Overview of Sustainable Infrastructure Investment

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I. Background

Sustainable infrastructure is at the center of the three challenges the global community is facing: i) reigniting global growth, ii) delivering on the Sustainable Development Goals, iii) protecting the future of the planet.

i) Investing in sustainable infrastructure will boost global demand and activity in the short term and lay foundations for sustained long-term growth.

ii) Sustainable infrastructure is important for the attainment of Sustainable Development Goals through the opportunities that it creates for inclusive growth and access to basic services.

iii) A large part of carbon emissions emanate from investment in the use of infrastructure. Choices in the design and use of infrastructure have long-lived and difficult to reverse impacts on the carbon, land, and water intensity of future patterns of development.

Reference

Bhattacharya, 2016. Sustainable Infrastructure – A Transformational Challenge

World Bank, 2012 Inclusive Green Growth: the Pathway to Sustainable Development
http://siteresources.worldbank.org/EXTSDNET/Resources/Inclusive-Green-Growth-Chapter6.pdf

World Economic Forum, 2013 The Green Investment Report 2013
http://www3.weforum.org/docs/WEF_GreenInvestment_Report_2013.pdf

Definition/Concepts:

Green Growth vs Sustainable Development

Sustainable development is a defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987).

Green growth is not equal to sustainable development, but a subset of it. It is narrower in scope, entailing an operational policy agenda that can help achieve concrete, measurable progress at the interface between the economy and the environment.

The United Nations Environmental Programme (UNEP, 2011) defines a “green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.”

Green Infrastructure vs Sustainable Infrastructure

Green Infrastructure is defined as a “strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings”. (EU Commission, 2013)

Examples are biodiversity-rich parks and forestry, eco-roofs and walls, and green alleys and streets.

It is different from “grey” infrastructure such as wastewater treatment facilities, which can still contribute to the greening of the economy and increasing climate resilience. These infrastructure approaches often have a higher impact than green infrastructure.

Sustainable infrastructure is infrastructure that is socially, economically, and environmentally sustainable.

- Social: Sustainable infrastructure is inclusive and respects human rights. Such infrastructure meets the needs of the poor by increasing infrastructure access, supporting general poverty reduction, and reducing vulnerability to climate change risks. For example, infrastructure such as distributed renewable power generation in previously un-electrified rural areas can increase household income and improve gender equality by reducing the time needed for basic house-hold chores. It is important to keep in mind that successful infrastructure development that is socially sustainable requires appropriate accompanying institutional development.

- Economic: Sustainable infrastructure is also economically sustainable. It positively impacts GDP per capita and job outcomes. Sustainable infrastructure does not burden governments with debt they cannot repay, or end-users—especially the poor—with tariffs they cannot afford. Economically sustainable infrastructure may also include opportunities to build local developer capacity.

- Environmental: Sustainable infrastructure is also environmentally sustainable. This includes infrastructure that establishes the foundation for a transition to a low-carbon economy. Environmentally sustainable infrastructure mitigates carbon emissions during construction and op-eration (e.g., high-energy efficiency standards). Sustainable infrastructure is also resilient to climate change (e.g., by building public transport systems in less fragile places or to different specifications due to climate change risks).

Sustainable infrastructure can also employ fundamentally different ways of meeting infrastructure service needs, including the implementation of more responsive and integrated information systems that complement hard infrastructure (e.g., demand-side management systems, super-responsive grids).

References

UN World Commission on Environment and Development: http://www.un-documents.net/ocf-02.htm
UN Environment Programme:
https://sustainabledevelopment.un.org/content/documents/126GER_synthesis_en.pdf
European Commission :
http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf

II. Infrastructure Investment Needs

Global investment in core infrastructure (power, transport, water and waste, and telecommunications) has increased by $ 1 trillion per year over the past decade in response to the structural changes in the global economy to around $3.4 trillion per year. The bulk of the increase has been in emerging market and developing countries and notably in China. (Bhattacharya, 2016)

Investment in sustainable infrastructure needs to increase even further. Total infrastructure investment requirements over next 15 years are estimated to be on the order of $75 - $85 trillion, equivalent to much more than the current existing stock. (Bhattacharya, 2016)

Seventy percent of the projected investment needs (between US$ 3.5 – 4.0 trillion p.a. on average) will be required in emerging market and developing countries. With rapidly growing population and urbanization, investment requirements in Africa will grow most rapidly. A majority of these investment needs will come from cities. (Bhattacharya, 2016)

Newer and widely accepted estimates are predicting even higher numbers. The world is expected to invest around US$90 trillion in infrastructure over the next 15 years, more than is in place in our entire current stock today (The New Climate Economy, 2018). These investments are needed to replace ageing infrastructure in advanced economies and to accommodate higher growth and structural change in emerging market and developing countries. This will require a significant increase globally, from the estimated US$3.4 trillion per year currently invested in infrastructure to about US$6 trillion per year (The New Climate Economy, 2018).

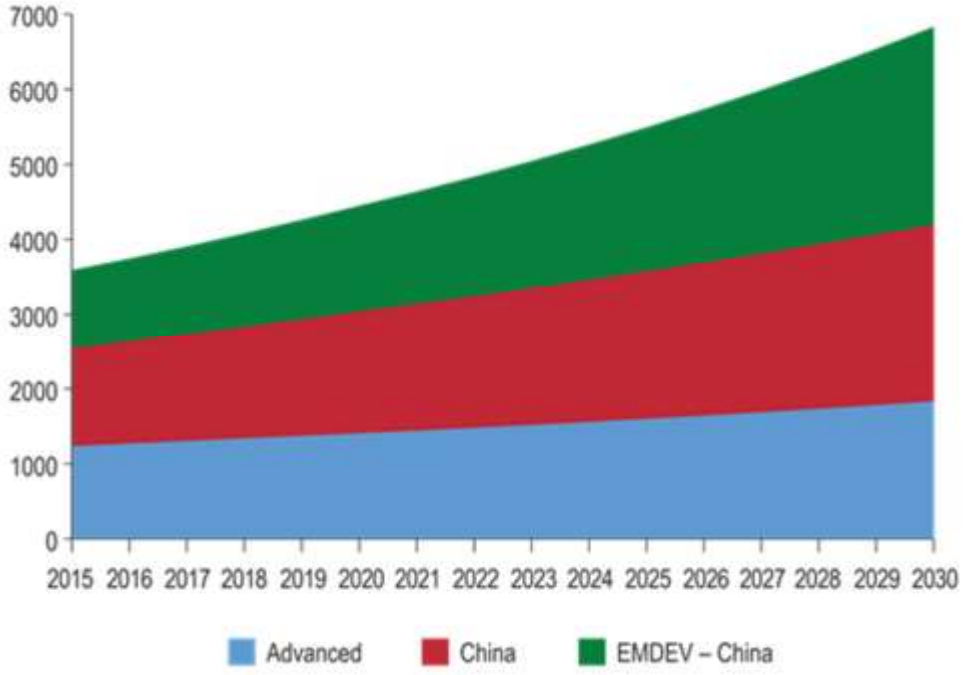
The global South will account for roughly two-thirds of global infrastructure investment (or about US$4 trillion per year) and can lead in building new sustainable infrastructure that “leapfrogs” the inefficient, sprawling and polluting systems of the past (The New Climate Economy, 2018).

Transformative change is needed now in how we build our cities, transport people and goods, produce and use energy, and manage our landscapes. Globally, at least 60% of infrastructure investment over the next 15 years will be made in the energy and transport sectors (The New Climate Economy, 2018).

Reference:
The New Climate Economy Report, 2018. The Global Comission on the Economy and Climate. https://newclimateeconomy.report/

Fig 1:

Unit: billion USD



Source: *Bhattacharya, 2016*

III. Impediments to Delivery of Sustainable Infrastructure

Constraints on the ability to deliver on the quality and quantity of investment needed can be divided into policy-related and finance-related impediments.

Policy:

A lack of well-articulated and coherent investment strategies and upstream planning that can be translated into a pipeline of viable projects. Many countries lack effective PPP frameworks and implementation capacity.

Government-induced policy risks remain a common impediment to infrastructure investments by the private sector.

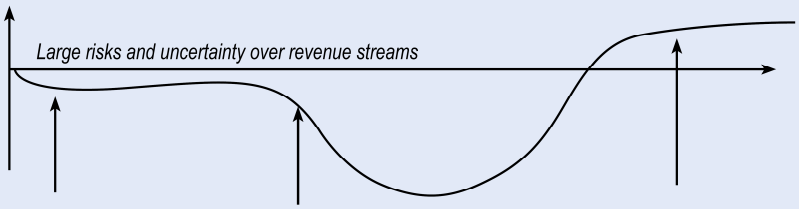
Pervasive fossil fuel subsidies and the absence of carbon pricing tilt incentives against more sustainable infrastructure. Investment strategies are mostly disconnected from climate and sustainability.

Finance:

Especially in emerging market and developing countries, most investments are in greenfield projects, with large upfront costs and high initial risks during construction phase. Therefore, the need for large up-front debt finance at reasonable cost is critical.

However, capital market imperfections and policy barriers in emerging market and developing countries limit the availability and increase the costs of long-term financing.

Fig 2

	Preparation	Construction	Operation
Description	Developer/government organizes feasibility studies; models cash flows, finances; organizes contracts with utilities, operators and construction firms	Construction first build the project to specifications	Separate operating company takes over operation and maintenance of the project
Main risks	Macroeconomic & political risks Technical risks to project viability Environmental and planing risks	Macroeconomic & political risks Construction risks (e.g., of overrun, delay)	Macroeconomic & political risks Demand/traffic risks Operating risks Policy risks (e.g., tariff changes)
Cash flows (stylized)			
Financing moments	During project preparation and feasibility studies the developer seeks patient capital or, often, public funds	Once project is 'bankable' the developer will seek equity investors and debt providers to finance the project	Once construction is compete and started to operate project can be refinanced to reflect the changing risk profile

Source: Bhattacharya, 2016

IV. The Role of MDBs in Addressing Impediments

A **more systematic review of the role of MDBs** and needed changes could help strengthen their individual and collective roles and garner support from shareholders and other stakeholders.

- Governments and **development banks** should focus investment on project-preparation facilities and technical assistance to increase the "bankability" of project pipelines (meaning those that have an attractive economic profile). This is the highest-risk phase of the project life cycle; it is critical to get right; and it is subject to significant rent-seeking conduct. Given a chronic shortage in many developing countries of the right developer equity/expertise, this is an arena in which the right financing facilities could have disproportionate returns.

- Use development capital to finance sustainability premiums. Encourage **development banks** and bilateral-aid organizations to provide financing for the incremental up-front capital spending required to make traditional infrastructure projects sustainable, in economic, social, and environmental terms. Attract private-sector financing by demonstrating that risk-adjusted returns can be competitive with those of traditional infrastructure, even if the policy settings and prices do not fully reflect the total benefits of greater sustainability.

- Improve the capital markets for sustainable infrastructure by encouraging the use of guarantees. Increase **development bank** guarantee programs for sustainable infrastructure by expanding access to guarantees. Insofar as these guarantees price in sustainability benefits, they could help to overcome the policy-sensitivity of these investments, reducing risks for private investors.

- Encourage the use of sustainability criteria in procurement. Governments should strengthen sustainability criteria in both public-procurement processes and public-private partnerships.

- Increase syndication of loans that finance sustainable-infrastructure projects. Encourage **development banks** to expand loan syndication and create a larger secondary market for sustainable-infrastructure-related securities. This would increase institutional-investor familiarity with the asset class, reduce transaction costs, and allow the recycling of development capital.

References:

McKinsey & Company, 2016. "Financing change: How to mobilize private sector financing for sustainable infrastructure"
http://2015.newclimateeconomy.report/wpcontent/uploads/2016/01/Financing_change_How_to_mobilize_private-sector_financing_for_sustainable-_infrastructure.pdf

The capacity of development banks to invest in infrastructure and agricultural productivity needs to be substantially augmented in order for them to pioneer and support changes needed for better infrastructure.

MDBs will need to increase their infrastructure lending five-fold over the next decade, from around $30-40 billion per year to over $200 billion, in order to help meet overall infrastructure financing requirements. (Bhattacharya et al., 2015)

Reinvigorating the MDB role in infrastructure finance will therefore require real internal change in order to:

- Reform safeguard policies so that they are far less procedurally burdensome while still being substantively effective;
- Rebuild staff capacity, skills, and confidence in making judgments;
- Put in place the necessary instruments to catalyze the different pools of private financing, including through more innovative uses of balance sheet capacity;
- Focus on catalyzing and mobilizing private finance through investments.

References:

Bhattacharya, Oppenheim, Stern. Brookings Institution*, 2015. Driving Sustainable Development through better Infrastructure: Key Elements of a Transformation Program* http://2015.newclimateeconomy.report/wp-content/uploads/2016/01/Driving-sustainable-development-through-better-infrastructure.pdf

V. Relevant Sectors

Infrastructure policies are central to green and sustainable development because of their unique characteristics. First, infrastructure choices are long-lived. They influence the purchase of consumer durables and the location choices of households and firms. Second, as infrastructure is a domain in which substantial synergies exist between economic growth and the environment it has a vast potential for co-benefits. (World Bank, 2012)

The areas that are often cited in literature as key sectors for green infrastructure investments are electricity , transport, buildings, water and waste.

References

World Bank, 2012 Inclusive Green Growth: the Pathway to Sustainable Development
http://siteresources.worldbank.org/EXTSDNET/Resources/Inclusive-Green-Growth-Chapter6.pdf

Intergovernmental Panel on Climate Change, 2014. Climate Change 2014 Mitigation of Climate Change
https://www.ipcc.ch/report/ar5/wg3/

1. Electricity

Electricity and heat generation is responsible for more than 25% of the CO2 emitted into the atmosphere each year. (IPCC, 2014) If we are to limit emissions what is required over the coming few decades is nothing less than a complete restructuring of our energy infrastructure.

A future low-carbon energy system is likely to include a meaningful contribution from energy sources including on- and offshore wind, solar photovoltaic (PV), solar thermal electricity generation (STEG), geothermal power, etc.

The grid of the future will have to cope with decentralized, fluctuating supply. It will also be expected to deliver a far more sophisticated range of services to help with demand-side energy management. Only a new and fully digitally-enabled grid architecture will be able to meet these needs. (World Economic Forum, 2009)

References
World Economic Forum, 2009. Green Investment Report 2009
http://www3.weforum.org/docs/WEF_IV_GreenInvesting_Report_2009.pdf

2. Transport

Transportation of people and goods accounts for 14% of global greenhouse gas emissions (IPCC, 2014) Sustainable transport systems are critical for tackling global climate change, improving road safety and reducing local air pollution. This is particularly the case in the world's urban areas, as the majority of transport trips take place in and between cities.

There are multiple ways to create green transport systems, which can include smart urban planning, high quality and efficient transport systems, comprehensive infrastructure for cyclists and pedestrians, etc. (GIZ, 2012)

Recently, the sustainability community is asking for the sustainable design of ports, airports and railways, which can play an important role in improving the air and water quality and reducing CO2 emissions. (World Economic Forum, 2013)

References

Bongardt & Schaltenberg (GIZ), 2012. Transport in a Green Economy
http://www.sutp.org/files/contents/documents/resources/E_Fact-Sheets-and-Policy-Briefs/SUTP_GIZ_FS_Transport-in-Green-Economy-EN.pdf

United National Environment Programme, 2011. Transport – Investing in Energy and Resource Efficiency
http://www.unep.org/transport/lowcarbon/newsletter/pdf/GER_10_Transport.pdf

World Economic Forum, 2013. Green Investment Report 2013
http://www3.weforum.org/docs/WEF_GreenInvestment_Report_2013.pdf

3. Building

Generating around 6% of all greenhouse gas (GHG) emissions (IPCC, 2014), buildings represent a key area for climate change mitigation. Current trends in population growth and urbanization will lead to a significant need for new buildings in the near future. It is critical to incorporate energy efficiency measures (e.g. insulate walls, increase the efficiency of space heating or lighting systems etc.) in buildings in order to reduce energy demand. (International Center for Climate Governance, 2016)

References

Polesello & Johnson (International Center for Climate Governance), 2016. Energy-Efficient Buildings for Low-Carbon Cities
http://www.iccgov.org/wp-content/uploads/2016/03/47_Energy-efficient-buildings-for-low-carbon-cities_Viola-Katie.pdf

4. Water

Climate variability and change have a direct impact on water availability and the frequency and magnitude of water-related natural disasters. In response, sustainable solutions and frameworks for water infrastructure planning and management have become global priorities.

These include reengineering existing infrastructure and creating new green water infrastructure. (World Water Council & Government of Korea, 2012)

Water projects conducive to a green economy are in the fields of ecosystem recovery and water quality improvement, watershed management and the “greening” and restoration of “grey” water facilities. [1]

References

UN-Water Decade Programme on Capacity Development, 2012. Water and the Green Economy – Capacity Development Aspects
http://www.unwater.org/downloads/greeneconomy-capacity-development.pdf

World Water Council & Government of Korea, 2012. Water and Green Growth
http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/2.Green_Growth_Report_Edition1.pdf

5. Waste

The waste sector can offer net carbon savings and a resource efficient contribution to the economy. It can also support local economies to become more resource independent which is increasingly important given that raw materials are not distributed evenly across the globe and competition for access to natural resources has already lead to serious conflicts.

Sustainable waste infrastructure (such as energy plants and recycling plants) is needed for waste material separation, processing and recycling. Furthermore, conversion technologies can be developed to turn solid waste into useful products, chemicals and fuels.

References

International Solid Waste Association, 2012. Waste Management Improvements: Combined CO2 Reductions with Environmental and Economic Benefits
http://www.iswa.org/fileadmin/galleries/Conferences/UNFCC_Doha_18/Case%20studies%20ISWA%20Doha%202012-23%2011%2012_final_final.pdf

[1] This includes measures such as the rehabilitation of waterbanks.

Appendix : Case Studies

The cases were selected according to the relevant sectors mentioned in the previous sections and demonstrate best-case practices from merely countries of the global south.

1. Electricity

Nepal : Rural Energy Development Programme

Nepal is a small, landlocked, mountainous country, with roughly a quarter of its 30 million people living below the national poverty line. Despite significant hydropower potential, hydropower-electricity meets only 2 percent of the total energy consumption. Instead, more than 80 percent of Nepal's energy consumption comes from traditional biomass, as nearly 85 percent of the population lives in rural areas.

As a result, Nepal has one of the world's lowest per-capita electricity consumption levels: only 56 percent of the population (49 percent in rural areas) has access to on- and off-grid electricity; firewood is the main fuel source for cooking for two thirds of households. The heavy reliance on biomass has a negative impact on the environment (due to deforestation) and health (due to indoor air pollution), as well as additionally burdening women who are the primary fuel gatherers. Significantly expanding household access to reliable electricity services is therefore key to sustainable development in general, and poverty reduction in particular, in Nepal.

The Rural Energy Development Programme has introduced **decentralized renewable energy services** to some of the most remote parts of Nepal. By building **micro hydropower systems** and providing **improved cooking stoves**, the programme has provided reliable, low-cost electricity to large numbers of isolated, rural communities. In so doing, the programme has created new rural income- and employment generation opportunities, improved health and environmental conditions, and strengthened local governance. In this and other ways, the programme demonstrates the benefits that can come from rural development programming that takes an integrated approach to economic, environmental, and social development challenges.

The programme was launched in 1996 as a small pilot initiative in five remote hill districts, with UNDP support. The programme was subsequently scaled up via the national Hydropower Development Policy of 2001, which focused on rural development via low-cost hydropower systems. The lessons learned from this programme were taken on board in the formulation of Nepal's National Rural Energy Policy in 2006, and subsequently in its national five-year plans.

As of 2010, the programme had:

- connected 59,000 households to micro hydropower installations;
- constructed 317 new micro hydropower plants, with 5.7 megawatts of installed capacity; and
- installed nearly 15,000 improved cooking stoves, 7,000 toilet-attached biogas plants, and 3,200 solar home heating systems.

The primary beneficiaries of the programme, which is being extended to all 75 districts, are in rural communities, with particular attention to vulnerable communities like women, Dalits (often viewed as the lowest social caste, or the untouchables) and indigenous people.

References

United Nations Development Programme, 2012. Triple Wins for Sustainable Development
http://www.undp.org/content/dam/undp/library/Cross-Practice%20generic%20theme/Triple-Wins-for-Sustainable-Development-web.pdf

Asian Development Bank, 2010. Clean Energy in Asia: Case Studies of ADB Investments in Low-Carbon Growth
http://www.adb.org/sites/default/files/publication/28000/clean-energy-case-studies.pdf

2. Transport

Colombia: TransMilenio Bus Rapid Transit System (Bogota)

By the end of the 1990s, Bogota's public bus transportation system suffered from underuse, with poor quality service and efficiency. The average speed of public transportation was 10 km/hour, reduced to 5 km/hour during peak hours due to heavy traffic. Passengers became increasingly frustrated by consistently long wait times for buses. To reduce waiting time, riders had to use the first bus available rather than wait for a less expensive bus to arrive. Without price regulation, private bus operators were free to hike up prices and charge far more than public bus operators.

In 1998, the city launched a long-term urban mobility plan, as part of an urban renewal strategy. It consisted of measures that would restrict private automobiles, promote non-motorized transportation, and improve public transit by partly financing infrastructure improvements. In 1999, after the new National Government rejected plans for a subway system, a plan for a **Bus Rapid Transit (BRT) system** was presented.

The **TransMilenio** operates 87 km of **trunk corridors** that receive passengers from an integrated feeder system. The system increased efficiency through pre-boarding automated fare collection, free transfers, **raised platforms** for quick boarding and exiting, high occupancy vehicles (160 to 260 passengers), **segregated bus lanes**, and **express routes**. A single fare cross-subsidizes the poor, who often live on the city periphery. All buses comply with Euro II emission standards and are equipped with GPS that allows a centralized management system to respond in real-time to contingencies and re-route buses to meet demand. **Pedestrian and bike pathways are integrated into the system**, with free **bike parking** available at many terminals.

Bogotá's bus rapid transit system and network of non-motorized transport infrastructure has become the exemplar for nations grappling with congested roadways, growing urban populations, and rising transport-related greenhouse gas emissions. Centered around the TransMilenio Bus Rapid Transit, the city's multimodal transit system and innovative policies have made inroads in reducing traffic congestion, accidents, crime, and air pollution. For example, before TransMilenio, commutes averaged 1.5 hours in each direction, with private vehicles accounting for less than one-fifth of trips yet occupying 95 percent of roads. Now, average commute times in Bogotá have been cut by 20 minutes, air quality has improved by 40 percent, and accidents have decreased by 79 percent.

References

Kumar, Zimmermann & Agarwal, 2012. The Soft Side of BTR-Lessons from Five Developing Cities
http://www.vivanext.com/files/TransitPanel/BRT-Case-Studies.pdf

Center for Clean Air Policy, Reducing Traffic Congestion in Bogotá Through Bus Rapid Transit and Non-Motorized Transport
http://ccap.org/assets/CCAP-Booklet_Colombia.pdf

China: Building a world class Bus Rapid Transit network (Guangzhou)

Guangzhou is one of the fastest growing cities in the world. Rapid motorisation had taken place in the city for three decades leading to congestion and a poor local environment. In 2010 Guangzhou began to implement a scheme to improve public transport, the local environment and reduce levels of greenhouse gas emissions from the transport sector. A key part of this package was the development of a **Bus Rapid Transit (BRT) network.**

The city's BRT system was launched in February 2010. It currently carries 26,900 passengers per direction per hour with a daily ridership level of roughly 800 000.

The scheme is the first in China to include **bicycle parking at the stations** and to include **direct tunnels between metro and BRT stations**. To further support the uptake of non-motorised transport, **new bicycle lanes** were developed running parallel to the BRT stations and a bike sharing scheme launched in June 2010 with 1,000 bikes initially (ITDP).

The benefits of the project can be listed as follows:

Environmental

- As part of the integrated process polluted waterways have been reclaimed as public space.
- It is estimated that the scheme have reduced CO2 emissions by approximately 20 000 tonnes a year through supporting a modal shift of 10-15% from private vehicles.

Social:

- Platforms are at grade with the bus floor ensuring easy access for mobility impaired groups.

Economic

- BRT is estimated to have saved 30 million passenger hours in the city in the 1st year of implementation.
- The scheme operation does not require a Government subsidy.
- Guangzhou's BRT has opened up a range of employment and business opportunities for people who were previously restricted by the time and cost required to move along the Zhongshan Avenue corridor.
- The BRT and metro fare system are integrated helping to ensure seamless transitional between the two modes.

References

United Nations Economic and Social Committee for Asia and the Pacific, 2012. Low Carbon Green Growth Roadmap for Asia and the Pacific – Urban Transport: Policy Recommendations for the Development of Eco-Efficient Infrastructure
http://www.unescap.org/sites/default/files/7.%20Urban-Transport.pdf

3. Building

China : Beijing Olympic Village

The Beijing Olympic Village was used to house 16,000 plus athletes and officials of the 2008 Beijing Games. The project was financed and built by a local developer. Residential units were sold after the Games as high-end condos. The developer's goals were to build a project that met the strong environmental commitment of the Chinese government on the Games, while increasing the project's market appeal at a cost that assured a reasonable profit margin.

The green highlights of the project are:

Energy efficiency and renewable energy applications

All the buildings were designed with **high energy envelope and low-e windows** and all residential units were **sunlight oriented** in order to improve the indoor environment. A **wastewater heat pump** is the heating and cooling source for the project to replace the regular heating coal boiler and air conditioners, which can reduce coal burning 24,000 tones and 61,000 tons CO2 emission. Furthermore, it is cleaner and quieter.

Roof installed hot water systems can produce 600 tons hot water each day to meet hot water demand of athletes during the Game and residents after. The system can bring energy savings of 5,570,000 kwh each year to reduce CO2 emission near 5,600 tons. All lighting fixtures in the project are efficient CFLs. There are 760 solar energy lighting fixtures, outdoor LED lightings and sunlight duct for underground lighting saving energy equivalent of 15,000 kwh each year. The efficient lighting system can save a total of 580,000 kwh every year.

Water efficiency

Grey water from buildings and storm water are treated on site and collected for reuse in toilet flushing and landscape irrigation. All pavements in the project are designed water permeable in order to reduce runoff. More than 76,000 tons of potable water is saved by water recycle strategies, and it achieved an 80 percent runoff reduction over regular neighborhoods in a similar scale.

Materials

Most pavements and outdoor components are made of **recycled material**, such as wasted plastic and wasted slag. All recycling containers are recycles made of wasted plastic and wood. Over 90% of the building materials were locally sourced close to Beijing, which greatly reduced transportation energy and help shorten the construction schedule.

Micro-energy demonstration project

As a highlight green point, US Department of Energy and Beijing administration planned the reception center (used as a kindergarten after the Game) to be a micro energy demonstration through energy integrative design and 23 green technologies, including **solar passive design, high performance building shell, solar heating and cooling storage system, solar water heating, solar and wind power on site supply**. The contribution of renewable energy sources is more than 60 percent, based on its own reduction of buildings energy consumption. Winter cool storage can provide 20 percent of the cooling requirement. The project was LEED certified under the Neighborhood Development rating system in 2008 and was the first China LEED green neighborhood project.

References

Jin & Alyas, 2010. American Council for Energy-Efficient Economy Summer Academy - China Building Green Practice
http://aceee.org/files/proceedings/2010/data/papers/2032.pdf

4. Water

Turkey: Rehabilitation of urban estuary (Golden Horn, Istanbul)

The Golden Horn, the estuary in the Bosphorus that divides Istanbul, has been an industrial region since 1937. The industrial zone came with disadvantages, including overpopulation and increased pollution in an area with no infrastructural planning. By 1985, the extensive industrial zone around the Golden Horn, along with the active operation of dockyards, factories and warehouses, increased pollution of the estuarine waters.

The Golden Horn rehabilitation project is a multidimensional plan aimed at improving water quality and navigation in the estuary. The project had five phases: investigation; dredging; construction of wastewater facilities; landscaping; and repurposing the area as a tourism and cultural destination. Much of the initial work was concentrated in dredging over 5 million m^3 of accumulated sediment and disposing of it properly, and diverting sewage from entering the Golden Horn by sending it to a treatment facility. The landscaping and repurposing of this strategic and historic waterway became an engine for economic growth.

A **wastewater treatment plant** was constructed on each side of the estuary and now the wastewater from settlements is collected through collectors and tunnels. The **rehabilitation scheme moved heavy industrial plants away** from the area and cleaned up the industrial pollution, resulting in the creation of vacant green areas on the coastline. **Remediation of "brownfields"** and the retrofitting of historically significant abandoned buildings for cultural and educational purposes have helped to define a new economy and social life, as well as create green areas along the coastline.

As an outcome, oxygen levels in the Golden Horn have reached saturation levels, over 30 species of fish have reappeared and sea transportation has been re-established. International water sports events are held there, and the waterfront area hosts cultural centres, museums, and entertainment and exhibition halls. The water quality measurements in the Golden Horn, Marmara Sea, Bosphorus and the Black Sea outlets are monitored regularly. The quality of water continues to improve.

References

World Water Council & Government of Korea, 2012. Water and Green Growth
http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/2.Green_Growth_Report_Edition1.pdf

India: Role of technology in water quality improvements (Gujarat State)

Water shortages in Gujarat State of India affected drinking water and irrigation and thus the development of the State. Prior to 2001, drinking water scarcity posed a serious threat to human and cattle populations. The State government had to spend billions of rupees on temporary measures to supply drinking water by road tankers and special water trains. The State even witnessed "water riots" due to severe water scarcity compounded by poor water resources management. In addition, many areas suffered from serious water quality problems

due to excessive fluoride, nitrate and salinity. Fluoride has been the cause of extensive health problems in many parts of Gujarat. As most of the drinking water supply had earlier consisted of groundwater from deep tube wells with high capacity pumping machinery, water supply was also a very high consumer of electricity.

The numerous projects to improve water availability and quality in Gujarat have had wide ranging impacts through both **large-scale water management and micro-scale water harvesting schemes in improving river ecosystems, reversing the trend of declining water tables** and generating tremendous growth in agricultural production. Employment opportunities have been created for local residents and increased agricultural production has led to a rise in household incomes. The average annual growth in milk production of the State during the last decade is 50% higher than the national average.

Improvements in the water grid

The State drew up an ambitious strategy for bulk water transmission from sustainable surface water resources to areas with shortages. The investment requirement in large-scale infrastructure was huge, including almost 2,000 km of **bulk pipelines**, more than 115,000 km of **distribution pipelines** and over 150 **water filtration and treatment plants**. Treated water is delivered to more than 10,500 villages and 127 towns in the State, ensuring water supply to about 65% of State's population in drought-prone areas. This initiative has not only largely solved the problems of drinking water and improved water quality, but has also relieved the problem of excessive fluoride contamination.

Power sector reforms

In several villages, the operational hours for the bore wells have been reduced, and **solar pumps** have been commissioned in several hundred villages. In various parts of the State, including coastal and tribal areas, **rooftop rainwater harvesting structures** have also been installed in public buildings, schools and households, which have resulted in substantial energy savings. The Jyotigram Scheme is an initiative that uses an intelligent rationing system for farm power supply to limit the competitive pumping of water and to address the common property concerns inherent in groundwater irrigation. Better access to water allowed for production of high value fruits and vegetables, livestock and fisheries.

Rainwater harvesting for irrigation

Another technique used to improve water supply to small and marginal farmers was the introduction of rainwater harvesting for micro-irrigation. The Sardar Patel Participatory Conservation Project involves construction of **check dams** and **village tanks/ponds** by a designated beneficiary group or an NGO, with technical and financial assistance from the district office. Six prototype designs were circulated with a maximum cost of 1 million rupees. More than 350,000 check dams and village ponds/tanks have been created in the last eight years, providing direct benefit to over 13 million people in rural Gujarat.

Malaysia: The N-Park Negalitres Project: A pilot water-saving initiative

The N-Park condominium, a four-block apartment comprising 965 units in Batu Uban, Penang, Malaysia, was the first condominium in the country to carry out a watersaving project. The N-Park Negalitres Project started in August 2009 and ended in December 2010. This was a smart-partnership project jointly implemented by the Drainage and Irrigation Department (DID), Water Watch Penang (WWP), NPark Management Corporation (NPMC) and Penang Water Supply Corporation Bhd (PBA). The project involved three main components: (i) a **rainwater harvesting system** comprising six tanks of 10,000 litres capacity each, built on the roof of one of the car-parking blocks adjacent to Block D; (ii) the **installation of water-saving equipment** in all the common area toilets with dual-flush cisterns, push-flush urinals and automatic push-taps; and (iii) a resident water-saving activity involving 100 apartments. Under that activity the participating apartment residents competed against one another to reduce their water use. Meetings and discussions were held every month to learn from one another and to iron out problems. Two water auditors gave advice and assistance to the participating residents.

Results of the project showed that the rainwater harvesting system was most successful as the rainwater harvested was used for gardening, washing common areas and toilets, and for flushing toilets in the common areas. The water-saving equipment also resulted in substantial water savings. Both these items reduced water usage in the common areas of the condominium by 37.38 percent in May, 36.51 percent in July and 12.00 percent in September 2011. This is an average monthly water savings of 28.63 per cent. Residents' behavior became more water conscious through awareness of the many advantages of water demand management, rainwater harvesting, and available water saving devices. Co-benefits of the project included strengthened ties between neighbours and a greater sense of harmony amongst different ethnic groups.

The project has shown potential for replication. The successful N-Park project has proven that water demand management through smart partnerships between government, the private sector, NGOs and local communities is feasible. It has demonstrated best management practices for improving the water sector via both the technical as well as the human dimensions of sustainable water resource management. These practices can be publicized and replicated in residential, service, and public facilities across the country, leading to a more environmentally friendly water sector that supports the broader objectives of green growth.

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5. Waste

India: Integrated Municipal Solid Waste complex (Kanpur)

Few years ago solid waste management in Kanpur was similar to most other Indian cities. The Municipal Corporation (KNN) had the responsibility for collecting, transporting and disposing of the solid waste generated in the city, estimated at about 1,500 tonnes per day. There were numerous collection centres in the city, more than 400 of which were open dumps. A fleet of

132 vehicles and 3,000 informal sector workers were supposed to collect and transport the city garbage and dump it at an “authorised” site a few kilometres away from the city. The collection and transportation activity was financed out of grants from the State Finance Commission. A community of rag-pickers was involved in removing recyclable waste from the waste chain.
In June 2008, KNN and the government of Uttar Pradesh worked together to experiment with public private partnership in transforming the system of solid waste management in the city.

The garbage is taken to a central **waste processing facility** where it is sorted, segregated and transformed into a number of products of value, such as premium quality compost, RDF, and interlocking tiles from construction debris for use in footpath paving. After selling off some other recyclable material, very little (less than 2% or so) remains to be deposited in the landfill. The landfill which was expected to fill up in 7 years may actually take much longer thanks to the success in reusing most of the waste. Door-to-door collection of garbage is being done in bins attached to rickshaws by former informal sector workers (safai mitras), using hand gloves and protective masks. The garbage is directly unloaded into refuse compactor trucks of varying capacity, which can typically take the load of 40-50 bins.

Kanpur Waste Management Plant is the largest producer of compost from organic waste; a very large percent of the waste collected from Kanpur is biodegradable. The quality of the compost is enhanced by scientific inputs coming from the R&D lab at the plant. The premium quality organic fertiliser is sold through fertiliser marketing companies, and also directly under their own brand.

Finally, in 2010, a **waste-to-energy plant** was set up, thus creating the largest integrated project in solid waste management in Asia. The plant produces 15 MW of electricity, using RDF produced in-house.

The project CO2 savings are almost 69,000 tCO2/year. The environmental and health benefits resulted from the closure of 400 small dumpsites located within the city's neighborhoods are really difficult to be measured, but it is estimated that the living conditions of almost 400,000 people were radically improved.

The working conditions of the former waste pickers have been improved as well, as they deal with waste at source, they receive uniforms, protecting equipment, and there has been is a decrease in the incidences of diseases (like diarrhoea, fever, skin infections, jaundice etc).

Regarding employment benefits, 130 informal pickers have been directly employed to provide waste management services; they receive training, salary and various financial services. They are provided with social security coverage (pension, insurance etc.), their monthly income rose from Rs 1,500 to Rs 2,800 per month, their work hours have regularized, and have identity cards. Also, their social status has risen, they cause less harassment, as they are easily identifiable by their uniforms, and their young kids have started going to schools.

Overall Impact: door to door collection of waste has increased to 50% with an overall collection efficiency of 90% after implementation of the project. Recycling and reuse of waste has increased up to 85%. Improvement in cost recovery of SWM charges up to 60%.

References

International Solid Waste Association, 2012. Waste Management Improvements: Combined CO2 Reductions with Environmental and Economic Benefits

http://www.iswa.org/fileadmin/galleries/Conferences/UNFCC_Doha_18/Case%20studies%20ISWA%20Doha%202012-23%2011%2012_final_final.pdfArgentina: The "green" Norte III facility produces energy from waste (Buenos Aires)

The environmental facility Norte III is located in the Metropolitan Area of Buenos Aires, Province of Buenos Aires, Argentina, and daily receives 17,000 tons of MSW generated in the City of Buenos Aires and 27 other localities of the Province of Buenos Aires. This is 90% of the waste generated in Gran Buenos Aires.
The facility is composed of:

- 9 **social plants of manual separation** of Municipal Solid Waste (MSW), destined to the social inclusion of waste pickers
- 3 **private plants of manual separation** of MSW
- 1 **waste tyre recycling plant**, which processes 400 tons/month
- 1 **composting plan**t, that receives 1,200 ton/month of green waste
- 1 **mechanical biological treatment plant**, that receives 1,000 ton/day
- 2 **degasification plants** with flares
- 2 degasification plants that generate 15 MWh of energy

The biogas produced at the Norte III landfill site will be captured by setting up and operating an extraction plant comprised of a network of wells and connected pipes, running into blowers and then into torches in order to flare it.

The 4 degasification plants are registered in the CDM and their greenhouse gas emission reduction potential is of 21,341,995 tonnes CO2 Eq.

The CO2 reduction of the whole project accounts for 296,807 tCO2/year. 15 MWh of energy is conducted into the electrical national grid, supplying the daily energy needs of 25,000 people.

This project contributes to the sustainable development of the area immediately surrounding the landfill, of the Buenos Aires Province and Argentina as a whole:

- Abatement of the CH4 emissions from the landfill;
- The area immediately surrounding the landfill get immediate benefits from the elimination of odorous gas emissions coming from the landfill. Substantial reduction or elimination of these gases mitigate the health problems that these gases can cause to the local population and have a positive impact on the development potential of the area surrounding the landfill;
- Safe and effective extraction of the biogas produced by the landfill also significantly reduces the risk of fire and explosion at the landfill;
- The project has a positive impact on local economy, employing local workers and using local materials whenever possible.

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