A solutions landscape for Gujarat cities

The Urban Infrastructure Initiative I UII

Summary report

wbcsd urban

Introduction

Experts from leading companies operating in India have worked with the Government of Gujarat and the four largest cities in the state – Ahmedabad, Rajkot, Surat and Vadodara – to identify workable solutions for the cities to achieve inclusive, competitive, and sustainable growth.

The companies are members of the global Urban Infrastructure Initiative (UII), a unique project that provides multi-sector expertise to help transform a city's sustainability vision into effective action plans. The group of seven global companies and their colleagues in India are active in energy, materials, technology, water and urban planning (ACCIONA, AECOM, AGC, GDF SUEZ, Schneider Electric, Siemens, UTC). They combined their resources and, along with the WBCSD, worked with officials from the Government of Gujarat and Municipal Corporations to identify key challenges specific to the Gujarat cities, and to propose practical solutions.

The UII began the engagement with endorsement by The Honorable Chief Minister of Gujarat early in 2011. The companies met with the state Urban Development and Urban Housing Department (UDUHD) and Gujarat Urban Development Corporation (GUDC), as well as the Municipal Commissioners of the four leading cities: Ahmedabad, Rajkot, Surat, and Vadodara.

The UII team met officials in each of the four cities in July 2011. They discussed the cities' sustainability challenges, plans and priorities – the "issues landscape" that the team would address.

UII's proposed solutions include a comprehensive approach to urban planning, as well as specific measures to improve building energy efficiency and wastewater management.

The discussions with government and city officials, as well as other stakeholders active in urban development in Gujarat, demonstrated the value of providing multi-sector input to city thinking. It has allowed city officials to consider a variety of ideas, and engage with the private sector collectively, rather than only in relation to specific projects. Such holistic thinking is of increasing importance for inclusive and sustainable urban development around the world.

Separately, the UII team acted as a stakeholder providing business insights into development of Surat's Solar City master plan.

The State of Gujarat is the first region in the global project in which UII companies collaborated with more than one city, and with the state government. The discussion identified key themes relevant to all cities, as well as specific challenges stemming from a particular city's history, situation, growth projections, and leadership priorities. Many of the specific solutions put forward in this document can be applied to other cities in Gujarat, and elsewhere in India, as well as in other rapidly developing regions facing the challenges of growing urbanization and increasing resource constraints.

This document is a summary of the full report *A solution landscape for Gujarat cities* (www.wbcsd.org/uiigujaratreport.aspx) submitted to the Government of Gujarat and the Municipal Corporations in July 2012.

A vibrant future for Gujarat – toward sustainable urbanization

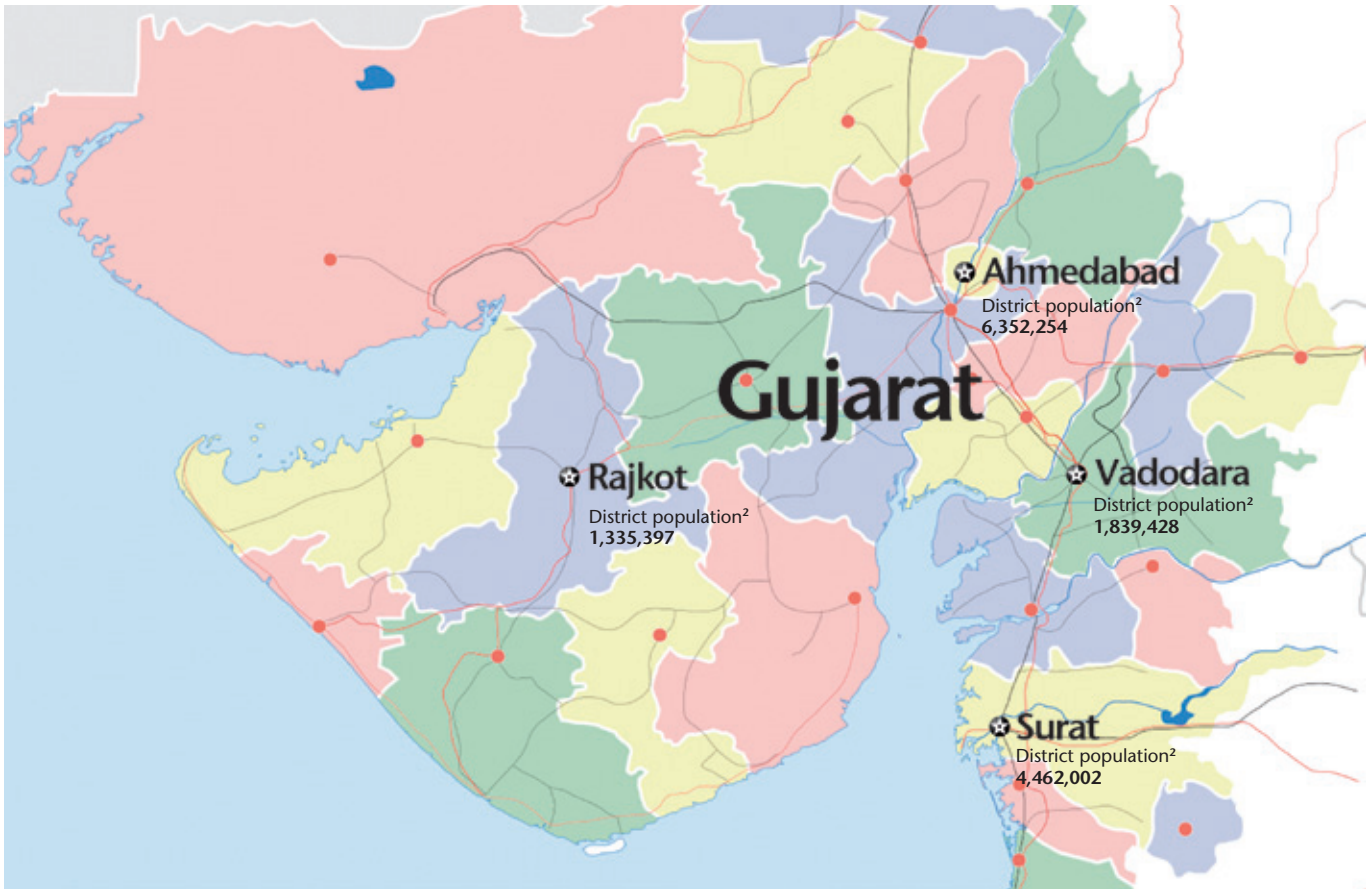
Gujarat is one of the most industrialized and urbanized states in India and, in common with the rest of the country, these twin trends are continuing. The state government and city leadership are very conscious of the need for development to be inclusive and sustainable.

Gujarat will soon have more people living in cities than in villages for the first time in history. It is known as "The Urbanized State of India". Per capita GDP is almost twice the national average, and Gujarat has the fastest growing economy in the country.

This rapid urbanization and industrialization have had some adverse impacts on quality of life and the environment. Inconsistent regulatory measures and enforcement have resulted in haphazard growth, and unplanned urban development. This has led to poor air and water quality, inadequate wastewater management, intermittent energy supplies, and degradation of ecosystems and habitats. Rapid expansion of electricity generation, mostly using coal, has increased greenhouse gas emissions that contribute to localized pollution problems and wider climate change.

The state government is conscious of the need to act on climate change, and is the only Indian state with a Climate Change Department. It has been proactive in promoting renewable energy projects as a means of meeting demand, without adding significantly to emissions. In 2009, Gujarat became the first state to announce a comprehensive solar energy policy, capitalizing on the second largest amount of solar radiation of all India's states, with an average 300 sunny days per year, providing up to 6kWh/m²/day.[3]

Figure 1: The largest cities in the state of Gujarat, India - Urbanization rate 44% (2008), projected 66% in 2030[1]



The issues landscape

Initial dialogue in Gujarat considered the broad topic of sustainable urban development. Energy efficiency and wastewater management were identified as specific challenges the UII could help cities to address. To ensure a long-term holistic approach, however, the UII team explored these specific issues under the umbrella of urban master planning.

A holistic approach to sustainability is essential, to integrate the potential of individual solutions. Master planning is the overarching tool that addresses the needs of multiple communities with appropriate solutions, to significantly improve the quality of urban life. It extends beyond cities' physical layout and development, to include energy and water supply, transport systems, as well as working and living conditions. Successful master planning will optimize urban centers, and reduce their total ecological footprint. It will also plan and provide for Economically Weaker Section (EWS) housing as part of the overall urban development strategy. The Government of India defines EWS as the category of people below a set income threshold. Holistically integrating sustainability into urban planning is key to addressing the challenges of increasing urbanization and industrialization, which will further strain the sustainability of Gujarat's cities.

Urban planning issues

Planning provides the framework for all energy and water management, but there are specific urban planning issues to address in Gujarat. Unplanned and informal urban development is prominent in Gujarat; for example, unplanned settlements to accommodate migrant workers rapidly have emerged near Amroli, Uttraran, and Mota Varacha, north of Surat municipality.

Three specific challenges were the focus for the UII's planning inputs:

- Master planning challenges – macro-level planning, that sets an overall strategy to create a cohesive vision for future growth. Issues include integration of land use and infrastructure development, coordination of transport systems, resource conservation and environmentally-sensitive urban design.
- Infrastructure planning challenges – urban development often takes place without core infrastructure improvements, exerting additional pressure on existing systems. This results in chaotic development patterns and environmental hazards adversely affecting the long-term quality of urbanized areas.
- Professional and technical capacity challenges – a lack of urban planning professionals is a major concern, affecting successful development and administration of planning policies and actions. The planning process is further hampered by a lack of integrated city information databases. Data is not currently standardized, and is only available haphazardly.

Energy issues

Gujarat has the second highest per capita electrical consumption in India, and demand will increase with growing urbanization, industrialization and improved standards of living. Energy conservation and efficiency improvement programs are therefore essential to minimize emissions, as well as to contain the growth in energy demand.

The UII's discussions with the four cities revealed that their awareness and perceived impact on energy efficiency is focused on municipal buildings, street lights, and pumping water and sewage. However, energy use in non-municipal buildings offers many opportunities for improvement, and will be increasingly important as the cities expand. Discussions therefore identified energy efficiency in buildings as the key issue on which private sector input can stimulate transformation, beginning with awareness of its importance, and including financing models for energy conservation.

The UII identified three broad challenges requiring solutions:

- Regulatory challenges – current regulations, or their enforcement, provides an insufficiently strong framework for energy efficiency in the cities and their buildings.
- Lack of knowledge and skills – the current level of knowledge about energy efficiency solutions is limited in depth and breadth among the many stakeholders involved in energy efficiency. A lack of awareness, understanding and skills inhibits implementation of energy efficiency solutions.
- Implementation challenges – barriers exist to implementing energy efficiency projects, even where the potential is well understood. Financial barriers are particularly significant because incentives tend to be split between owners, occupiers and other stakeholders, and the first cost of investment is a deterrent to action.

Wastewater issues

Existing water infrastructure in cities such as Ahmedabad and Rajkot struggles to cope with the load resulting from unprecedented growth. Storm water accumulates in some low-lying areas, or is channeled into sewage systems, even in water-deficient areas of the state. The quality of wastewater generated in the cities is another significant issue, with serious pollution problems in industrialized zones, such as Hazira, near Surat.

The UII identified three major barriers to successful wastewater management in Gujarat cities:

- Infrastructure capacity – the potential varies from city to city. Ahmedabad and Surat can segregate runoffs, and use that resource to recharge groundwater. In Rajkot, lack of a perennial water source and permeable soils require an alternative approach.
- Quality of treated water – in Ahmedabad, industrial effluent is channeled into the domestic system, complicating the process, and exerting pressure on existing infrastructure. The presence of industries within residential areas has an adverse effect on wastewater quality, especially in Surat, where industries release effluents into the domestic wastewater networks and natural streams.
- Economic viability – the financial responsibility for wastewater treatment systems generally lies with the public authorities. However, for whomever is responsible, the success and failure of the economic models used in various projects are not always adequately evaluated to help develop efficient wastewater management systems elsewhere.

The solutions landscape

The UII proposed solutions responding to the challenges of urban planning, energy efficiency and wastewater. Several strategies are identified within each of these three broad areas, and each strategy consists of several solutions, as summarized in Table 1. While the solutions are presented here individually, urban planning is the umbrella under which energy efficiency, wastewater and other sustainability issues should be considered.

Regulatory strategies are required across all three areas, which also all include solutions focusing knowledge and/or capacity development. Each solution proposed is explained in more detail from p. 8 onwards, as well as in the full report *A solutions landscape for Gujarat cities* (wbcsd.org/uiigujaratreport.aspx).

Table 1: The solutions landscape

Urban planning

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Solutions

Master planning strategy	Regulatory strategy	Capacity building strategy
• Sustainability/smart growth pilot project • Master planning scope integration and long-term plan • Integrated mobility plan • Comprehensive parks and open space plan	• Quality assurance and control procedures • Urban growth boundary and new township regulatory policies	• Technical and vocational planning programs • Database systems development and management pilot project • Knowledge partnership program

Energy efficiency

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Solutions

Regulatory strategy	Knowledge development and capacity building strategy	Implementation strategy
• Building rating system • Retrofitting • Passive design	• Energy awareness campaign • Energy efficient lighting • Capacity building program • District power, heating and cooling	• Solar water heating • Financing energy efficiency

Wastewater management

p.20

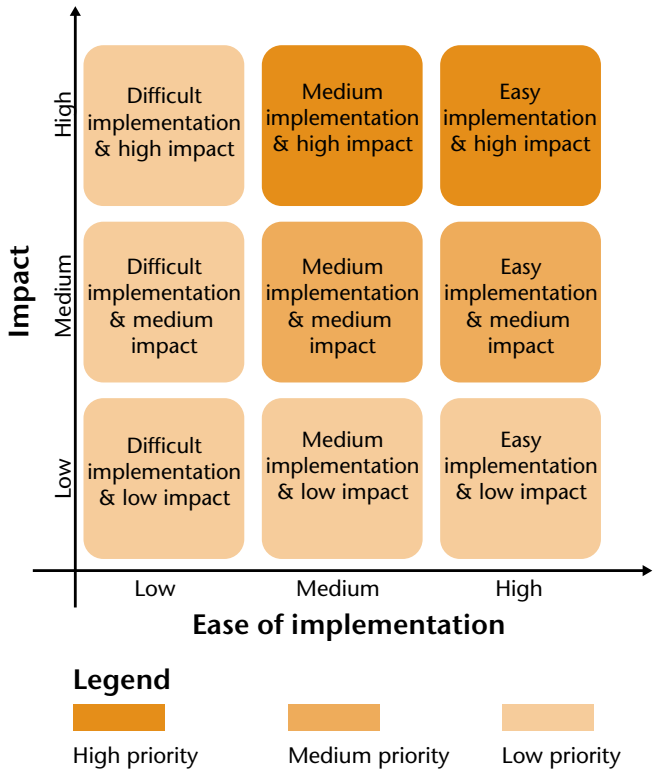
Solutions

Knowledge planning	Regulatory strategy	Infrastructure development and innovative systems strategy	Implementation
• Integrated water resource management plan • Industrial effluent characterization and usage study • Water balance model	• Treated water use policies	• Decentralization plan • Constructed wetlands pilot project • Green community sewage treatment plant pilot project • Segregation at source program • Public awareness and education program	• Implementation models

Prioritizing the solutions

The solutions are prioritized and based on the UII's assessment of the ease of implementation in there cities and the potential impact. The priorities are presented in figures 3 (Urban planning), 6 (Energy efficiency) and 8 (Wastewater management). In this context, the "ease of implementation" takes account of technical, political and economic factors.

Figure 2: **Prioritization diagram**



Urban planning solutions

The nine proposed planning solutions are grouped under three strategies:

- Master planning strategy – solutions aim for integration and holistic thinking, providing cohesive long-range planning, improved multi-modal transport and circulation planning, integrated parks and open space design.
- Regulatory strategy – solutions are designed to promote sustainable planned growth, and create high-quality, world-class urban environments. Proposed solutions will establish urban growth boundaries and new townships, as well as construction quality assurance and control procedures.
- Capacity building strategy – solutions should overcome the barriers which inhibit state and local governments from achieving their planning and development goals. These include knowledge partnership programs with industry leaders and professionals, technical and vocational educational programs for design and planning professionals, and pilot projects, for integrated database development and management.

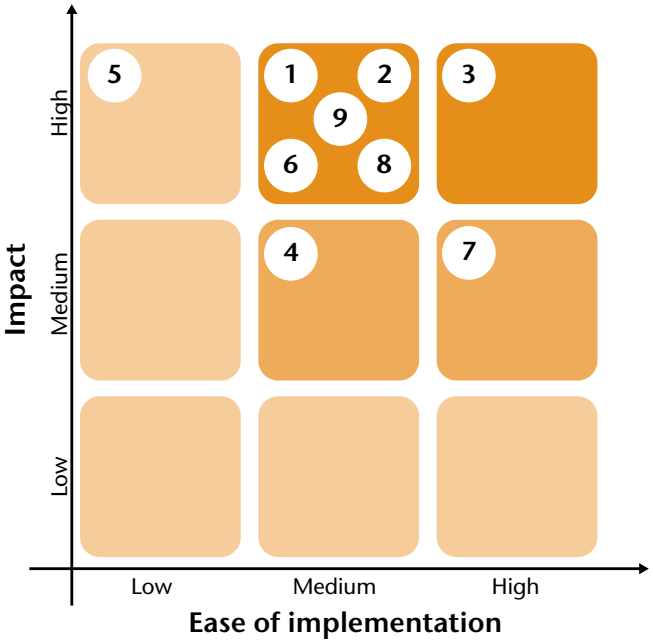
The solutions are a package to be implemented in three stages, as part of a wide-ranging plan. The foundation consists of a long-term master plan, and individual plans for integrated mobility and open spaces. The second stage, which will build on this base, will introduce regulatory policies for urban boundaries and new townships, and procedures for quality assurance and control. Finally, supporting actions will complete the plan, with pilot projects on database development, sustainability, and smart growth in the cities, and programs for a knowledge partnership and technical/vocational training.

The solutions are presented below in order of priority.

Solutions

1. Sustainability/smart growth pilot project
2. Master planning scope integration & long-term plan
3. Integrated mobility plan
4. Comprehensive parks & open space plan
5. Urban growth boundary & new township regulatory policies
6. Quality assurance & control procedures
7. Knowledge partnership program
8. Technical & vocational planning programs
9. Database systems pilot project

Figure 3: **Prioritization diagram – Urban planning**



Master planning solutions

High priority (1, 2, 3, 6, 8, 9)

Master planning strategy

Solution 1 – Sustainability/smart growth pilot project

A pilot project for a specific area may include a town planning scheme, a redevelopment area, or transit-oriented development, and should apply the best practices in sustainable development and smart growth. The main project features will include:

- A mix of various land uses, such as residential, retail, public uses, and recreational facilities
- Integrated infrastructure and transport systems and a wide range of transport options
- An array of housing opportunities and choices incorporating sustainable building design
- Preservation of open spaces and environmentally sensitive areas
- Smarter and green infrastructure, incorporating solar-oriented design, energy efficiency, water conservation, native plants for landscaping, reduction and recycling of waste
- Community and stakeholder collaboration in development decisions
- Planning and provision for Economically Weaker Section (EWS) housing

Considerations

- Example for sustainable development projects incorporating cutting-edge technologies

Next steps

- Implement a pilot project demonstrating holistic sustainability/smart growth principles
- Provide mix of land uses, state-of-the-art infrastructure, and multiple transport choices
- Plan compact and walkable neighborhoods, incorporating range of housing options with energy rating/labeling
- Preserve open spaces and environmentally sensitive areas
- Incorporate green technologies such as renewable energy, distributed power generation, energy and water efficient buildings and waste recycling
- Establish community and stakeholder collaboration in development decisions
- Identify adequate financing sources for implementation of pilot project

Master planning strategy

Solution 2 – Master planning scope integration and long-term plan

A long-term master plan will identify sustainable urban growth patterns as a basis for developing adequate infrastructure for expected population and industrial growth. The plan will integrate sectoral plans for land use, transport, infrastructure, and environmental planning at regional, state and city level. It will build a bridge between cities' current 5-year to 10-year planning work, and the longer 20-year to 50-year plans.

The master plan will be based on a consistent statement of goals, objectives, policies and programs. It will take an integrated approach to land use/zoning, transport/circulation, infrastructure, and natural resources. This will ensure that urban development starts with the expansion and upgrading of infrastructure and public services.

Considerations

- Disjointed planning practices leading to disorganized growth
- Blueprint for future growth
- Integration of various sectoral plans at all levels - regional, state and city
- Infrastructure, transport and other public utilities/amenities to precede development

Next steps

- Implement comprehensive, integrated approach to land use/zoning, transport, infrastructure and environmental planning
- Prepare long-term 20-40 year master plans, to supplement current short-term 5-10 year plans

Master planning strategy

Solution 3 – Integrated mobility plan

An integrated mobility plan will provide long-term solutions that integrate regional, state, and city transport networks, and provide sustainable choices for businesses and citizens.

Gujarat's cities would benefit from strengthening and extending existing transport networks and establishing connections within and among different transport modes. The plan will be coordinated at regional, state, and city level.

A key priority is providing cheap, accessible and efficient public transport systems, aiming for approximately 60% of residents using public transport, compared to only 15-18% in Ahmedabad currently[4]. The plan will examine encouraging public transport through tax incentives, employer transport benefits and similar programs.

The existing road network also needs to be improved, to enhance accessibility, and provide multiple options for efficient mobility. Provision for bicycling and walking will also be included.

The plans will aim to integrate the different modes, with easy, convenient linkages. For example, feeder buses transporting passengers from high intensity use areas such as high density residential or business centres, will help to increase the use of Metro Rail and BRT.

Considerations

- Congestion on roads
- Connections among different modes of transport
- Greater choice of ways to travel
- Increased use of public transport

Next steps

- Coordinate transport plans at all levels - regional, state and city
- Conduct detailed assessment and develop models for urban mobility management
- Construct new roadways, Metro Rail and BRT, or expand existing ones
- Design clear provisions for bicycling and walking
- Provide public transport incentives
- Identify requirement and location of intermodal facilities

Figure 4: **Integrated mobility plan**

Regulatory strategy

Solution 6 – Quality assurance and control procedures

A quality management system will promote the use of advanced, sustainable technologies to achieve high standards for construction projects in the four cities.

It will incorporate quality assurance and control, and will be an important consideration in contractor selection, which will be based on long-term quality, instead of merely cost. The aim is to avoid the poor quality in many construction projects which undermines even innovative and technically advanced development plans. The quality management system will include stringent quality standards for construction materials and supplies. Using smart building management systems will enable suitable performance measurement and verification.

Sustainable technologies need to be included in the Schedule of Rates, which frames the selections that designers and architects make. The Request for Proposal (RFP) also needs to include examples demonstrating desired quality and competence to hold contractors to high-quality standards.

Considerations

- Lack of quality management at each stage - planning, design and construction
- Poor translation during construction resulting in low-quality output

Next steps

- Establish robust quality management system including policies, procedures and processes
- Integrate quality assurance and control procedures in RFPs, and include them in contractor selection criteria
- Incorporate new "green" technologies and design details in Schedule of Rates
- Set up skills development and training for construction workers

Capacity building strategy

Solution 8 – Technical and vocational training programs

Educational programs will provide expertise in urban planning for practising professionals, as well as at post-graduate, graduate, and vocational levels, to raise planning skills, especially in the public sector.

The number of urban planning professionals in the private sector has increased recently, but the cities lack urban planners with the advanced expertise for large, complex urban areas. Coordination is required with the Ministry of Urban Development and Ministry of Human Resources, to catalyze an increase in the supply of planning professionals from academic institutions[5].

Technical and vocational training courses must be established, covering sustainability best practices and technologies. Specialization is needed in areas such as sustainability, environmental and natural resource planning, land-use and code enforcement, and transport planning.

Considerations

- Lack of urban planning professionals at all levels in public and private sectors

Next steps

- Establish advanced urban planning educational programs for larger urban areas and basic vocational training for smaller towns and villages
- Introduce specialized programs in environmental planning, transport, urban design and economic development
- Provide sustainability courses addressing climate change mitigation, energy efficiency, green buildings, water/wastewater management and waste treatment

Capacity building strategy

Solution 9 – Database systems pilot project

A pilot project to develop a consolidated planning database system in one of the cities will demonstrate the benefits for all those involved in urban planning issues.

This database will be managed by the Municipal Corporation. It will aid professionals, government officials, researchers, and other stakeholders in making sound decisions on sustainable urban planning issues. The system will be centralized and synchronized, in order to avoid duplicate and uncoordinated data, and to provide easy access for various city departments, as well as external agencies. It will be an open-ended structure that can be added to and expanded as additional information becomes available.

Data will cover land use, zoning, developed areas, vacant land, roadways, location of utilities and amenities, lot sizes, and building heights. It will combine existing basic information with new technologies, such as digital mapping techniques.

Considerations

- Unavailability of centralized, well-structured urban planning database to inform strategic planning processes
- Existing inaccurate and duplicate data, resulting in errors and inefficiencies

Next steps

- Implement comprehensive, integrated approach to land use/zoning, transport, infrastructure and environmental planning
- Prepare long-term 20-40 year master plans, to supplement current short-term 5-10 year plans

Medium priority (4 and 7)

Master planning strategy

Solution 4 – Comprehensive parks and open space plan

A comprehensive plan in each city for parks and open spaces will support healthy urban living, and provide habitats for plants and wildlife. Well-designed public open spaces are particularly important for high-density areas in Gujarat's cities. Areas need to be identified for preservation as open spaces when new development occurs.

A parks and open space plan will determine the per capita norms for green space, bearing in mind the World Health Organization recommendation for 9 square meters per citizen. The plan will envisage a network of publicly accessible open spaces along riverfronts, woodlands, and other special natural habitats, providing recreational facilities, street landscape corridors, and open space buffer areas at city, community, and neighbourhood levels. It will seek to promote sustainable practices such as urban forestry and urban agriculture to plant, maintain, and preserve trees and vegetation and promote better access to fresh and nutritious food.

Next steps

- Prepare comprehensive parks and open spaces plan, identifying active parks, recreational facilities, and open spaces at all levels - city, community and neighborhood
- Design self-sustaining ecosystems
- Implement sustainable practices, such as urban forestry and urban agriculture
- Address ongoing maintenance and management of public parks and open spaces

Considerations

- Publicly accessible network of parks and open space
- Lack of common, centralized city- and community-level parks
- Interconnectivity to support long-term sustainability
- Balance between environmental protection and recreational use of open spaces

Figure 5 : **Comprehensive parks and open space plan**

Capacity building strategy

Solution 7 – Knowledge partnership program

A knowledge partnership program between cities, government agencies, and expert "knowledge partners" will encourage learning, and facilitate knowledge exchange, to advance urban planning capabilities. It will expand the existing limited resources available to Municipal Corporations and Urban Development Authorities.

Knowledge partners will bring expertise and technical know-how on urban and regional planning, to supplement existing local government knowledge in disciplines such as environmental planning, sustainability, land use and code enforcement, infrastructure, transport, historic preservation, and housing. They will work closely with local planners to provide context-sensitive solutions that reflect the aspirations of Gujarat residents.

Considerations

- Limited existing sustainable urban planning capabilities and resources available to local authorities
- Collaboration among various cities, governmental agencies and knowledge partners

Next steps

- Establish knowledge partnership program with industry leaders, experts, consulting groups, real estate developers/builders and academics
- Render additional material and personnel resources to local authorities
- Provide specialized technical knowledge of disciplines such as environmental planning, sustainability, land use/ enforcement, infrastructure, transport and housing

Low priority (5)

Regulatory strategy

Solution 5 – Urban growth boundary and new township regulatory policies

More effective regulatory policies are needed to establish and manage urban growth boundaries, and ensure sustainable development in the cities and new developments around them. Developments in outlying areas are currently the responsibility of local village panchayats (or village councils) which do not have the capacity to manage them.

A boundary should be mandated to delineate urbanized areas and future strategic growth areas. These boundaries should be used by government agencies to guide land use and zoning decisions. The policies should also dictate systematic planning for new townships, to promote planned urbanization, thereby avoiding ad hoc growth. New townships should be inclusive, combining a hierarchy of employment, commercial, residential, public, and recreational land uses. Additionally, planning for new growth areas should also encourage infill development within existing urbanized areas. A more sustainable and smart growth approach can direct development to the urban core, ensuring new townships are only built when absolutely necessary.

New townships should be part of a strategic framework to create compact, high-density, mixed-use, and transit-oriented developments. These developments should incorporate latest sustainability-focused technologies in infrastructure and building design, including smart grid technology, renewable energy, smart water conservation and reuse, waste management, and energy efficient building codes that address the aspirations of Gujarat residents.

Considerations

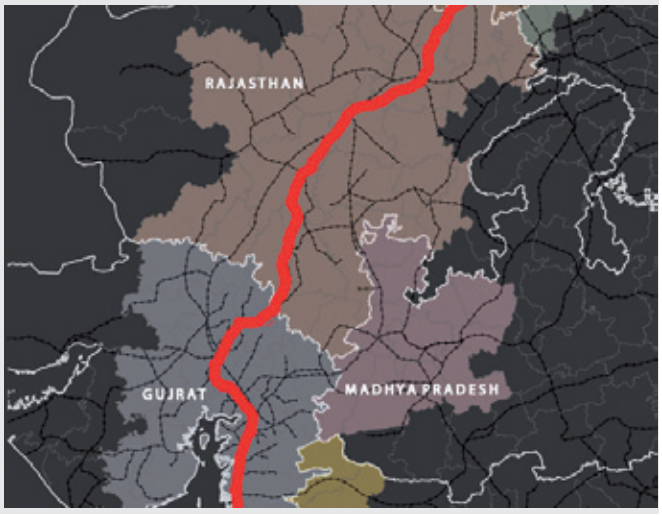
- Absence of strong regulatory bodies and weak planning controls for areas outside the jurisdiction of local authorities
- Numerous environmental impacts, due to unsustainable development patterns

Next steps

- Implement stringent policies at regional or state level, to establish and manage urban growth boundaries
- Prepare a strategic framework for identification and development of new planned townships
- Integrate sustainability planning solutions in new townships, including smart grid technology, combined gas and steam power generation, solar power plants, wind turbines, wireless sensors

Case study

New townships are currently being planned along the Delhi Mumbai Industrial Corridor (DMIC) providing strategic nodes for future growth. The DMIC is a 1’483 kilometer corridor of 150-200 square kilometers on both sides, where 24 new townships or growth nodes will be developed, including 8 in Gujarat (such as Dholera). These nodes will be industry-driven, and create a balance between work and housing. They will be based on detailed site assessment and area delineation, population forecasting, and demand modelling. This will help determine land demand for preparation of a 30-year land use program covering industrial and non-industrial uses.



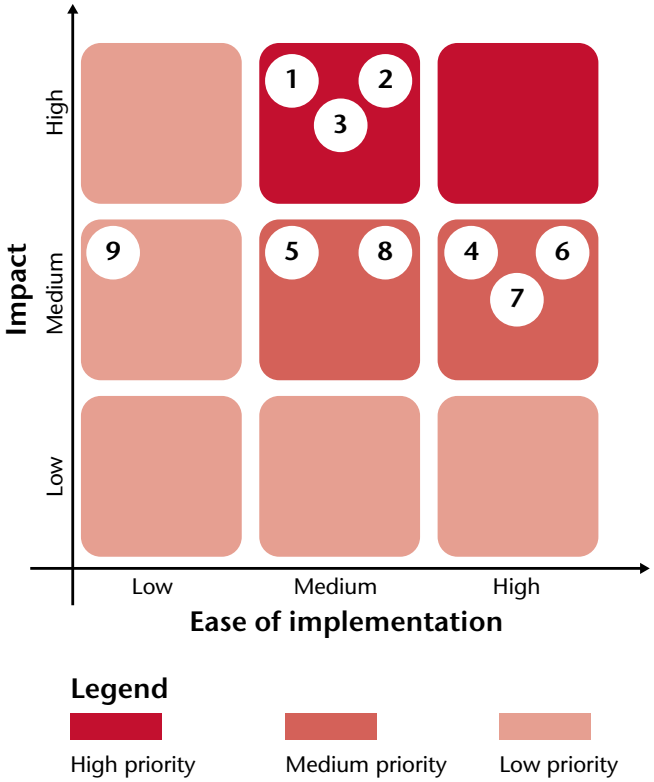
Energy efficiency solutions

The nine proposed solutions to transform energy use in Gujarat cities are grouped under three strategies. While energy efficiency is the primary objective of all solutions, other benefits include lower operation and maintenance costs, increased productivity, improved well-being and comfort of building occupants, and increased building and component durability and flexibility. The return on investment on energy efficiency measures can also be very attractive.

- Regulatory strategy – focuses on enforcing new regulations and amendments to existing bye-laws, to provide the necessary framework for energy efficiency. Proposed solutions include building rating systems, passive design techniques, and building retrofit.
- Knowledge development and capacity building strategy – focuses on overcoming a lack of understanding which inhibits varied stakeholders from implementing energy efficiency solutions. Proposals include a widespread energy awareness campaign, which will build strong foundations for stakeholder acceptability of all other solutions proposed. The capacity building program focuses on technical qualifications for construction industry workers, as well as skills development among policy makers, designers and developers.
- Implementation strategy – focuses on implementation requirements for energy efficiency, including encouraging ESCO (Energy Service Company) to finance energy efficiency, and incentives for solar water heating.

The solutions below are presented in order of priority.

Figure 6: **Prioritization diagram – Energy efficiency**



Solutions

1. Building rating system
2. Retrofitting buildings & equipment
3. Passive design
4. Energy awareness campaign
5. Energy efficient lighting
6. Capacity building program
7. District power, heating & cooling
8. Solar water heating programs
9. Financing energy efficiency

High priority (1, 2, 3)

Regulatory strategy

Solution 1 – Building rating system

Mandatory compliance with the Energy Conservation Building Code (ECBC) for new buildings, and a mandatory rating system for all non-residential buildings above a minimum size, will enforce higher energy efficiency standards.

A rating system categorizes buildings according to their level of energy efficiency, and can cover broader environmental and sustainability issues as well. India's Bureau of Energy Efficiency (BEE) has introduced the Energy Conservation Building Code (ECBC), which is a foundation for many building rating programs and assessments.

Using a rating or labeling system supports transparency, and can stimulate energy efficiency action. It can also be the basis for additional policy initiatives, ranging from building regulations to financial measures, and can encourage capacity building among all those involved in building energy use. Cities can make regular auditing a requirement, so that buildings are re-evaluated from time to time to ensure that actual performance is maintained at the appropriate level.

Considerations

- Type of buildings to be covered
- Stakeholders affected
- Nature of rating scheme
- Minimum mandatory requirements
- Incentives for meeting norms, or penalties for non-conformance (indirect financing)

Next steps

- Reach stakeholder consensus
- Identify partners
- Create communication campaign and capacity-building workshops to support implementation
- Launch rating scheme

Regulatory strategy

Solution 2 – Retrofitting

Full retrofitting of major buildings, based on a requirement to meet ECBC guidelines, will improve energy efficiency of existing properties. While a full building renovation will have the most impact, replacement of equipment or components can also save energy.

Building owners may perform full energy audits to determine the most effective improvements. Audits should target whole building considerations to avoid piecemeal approaches, such as replacing cooling systems without considering lighting and associated elements.

Considerations

- Nature of buildings to be covered
- Impacted stakeholders
- Minimum mandatory requirements based on nature of building
- Incentives for meeting norms, or penalties for non-conformance (indirect financing)
- Conformance deadlines

Next steps

- Reach stakeholder consensus
- Identify resources to support requirements
- Develop appropriate monitoring and verification protocols
- Share information with stakeholders

Solution 3 – Passive design

Passive design techniques with financial and/or non-financial incentives will improve energy efficiency in new building. They can cut heating and cooling energy consumption by 60%, and lighting energy requirements by at least 50%.

Passive design refers to aspects of the position and structure of the building. The building orientation and the "envelope" are the starting points for high performance, including the use of shade to minimize heating, and maximize natural light. Other passive measures include thermal mass, which reduces temperature variations, and the use of natural ventilation. Active measures apply technology to save energy in services such as lighting and HVAC.

This approach may challenge some traditional construction and tendering methods, and may require the impetus of incentives for achieving a specific overall rating or building energy classification (see Building rating system solution on p.15).

The full report of *A solution landscape for Gujarat cities* (wbcsd.org/uiigujaratreport.aspx) includes results from modeling by a UII member company, which show the varying cooling and lighting requirements for different building designs. For example, the energy requirement falls as overhangs are introduced to building design as they create shade which lowers the cooling needs.

Considerations

- Extent of mandatory elements
- Means of communication and enforcement
- Change in building by-laws

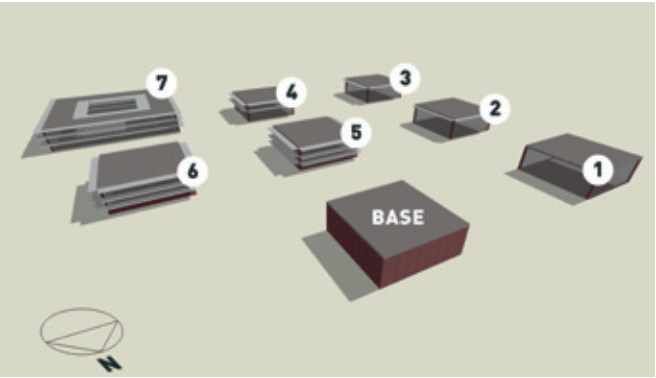
Next steps

- Reach stakeholder consensus on minimum requirements
- Identify resources to support requirements
- Develop/adopt appropriate monitoring and verification protocols
- Share information with impacted stakeholders
- Create awareness on passive design and high performance construction materials

Case study

The Center for Environmental Science and Engineering (CESE) building at the Indian Institute of Technology in Kanpur, Uttar Pradesh, has applied passive design to achieve substantial energy savings, in addition to gains from energy efficient technology. The building orientation and design optimizes daylight, and provides shade from sunshine to minimize the need for artificial cooling. The roof is shaded and insulated, and double-glazed windows are also shaded. Cooling needs are further reduced by an earth air tunnel incorporated in the Heating, Ventilation, and Air-Conditioning (HVAC) design. The building envelope uses high-performance materials insulated cavity walls.

Figure 7 : **Different passive design techniques for new buildings**



Base case	No windows
Case 1	WWR - 100%, no shading
Case 2	WWR- 100%, 0.6m overhang
Case 3	WWR - 100%, 1m overhang
Case 4	WWR - 100%, 1m overhang + 1 light shelf
Case 5	WWR - 80%, 1m overhang + 1 light shelf + 1 horizontal fin
Case 6	WWR - 60%, 1m overhang + 1 light shelf+ 1 horizontal fin
Case 7	Same building area with central courtyard, varying WWR on each façade (total 60%), 1m overhang + 1 light shelf + 1 horizontal fin
	WWR: Window to Wall Ratio

Medium priority (4, 5, 6, 7, 8)

Knowledge development and capacity building strategy

Solution 4 – Energy awareness campaign

A wide-ranging public awareness and action campaign will provide long-term underpinning for other solutions. It will create an energy-aware mindset among business and residential consumers that would discourage a high-energy culture.

Business owners need to be informed about the financial benefits of operating with greater energy efficiency, and the increased worker benefits of a healthier and more productive workplace. Citizens need to be encouraged to use energy wisely, as individual behavior is a critical element in most energy-saving solutions.

Advertising and other communications, including social media, could build on existing e-governance infrastructure, including the Gujarat Bank of Wisdom, that provides an open forum for suggestions and advice[6]. A campaign could also build on the existing Bal Urja Raksha Dal (BURD) school campaign, so that children take the message back home to motivate their parents.

Considerations

- Key target audiences
- Key messages
- Communication channels
- Measurement protocols
- Availability of state/city financing for campaigns

Next steps

- Identify key audiences, key messages and appropriate communication channels
- Develop communication campaign
- Launch campaign

Knowledge development and capacity building strategy

Solution 5 – Energy efficient lighting

Motivating users to adopt energy efficient lighting options will cut consumption in this significant contributor to building energy.

Daylight is the most energy efficient form of lighting, and the use of passive design techniques (see Passive design solution on p.16) optimizes the use of daylight. New technologies can reduce the energy consumption of artificial lighting, where and when it is needed. Incandescent lamps are still standard in most Gujarat homes. Commercial and industrial lighting is typically provided by fluorescent tubes. These technologies are relatively inefficient and can now be replaced by Compact Fluorescent Lamps (CFLs) and more efficient tubes (T5) respectively. They are more expensive than traditional light bulbs, but the energy saving provides a payback of just a few months. The initial cost often deters domestic buyers, however, unless subsidies and recycling programs are in place to attract new buyers.

Even greater efficiency can be achieved with the newer technology of LED lamps. They require only 10% of the power of a standard incandescent bulb, and last six times longer than CFLs. But they are currently three to four times the cost of CFLs, and may need subsidies or other incentives to be attractive to many users.

Considerations

- Target customers
- Viability of financing schemes and models
- Buy back/recycle policy

Next steps

- Determine appropriate scheme
- Identify appropriate financial models
- Develop buy back/recycle program
- Enter partnership with distribution utility
- Launch scheme

Knowledge development and capacity building strategy

Solution 6 – Capacity building program

A capacity building program, including a know-how exchange to complement education and training, will provide the knowledge to implement energy efficiency measures.

Education and training on energy efficiency is necessary for all those involved in financing, designing, constructing and operating buildings. Vocational training is essential for skilled and unskilled labor, particularly construction workers, but a state-wide capacity building program also needs to include professionals, policymakers and decision-makers. Appropriate skills are also necessary to maintain buildings and equipment to the standard necessary to achieve design efficiencies.

The existing Bal Urja Rakshak Dal (BURD) program could provide one solution, by extending the current work with schools into the tertiary education sector. In this way, BURD would stimulate the private sector to develop capacity building activity, and offer energy efficiency services necessary to increase adoption rates.

Considerations

- Target groups/workers
- Possible civil society, industry, and academic partners
- Financing models
- Course content
- Local languages

Next steps

- Determine target audiences
- Form industry, academic, civil society partnerships
- Develop course content
- Deliver training
- Set up refresher courses

Knowledge development and capacity building strategy

Solution 7 – District power, heating and cooling

An impact assessment in Surat to assess the potential of targeted district power, heating and cooling can identify opportunities in Surat and other cities.

Introducing a district power scheme would provide heat more efficiently than the current use of coal to generate steam. It would also address local emission problems. District power is estimated to be 40% more efficient than coal, can be powered by renewable energy to eliminate CO_2 from energy generation, and would reduce traffic and related emissions in distributing the coal.

District cooling systems can also be used, often in conjunction with the design of district power and heating grids, to offer chilled water resource for commercial district consumption. While the capital cost of such systems can be high, the efficiency benefits are significant.

Considerations

- Technical potential for power, heating and cooling
- Area of coverage
- Finance

Next steps

- Carry out technical feasibility study in one city
- Invite tenders
- Select contractors

Solution 8 – Solar water heating program

City-wide solar water heating programs will save energy by reducing the use of gas geysers.

Readily available sunlight for most of the year in Gujarat (average 300 days per year) makes this an attractive option. Several variants of solar water heating are available, and are used in Gujarat cities, to some extent. However, uptake of the technology can be slow. This may be because of a lack of awareness of the technology, and the financial support available to meet the initial costs, which are typically between Rs. 20'000 and Rs. 60'000 (equivalent to USD 360 to 1'100) for a 100 to 300 liters per day household system. Various incentives are already available, including a reduced property tax in Rajkot, and a subsidy from the Ministry of New and Renewable Energy for renewables projects. Further incentives and/or regulation may be necessary to increase adoption rates.

Considerations

- Scope and coverage
- Financial incentives or subsidies
- Extent of mandatory elements

Next steps

- Agree on mandatory/voluntary elements
- Source equipment
- Develop communication support
- Launch scheme

Low priority (9)

Solution 9 – Financing energy efficiency

Encouragement of ESCO (Energy Service Company) in the commercial sector and alternative financing programs can support energy efficiency measures.

An ESCO offers a broad range of energy solutions, including design and implementation of energy saving projects. The company guarantees a certain level of energy and cost savings, which is attractive to the user. It earns a return by taking a share of the total savings. This incentivizes the ESCO to ensure continued high performance.

Alternative financing can overcome the difficulty of meeting the swift repayment requirements of conventional loans. Financing programs in some markets are addressing these difficulties, with either the municipality or the utility providing a loan for the initial capital, with repayments to come from the energy cost savings.

A "design incentive" such as the Floor Area Ratio (FAR) used in Noida, Uttar Pradesh, is an alternative to a direct financial subsidy. Any application for construction of a building that meets appropriate energy efficiency specifications will be allowed an additional FAR of 1%, providing developers with an indirect financial incentive, because the extra floorspace will bring higher returns from their investment.

Considerations

- Target audiences
- Key messages
- Communication channels
- Measurement protocols
- Availability of state/city financing for campaigns

Next steps

- Identify target audiences, key messages and appropriate communication channels
- Develop communication campaign
- Launch campaign

Wastewater solutions

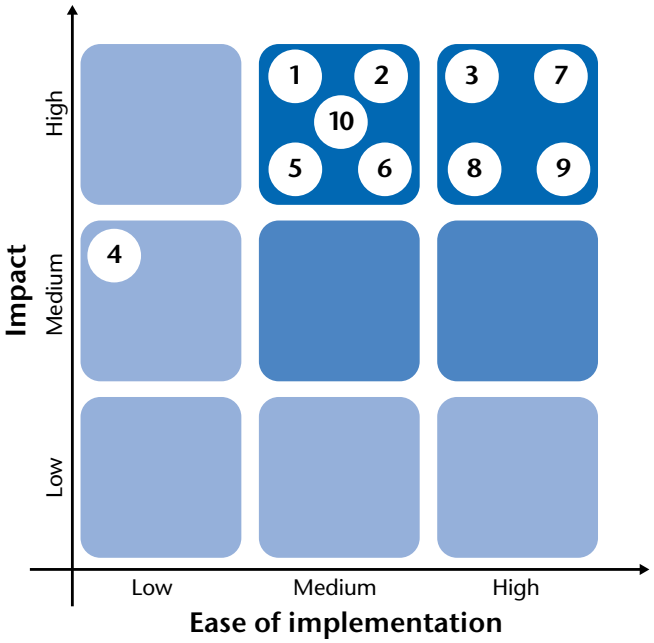
The 10 proposed solutions address wastewater issues within four strategies:

- Knowledge planning strategy – to compile and analyze information on wastewater sources, treatment, and disposal within a Municipal Corporation area, to understand the challenges and opportunities in treated water use. This strategy focuses on solutions involving collection, collation, and analysis of all data required to assess the issues at regional, city, community, and neighborhood level. Recommended solutions include an Integrated Water Resource Management (IWRM) plan, industrial effluent characterization and usage study, and water balance model.
- Regulatory strategy – to provide policy-level guidance and changes to the existing framework to determine design, process, methodology, and allocation of responsibilities for wastewater treatment and reuse systems. Solutions focus on policy-making to incentivize wastewater treatment and treated water use.
- Infrastructure development and innovative systems strategy – to build efficient wastewater infrastructure and promote new, environment-friendly technologies for wastewater management. In the short term, the strategy aims to reduce the load on existing infrastructure. In the medium term, it will enhance capacity and build innovative systems, and in the long term it will be decentralized to provide sustainable wastewater systems. Recommended solutions include decentralized planning, constructing wetlands, green community sewage treatment plants, and segregation of greywater at source.
- Implementation strategy – to develop suitable PPP models for the wastewater management solutions recommended. It identifies a wide-ranging spectrum of implementation models, with varying degrees of private sector participation and risk-sharing mechanism between public and private sectors.

The solutions are a package to be implemented in three stages. The primary solutions, based on an initial effluent study, will include a resource management plan, and models on water balance and plan implementation. Building on these, the strategy envisages tertiary water use policies, and a decentralization plan. Supporting actions will follow, consisting of wetlands and community sewage plant pilot projects, and programs on segregation at source, as well as on raising awareness and understanding of water issues among the public.

The solutions are presented below in order of priority:

Figure 8: **Prioritization Diagram – Wastewater management**



Legend

High priority | Medium priority | Low priority

Solutions

1. Integrated water resource management plan
2. Industrial effluent characterization & usage study
3. Water balance model
4. Treated water use policies
5. Decentralization plan
6. Constructed wetlands pilot project
7. Green community sewage treatment plant pilot project
8. Segregation at source program
9. Public awareness & education program
10. Implementation models

High priority

Knowledge planning strategy

Solution 1 – Integrated Water Resource Management (IWRM) plan

An Integrated Water Resource Management (IWRM) plan will examine all of the factors affecting management of wastewater in each city. It will include detailed mapping of sources of water supply, their utilization and disposal methods. The plan will examine industrial processes and urban usage, and will address land use, geographic and socio-economic factors determining wastewater volumes and quality.

The IWRM will respond to the cities' different circumstances. For example, in Ahmedabad there is far more domestic than industrial wastewater, whereas the opposite is true in Surat. Salinity is a significant factor in Rajkot, while the impermeable soils of Ahmedabad allow for surface run-off to be harvested and stored in lakes and ponds for domestic use.

Each city plan will address:

- Estimation of storm water versus wastewater quantities
- Formulation of viable strategies to harvest storm water, that will have an immediate impact on reducing wastewater infrastructure loads
- Segregation of domestic wastewater from industrial effluent volumes.
- Dissemination of information regarding wastewater issues to city planning officials

Considerations

- Lack of overall mapping of available water resources within a region
- Prioritization of use for primary and treated water

Next steps

- Prepare an IWRM plan with comprehensive data covering water supply, utilization and disposal aspects
- Develop strategies for effective macro-level water management, and identify specific implementation actions

Solution 2 – Industrial effluent characterization and usage study

Knowledge planning strategy

An industrial effluent study will identify water volume and treatment needs of key industries, feeding into a Water balance model (see Water balance model solution on p.22). It will examine the chemical composition and treatment of industrial effluents, as well as their subsequent use, leading to an analysis of the viability of Common Effluent Treatment Plants (CETPs) presently used by multiple industries.

The study will characterize treated water from CETPs into different grades, depending on the level of treatment and quality. It will examine the feasibility of using these different grades of industrial treated water in non-domestic uses such as forestry, floriculture, power generation, and rehabilitation of degraded areas.

The industrial effluent characterization and usage study will address the following aspects:

- Type of effluents within industrial zones
- Inventory of industries that reuse wastewater through resource recovery
- Viability of CETPs for different types of industries
- Land use/zoning strategies to implement effluent treatment effectively
- Innovative and green technologies for effluent treatment
- Use of treated water from domestic STPs in industries
- Use of treated water from CETPs in industrial and other non-domestic sectors

Considerations

- Non-availability of information on effluent usage in non-domestic uses
- Lack of awareness among industries regarding reuse of treated water from domestic STPs

Next steps

- Commission studies on types of effluents generated, and their possible uses pre- and post-treatment
- Collaborate with stakeholders to fund research of innovative uses of industrial effluents

Knowledge planning strategy

Solution 3 – Water balance model

A water balance model will estimate volumes of water flows in each city, and the infrastructure capacity required in different city zones. It will be based on the Integrated Water Resource Management (IWRM) plan (see IWRM solution on p.21) and effluent study analysis, and will estimate quantities of potable water, storm water and wastewater in the city. This will determine the infrastructure capacity required to treat wastewater, and identify zones within the city that have treated water surpluses and deficits.

The water balance model will include the following parameters:

- Potable water volumes available
- Domestic and non-domestic demand
- Wastewater volumes generated
- Industrial effluent volumes generated
- Infrastructure capacity
- Quality of treated water generated
- Distribution of treated water among various sectors
- Areas of surplus and deficit of potable and treated water

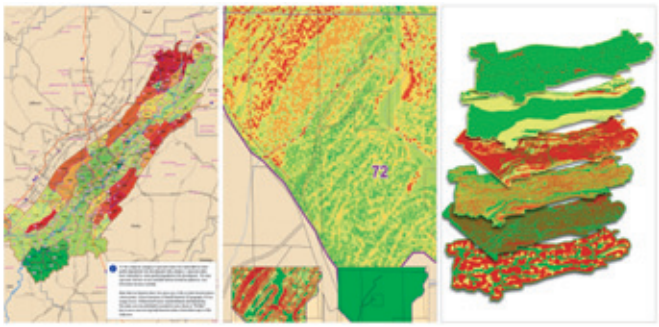
Considerations

- Increased demand on primary water sources
- Lack of holistic information on potable and treated water quantities
- Reusability of treated water

Next steps

- Assess available quantities and quality of potable and treated water
- Delineate areas of water surpluses and deficits
- Effectively distribute potable and treated water, depending on identified priorities

Figure 9: **Integrated Water Resource Management (IWRM) plan**



Infrastructure and innovative systems strategy

Solution 5 – Decentralization plan

A city-level decentralization plan will create smaller wastewater treatment units. This will increase wastewater treatment capacity locally, reducing loads at the higher level. It will help distribute costs and responsibilities, facilitating more effective management of wastewater systems, and optimizing the use of treated water by channeling it to secondary uses.

The plan will integrate small-scale Sewage Treatment Plants (STPs) within common open space areas in new and existing communities. It will achieve the following objectives:

- Modify existing networks into smaller centers aligned with water use cycles established in the water balance model
- Implement master planning tools, such as parcelling and repackaging land, to generate open space within inner city/densely urbanized areas, for locating decentralized units
- Enable participation of the private sector in design, construction, operation, ownership or leasing, and transferring treated water use facilities, wherever feasible
- Identify areas of surplus and deficit of potable and treated water

Considerations

- Ineffective functioning of centralized system due to overload
- Need to expand wastewater treatment capacity

Next steps

- Identify the viability of decentralization at different levels
- Study decentralization methods and workable models within communities
- Provide financial incentives for implementation of decentralization projects

Case study

A wetland project in Pune, India, was constructed in a natural storm water course downstream of a 5'000-person informal settlement that discharges wastewater into the wetlands. The pilot project is designed to handle a normal flow of 21'000–24'000 gallons per hour, as well as peak monsoon flows of 100 times the normal flow. It consists of four ponds in series, surrounded by an expanse of wetlands. Minimal flow is retained in the original stream-bed to preserve wetlands alongside ponds that act as a flood-plain during high monsoon flows, and "backup" natural cleansing system.

Infrastructure and innovative systems strategy

Solution 6 – Constructed wetlands pilot project

A pilot project will demonstrate the benefits of environment-friendly technologies for wastewater treatment. The constructed wetlands project, based on biotechnology and natural processes, will use mainly vegetation in a treatment process that produces treated water of reasonably good quality. Low operation and maintenance costs help make this process extremely viable.

Potential sites will include green belts and natural water courses, and may be close to existing treatment plants to accommodate overflow. Sites adjacent to river banks and lake shores will be desirable, processing storm water by trapping silt and checking soil erosion, thereby improving the water quality of the inflow.

Considerations

- Disposal of untreated effluents into the natural watercourses by overloaded centralized systems

Next steps

- Implement a wetlands pilot project to treat overflow through naturalized systems
- Introduce diversity of uses within the project to provide ecological and recreational value, in addition to appreciated real estate value for adjoining developments

Infrastructure and innovative systems strategy

Solution 7 – Green community Sewage Treatment Plant (STP) pilot project

A pilot community sewage treatment plant, operated and managed either through a Residents' Welfare Association, or third-party operator, will provide treated water for the local community. Processing wastewater within the community in this way will reduce infrastructure costs for the cities, while bringing environmental benefits. For example, treated water might be used to generate energy and usable produce that will help lower the carbon footprint of the community. The ancillary produce generated by treated water use from these systems will also reduce living costs.

The community STP pilot project will incorporate various advanced environmental practices including:

- Biogas plants to generate fuel
- Green roofs for climate control and vegetable gardens
- Rainwater harvesting at community level, to increase water supply
- Vermicomposting of kitchen and garden waste, to generate manure, using micro-organisms
- Productive landscapes, such as community gardens

Considerations

- Disposal of untreated effluents into the natural watercourses by overloaded centralized systems

Next steps

- Implement a wetlands pilot project to treat overflow through naturalized systems
- Introduce diversity of uses within the project to provide ecological and recreational value, in addition to appreciated real estate value for adjoining developments

Case study

In Chennai, India, the Alacrity Foundation promotes green water management programs, and implements cost-effective, on-site wastewater management and rainwater harvesting projects for residential areas. In a pilot project in a residential apartment complex in Srinagar colony, water for bathing and laundry is led via separate downpipes to flowerbeds of canna species, where bacteria in the roots purify the water naturally. The treated water is collected downstream of the flowerbed in a sump, and used on-site for gardening, car-washing, or flushing toilets. On-site STPs also produce treated water for non-domestic purposes.

Infrastructure and innovative systems strategy

Solution 8 – Segregation at source program

A community program will segregate reusable grey water at source, to reduce the load on existing treatment plants. The program will introduce point-of-use interventions to help separate grey water from wastewater in households. Grey water from kitchens and sinks, rainwater from roofs and other sources will be purified to procure safe, reusable water for secondary household uses.

Such a "segregation at source" program would reduce the treatment load by approximately 25%. Consequently, it would reduce the cost of upgrading the existing sewage infrastructure.

This approach is commonly used in households and schools of the tribal districts of Madhya Pradesh. The screen mesh and junction chamber systems use physical filtration at greywater discharge points to generate water for non-domestic uses.

Considerations

- Separation of reusable grey water from wastewater at household level
- Overload on community and city level STPs
- Usable treated water available at lower treatment costs

Next steps

- Collaborate with knowledge and technology partners to bring in point-of-use interventions and other water recycling measures
- Incentivize and subsidize technologies that help in treating water at the household-level

Infrastructure and innovative systems strategy

Solution 9 – Public awareness and education program

A public awareness program will increase understanding of water issues, and stimulate water saving action. It will educate residents of the cities about the limited availability of potable water, and the benefits of wastewater management. The program will involve public agencies and knowledge partners to promote large and small-scale wastewater management measures. Awareness among the general public will help reduce wastage of water throughout the human use cycle, and increase recycling practices.

The program will include:

- Print and broadcast media to improve visibility for community and household level water management measures, and promote their acceptance
- Focused educational workshops for administrative officials and the general public, to create awareness of best practices in wastewater management
- Specialized training to personnel involved in the operation, and maintenance of wastewater infrastructure at city, community, and neighborhood level
- Community programs to incentivize point-of-use interventions by individuals
- Curricula and workshops in schools and institutions introducing concepts of effective water conservation
- Master plan initiatives to promote improved wastewater management practices, integrated with other environment-friendly concepts and technologies

Considerations

- Lack of knowledge regarding conserving precious water resources
- Awareness among general public and officials about environmentally sustainable practices

Next steps

- Set up awareness programs to disseminate information regarding water harvesting, recycling and treated water use, and their environmental and economic benefits
- Publicize policies and incentives that encourage effective utilization of potable and treated water
- Encourage community involvement in decision making and implementation of sustainable wastewater management practices

Implementation strategy

Solution 10 – Implementation models

Public Private Partnerships (PPPs) will share resources, risks, rewards, and responsibilities in water management programs. They will provide options for efficient design, financing, execution, and operation of the wastewater solutions proposed here.

The PPP model needs to be appropriate for the risks involved by each partner. Several models, with varying extent of public and private participation, have been used successfully in the water treatment and distribution sector in India; for example, in Tiruppur, Tamil Nadu, Vishakhapatnam, Andhra Pradesh, and Haldia, West Bengal.

Attracting high private sector participation in implementation, operation, management, and maintenance of assets requires:

- Fair allocation of risks between public and private sector
- Proven institutional capability and financial capacity of the public sector
- Objective tariff fixing structure
- Independent dispute resolution mechanism

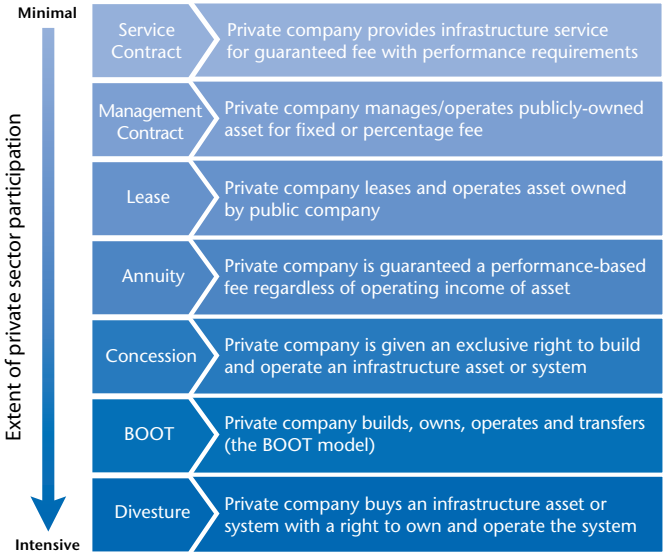
Considerations

- Effective wastewater management implementation strategies, involving both public and private sectors

Next steps

- Develop PPP implementation models that provide a suitable framework for distribution of risks and rewards
- Implement transition from an absolute public-sector to partial private-sector venture

Figure 10: **Private sector participation in various PPP models**



Low priority

Regulatory strategies

Solution 4 – Treated water use policies

Policies will promote the use of treated water by key industries and the commercial sector. They will drastically reduce the demand on primary sources, while allowing cities to increase availability of clean drinking water.

Policies are required to regulate demand and quality of treated water by:

- Restricting access to potable water, and diverting industrial demand to treated water
- Enforcing proper maintenance of wastewater treatment infrastructure
- Imposing penalties or taxes based on the "polluter pays" principle
- Implementing collaborative use of treated water between sectors that generate treated water, and those that consume it

Considerations

- Absence of a strong regulatory authority and policies to regulate effluent disposal
- Need to incentivize and promote treated water use

Next steps

- Prepare policies to improve quantity and quality of treated water available
- Develop regulatory framework to make use of treated water economically profitable
- Strictly regulate access to primary water sources

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