentially makes recycling and waste treatment a more competitive alternative.

But while this should mean a further rise in the number of projects in the sector, many developers are now struggling to secure long-term financing in the wake of the global financial crisis. The challenge is that most waste-related facilities have asset lives of more than 15 years but banks are generally unable to support debt tenors to match. This either presents project refinancing risk that impacts on the attractiveness of the deals or pushes the short-term costs up to such an extent as to erode early-year gains. Either outcome has effectively dampened growth for what otherwise would be economically and commercially sound propositions.

Putting aside regulation and financial challenges, however, many recycling and waste management developers face four key challenges that need to be overcome: planning, technology, feedstock availability and off-take agreements.

1. Planning

While the world's population seems more focused on environmental alternatives to landfill than ever before, few seem willing to live next to a waste treatment or recycling facility. As a result, many local governments have become rather restrictive in providing planning permission for these facilities even when proposed for suitable locations. So

“As consumers and businesses become adept at recycling, there is every indication feedstock will dwindle”

while there may be a compelling need (both economically and environmentally) for new waste-treatment infrastructure, the sector is challenged to secure appropriate locations close to their source that will suit their needs.

2. Technology

As the pace of technological change and innovation continues to pick up speed, we are starting to see a number of new technologies emerge in the sector. And while some energy from waste (EfW) technologies tend to be well understood, proven and reliable; new technologies may start to challenge the economics of the older, more traditional solutions. So while many of the emerging technologies still have some way to go before their mode of operation, efficiency and effectiveness is proven, there is concern on the part of EfW investors and funders that their eventual introduction may well divert feedstock (i.e. waste) away from their investments.

3. Feedstock

Securing a long-term feedstock supply contract from a credit worthy counterparty is often the golden key to delivering waste infrastructure solutions. As consumers and businesses become ever more adept at recycling, there is every indication that the levels of available feedstock will reduce. At the same time, we have seen a steady growth in the number of facilities now in operation around the world. As a result, there are concerns in some geographies that sustaining the level of feedstock required to operate these facilities will become increasingly difficult. But in many markets, where landfill is still the main option, this has not even

started to become a limiting factor. And in these markets the panacea to new investment is the utilization of the long-term availability of this feedstock that can, in some way, match the asset life.

4. Off-take

The final challenge relates to the ‘output’ of these facilities, either in the form of recyclables (such as paper, plastic, glass and metals), electricity or heat. To sustain profitable operations, investors take a serious look at how they can sustain long-term value from processing this fuel (i.e. the waste) via the sale of electricity, heat and other by-products. Closed loop solutions and strategic joint ventures can significantly enhance the returns for all parties.

Of course, these are not mutually exclusive challenges. Large, economically efficient EfWs provide good economies of scale, thus promoting low treatment costs but they take more feeding (with high levels of feedstock), are more difficult to get planning approval for, and generally drive the need for longer-term financings. On the other hand, smaller local facilities provide the option for low planning risk solutions, perhaps a requirement for shorter-term debt requirements (as the assets themselves have shorter lives) but become more challenging in providing a low-cost solution.

These challenges are not insurmountable. Pulling together a consortium of parties can drive rich rewards to the victors. And while it is no means an easy sector in which to operate, it remains that the growing world can no longer treat waste as a consequence of one's existence.

The main growth driver for this sector will continue to be the speed at which individual countries' appetites for dealing with the green agenda becomes a reality. In many cases, we will see an increase in education programs (which will likely increase the demand for these facilities and the related feedstock) and subtle changes in the way that municipalities collect waste and pay for treatment.

But as the world's resources become rarer, the economic need to drive more value from waste will become more acute. These fundamental drivers will therefore ensure that the present demand for the development of waste infrastructure facilities will continue for the foreseeable future despite the challenges highlighted above.



Communications Infrastructure

New Songdo Smart
City, South Korea





Communications Infrastructure



After the necessary agreements are in place, it will take approximately two years to manufacture, lay and commission the BRICS undersea cable – the third-longest in the world

Featured Project

The BRICS Cable

South Africa

By **James Kenny**, Infrastructure Journal

Although still in the early planning and feasibility stage, the BRICS Cable is one of the largest and most ambitious endeavors included in the *Infrastructure 100*. The BRICS submarine cable is a 34,000 kilometer, two fiber pair, 12.8 Tbit/s capacity, fiber optic cable system that will link cities in the BRICS economies – Russia, China, India, South Africa and Brazil – with the United States.

The BRICS countries are currently home to 40 percent of the world's population and 25 percent of global GDP. With urbanization rapidly increasing, access to a fast and secure global communications network is essential to the growth and prosperity of the BRICS states. The impact of this project cannot be understated.

Resoundingly positive

The concept for a worldwide cable first surfaced after South Africa was admitted to the BRICS economic bloc in 2010. Suggestions followed at the March 2011 BRICS summit in China that South Africa – the smallest of the economies in the grouping – was punching above its weight, and questions were asked about what additional value the country could bring to the table. With this in mind, the idea for the cable was put forward as a way of reducing reliance on links across Europe and the north Atlantic.

Currently, the BRICS countries are connected to each other via telecoms hubs in Europe and the United States, resulting in high costs and the risk of possible interception of critical financial and security information by non-member states. A new system would provide a shorter, cheaper and potentially more secure route for traffic flowing between the BRICS nations – along with enhanced internet connectivity to boost economic activity.

“A fast and secure communications network is essential for BRICS states”

In terms of routing, the cable will extend south from Vladivostok on Russia's Pacific coast through Shantou in China to Singapore. A spur will be built to Chennai, India as the main cable extends further south through Mauritius, on to Cape Town in South Africa, across the south Atlantic to Fortaleza in Brazil and then northward to Jacksonville in the US state of Florida. Extensions to other countries en route, such as Indonesia, will be possible.

The cable will not be a system that is merely self-contained. It will interconnect with several other cables, including the soon-to-be-operational West African Cable System (WACS) and SEACOM on the east African coast. The plan is to achieve speeds of 12.8 terabits per second, making it 1,000 times faster than the Telkom SAT-1 cable, which for 20 years was the primary connection between South Africa and Europe along the west coast of Africa, and two-and-a-half times faster than the brand new WACS cable.

Currently the estimated completion date for the whole development is the second half of 2014, with an estimated budget of US\$1.4 billion. While this amount may seem large, proponents say it is minuscule compared to the eventual benefits and impact on GDP growth.

Andrew Mthembu, chairman of technology group i3 Africa and one of the drivers of the project, is also responsible for the WACS

cable. Mthembu has stated in the press that he hopes to take many of the lessons from WACS and apply these to the BRICS system.

According to Mthembu, the necessary information is now in place to take the next step of seeking investors for the project. Traffic and feasibility studies have been carried out and the respective governments – along with telecommunications operators in these economies – have been canvassed to gauge their support. The result has been resoundingly positive.

Supporters suggest that the appropriate investment structure for the project would be a consortium. In this way, the operators in each country would come together by way of a construction and management agreement, making contributions to the overall cost commensurate with the capacity received from the system.

In association with Imphandze Subtel Services, i3 Africa is already in possession of the requisite telecommunications licenses in South Africa to land, operate and maintain the cable. It is now in the process of formally inviting telecommunications operators and other potential investors in the BRICS countries and the United States to participate in the project.

Strategic role

The next, crucial part is the agreements with operators and other governments, which could take a number of months to finalize. Mthembu has said the main lesson of the WACS cable was that getting the permits from 12 participating countries, each with their own regimes and laws, was the hardest bit.

When completed, the BRICS Cable will be the third-longest in the world. It is likely to prove a strong step in improving BRICS trade and driving South Africa to take on a strategic role as a gateway in the world economy. ■







Leaders in the field

Interfacing the future

In a United Nations report released in 2011, access to the internet and communication was declared a basic human right. Communication infrastructure is the backbone of how modern cities develop and run. In order to prosper, each city needs to embrace technology.

In Rio de Janeiro, Brazil's fast-growing capital, the city's **Intelligent Operations Center** uses IBM technology to coordinate its city services in real time – from responding to natural disasters to unsnarling traffic. While some cities contemplate such systems, Rio is actively innovating and implementing them. The operations center was opened at the end of 2010, and looks to improve and coordinate city services ahead of the 2014 World Cup and 2016 Summer Olympics.

Another large city in Brazil was given an honorable mention for its own initiative. **Curitiba Smart City** was singled out for using technology to tackle social issues from reducing crime to improving education. The city's program of building "lighthouses" for poorer residents – essentially electronic libraries – won praise as did a smart card system for payment on buses reducing the need for passengers to carry cash, thereby reducing the risk of muggings.

Of the number of internet focused projects considered, the 10,000 kilometer **South American Fiber Optic Ring** was among the most impressive. The ring will have a regional impact by creating direct connections between cities and countries without relying on the neighbor to the north – currently 80 percent

of international data traffic from Latin America passes through the United States. This project will not only increase the connection speed between South American cities by 20-30 percent, but it will vastly decrease communication costs.

Another hugely ambitious initiative designed to boost international communication between cities and global access to high-speed internet is the **BRICS Cable Project**. As the acronym suggests, this initiative aims to connect the BRIC markets and the United States with a 34,000 kilometer two-fiber pair submarine cable with capacity of 12.8Tbit/s via cities like Jacksonville (USA), Fortaleza (Brazil), Cape Town (South Africa), Port Louis (Mauritius), Chennai (India), Singapore, Shantou (China) and Vladivostok (Russia). With enhanced internet connectivity, the cable would boost trade links and economic competitiveness.

While many major African cities such as Johannesburg and Nairobi are increasingly well served by fiber-optic infrastructure, smaller and less developed cities in the sub-Saharan region lack the same level of connectivity. This is where satellite technology has a role to play – especially for cities located inland and therefore a greater distance away from submarine cables. **O3b Networks** has financed and is currently deploying a billion dollar next-generation satellite network that combines the reach of satellite with the speed of fiber – providing an internet backbone for people in Africa and other emerging markets with limited access to ►

The projects

IBM Intelligent Operations Center
Brazil
(pictured top left)

South American Fiber Optic Ring
South America

BRICS Cable Project
South Africa/
Mauritius

O3b Networks
Africa
(top center)

Kokua Wireless
United States
of America
(center right)

National Authentication Framework
Singapore
(bottom center)

Cisco HealthPresence
United States
of America
(top right)

Barcelona Smart City
Spain
(center left)

Amsterdam Smart City
The Netherlands
(bottom left)

New Songdo Smart City
South Korea
(bottom right)



“The city’s infrastructure will react to human movements at lightning speed”

broadband. The judges were impressed with the scope of the project which aims to connect several billion users in 177 different countries.

Beyond the large-scale satellite and fiber-optic ring operations, some judges wanted to recognize smaller projects with strong community credentials. The **Kokua Wireless** initiative in Hawaii – offering free municipal wifi on the island of Oahu – humbly began with 15 local businesses putting antennas on their roofs and sharing their internet access. The scheme quickly gained momentum by word of mouth and now has nearly 200 nodes. In exchange for participation, businesses receive free advertising. Every 30 minutes the internet connection is refreshed to prevent illegal downloading; when it boots back up, the user is reconnected and routed to the website of one of the businesses housing an antenna.

Increased global connectivity means that data security is quickly becoming a critical issue. For a city and country of slightly more than five million people, Singapore has long been determined to be ahead of the curve on technology. The **National Authentication Framework** is further evidence of that commitment and a key program under the iN2015 Masterplan to deploy a trusted and cost-effective nationwide platform for strong authentication by public-facing online services that handle sensitive information and/or facilitate transactions. The new system will boost the security of the country’s communication infrastructure by providing a more rigorous process of identification; thus safeguarding against unauthorized access to sensitive information such as bank account details, securities trading account details or electronic health records.

The crossroads of health and communication technology are perhaps best illustrated in the United States by the **Cisco HealthPresence** project in Tennessee. HealthPresence involves advanced care at

a distance via a platform that links patients and clinicians with HD video, audio, medical devices and collaboration tools. It works with medical diagnostic equipment, such as stethoscopes and otoscopes, to capture patient information, while also allowing patients to interactively discuss their conditions with their physicians remotely. The judges praised the project for its goals of lowering the cost of healthcare and allowing more patients in rural areas to be seen by specialists often located in large urban medical centers.

Cisco’s work in infrastructure extends beyond healthcare. Amsterdam (The Netherlands), Barcelona (Spain) and Incheon (South Korea) are all wired with Cisco fiber-optic broadband as part of their own smart city programs. Like IBM’s work in Rio de Janeiro, these cities have become Petri dishes for the world to watch, with sceptics questioning: “Can they deliver?”

Reinventing a city that was reinvented for the 20th century, **Barcelona Smart City** is a strategic initiative between the Catalanian capital’s city council and Cisco to develop a range of next generation city services in order to improve economic competitiveness and the welfare of its citizens. This includes energy monitoring of public buildings, rainwater harvesting, a smart bus network (relaying real-time transport information to the public), smart parking and public access to the internet.

In Holland, the **Amsterdam Smart City** initiative is a high-level cooperation between IBM, Cisco, the City of Amsterdam and Vattenfall-owned Dutch utility Nuon. Plans include smart chargers for electric cars, a smart metering initiative for 500 homes, and networks that will connect home appliances to an energy management system.

In South Korea, reclaimed land along the Incheon waterfront near the capital Seoul forms the foundation for **New Songdo Smart City**. Songdo contains a mixture of commercial, residential and retail property. Infrastructure will react to human movements at “lightning speed”, and the entire city will use technology to optimize resource use. Songdo also features an advanced pneumatic waste collection system that eliminates the need for garbage trucks. Green space has been factored into the plan, and accounts for up to 40 percent of the total area and a new 7.4 kilometer bridge links the city with Incheon International Airport. Full completion of the city is expected in 2016. ■

The power of fiber

By **Sharad Somani**, KPMG in Singapore

All hyperbole aside, communications infrastructure may well be the most critical asset of today's modern cities. It is a key enabler of economic growth, social development and – increasingly – of government service delivery.

Most cities have recognized the competitive advantage that can be gained through improved communications connectivity. Indeed, most cities – both in the developed and the developing world – are now actively competing with each other to roll out ever faster and more secure communications infrastructure. According to the *Master Plan on Asean Connectivity*, a 10 percent increase in broadband penetration boosts GDP by an average of 1.3 percent; and a 10 percent increase in mobile teledensity increases the GDP by 0.7 percent.

The urbanization trend and resulting need for improved infrastructure service delivery is the defining theme for most cities today. An efficient communication infrastructure is increasingly being looked at as a tool to smooth the whole urbanization process while ensuring that the economy continues to be competitive. Improved ways of delivering services (such as e-learning, e-health, and telecommuting) over high speed broadband infrastructure will also make the urban infrastructure challenge less daunting.

In addition to easing the challenges of urbanization, strong communication infrastructure is now commonly seen as a tool to gain competitive advantage through better trade, efficient manufacturing and connected knowledge economies.

However, developing a robust communications network in the urban environment brings its own set of challenges that need to be addressed by urban policy makers and planners. Likely the most complex issue relates to linking together all of the nodes necessary for bringing communications infrastructure the 'final mile' into homes and businesses. Challenges here include not only the development of complex funding arrangements intended to stimulate private participation, but also more physical considerations such as the retrofitting of older buildings or the laying of miles of cable under existing city infrastructure. Many cities have tapped on existing utility infrastructure – old copper wire cable ducts, sewage tunnels, power cable ducts and other utility tunnels – to help roll out the fiber in the most resource-efficient way. Clearly, there is more than one way to characterize convergence.

“An argument could easily be made that renewable energy cannot be adopted without robust urban communications technology”

Increasingly, mobile technology is complementing the physical rollout of optical fiber in the developing world. Given the increased penetration of smart phones, higher mobile bandwidth availability will necessarily require strong backbone infrastructure. The need for higher symmetric bandwidth (a trend of uploading information/data/videos started by the social media revolution) means that consumers are increasingly demanding high uplink speed as well, thereby underlying the importance of strong fiber-optic-based backbone communication infrastructure.

Encouraging social mobility

Many governments are also taking up the challenge of improving communications infrastructure to remove the digital divide that may be gravely damaging the social fabric. Initiatives include mandating universal service requirements, subsidizing costs to drive adoption, and empowering the citizens by helping harness the full potential of ICT.

While cities and urban zones will continue to have a demand-led development of communication infrastructure, the risk is that the digital divide will only increase if the communication infrastructure development is left to market economics. As a result, multiple governments are structuring intervention models to help take the communication infrastructure into rural areas. In fact, many now believe strong communications infrastructure provides a model for letting urban-led economic growth percolate to the lower rural segments of the economy in an effective manner.

This year, we have also seen the wide-scale emergence of so called 'smart cities' that leverage communications technologies to greatly enhance the efficiency and control of city administration. For example, Rio de Janeiro's new operations center includes smart city technology that supports the coordination of everything from emergency response and street-level security to traffic control and operations management. Other systems, such

as the one currently being rolled out in Barcelona, will include energy monitoring, 'smart bus' networks, and the management of waste collection.

One challenge that will urgently need to be addressed is the security of the information flowing through (or residing in) the communications infrastructure. A strong authentication mechanism would go a long way towards fully exploiting the power of strong ICT infrastructure in the urban economy. In this respect, the National Authentication Framework launched in Singapore may act as a pathfinder project for cities wanting to have a common security infrastructure across financial, health, governance and people-related services.

What remains to be seen, however, is how much government intervention will be required in order to stimulate some of the less commercially viable components (such as trunk infrastructure or submarine cabling) or the more innovative government-focused initiatives (such as smart cities, City Operating Systems or information security measures). Clearly, government will need to carefully consider how they might work with commercial and private organizations to develop the capabilities and infrastructure to turn these new opportunities into economic growth and development.

Way forward

This edition of *Infrastructure 100* has not only identified multiple business models to effectively bring together public and private sector capabilities, but it has also shown how the potential of communications infrastructure could be effectively tapped in the urban context for the growth of the economy. Communications technology is rapidly becoming one of the most important assets in today's urban environment. Looking ahead, it seems clear the sector will continue to rise in importance as more cities move towards the adoption of new technologies in their quest to be highly competitive economies offering a great work life environment to their people.

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