

INDIA | State of Karnataka

Creating a Sustainable Water Future for
Karnataka - Urban and Industrial Sector

November 2014



ACRONYMS	
BAU	Business-As-Usual
BBMP	Bruhat Bangalore Mahanagara Palike
BDA	Bangalore Development Authority
BOD	Biochemical Oxygen Demand
BWSSB	Bangalore Water Supply & Sewerage Board
CEA	Central Electricity Authority
CETP	Common Effluent Treatment Plant
CERC	Central Electricity Regulatory Commission
CII	Confederation of Indian Industry
CMC	City Municipal Council
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
CNNL	Cauvery Neeravari Nigam Limited
CoC	Cycles of Concentration
CSR	Corporate Social Responsibility
DEWATS	Decentralized Wastewater Treatment Systems
DIC	Department of Industries and Commerce
FICCI	Federation of Indian Chambers of Commerce and Industry
GDP	Gross Domestic Product
GoK	Government of Karnataka
IISc	Indian Institute of Science
IUWM	Integrated Urban Water Management
JICA	Japan International Cooperation Agency
KBJNL	Krishna Bhagya Jala Nigam Limited
KIADB	Karnataka Industrial Areas Development Board
KL	Kilo Litres
KNNL	Karnataka Neeravari Nigam Limited
KPCB	Karnataka Pollution Control Board
KPCL	Karnataka Power Corporation Limited

KSPB	Karnataka State Planning Board
KUIDFC	Karnataka Urban Infrastructure Development and Finance Corporation
KUM	Karnataka Udyog Mitra
KUWSDB	Karnataka Urban Water Supply and Drainage Board
LDA	Lake Development Authority
LPCD	Litres per capita per day
MLD	Million Litres Per Day
MTPA	Million Tonnes Per Annum
MW	Megawatt
MW/hr	Megawatt Hour
NGO	Non-Governmental Organization
O&M	Operations & Maintenance
PAT	Profit After Tax
PPP	Public Private Partnership
RTPS	Raichur Thermal Power Station
RWH	Rain Water Harvesting
SCADA	Supervisory Control And Data Acquisition
SWD	Storm Water Drainage
TMC	Town Municipal Council
TMC unit	Thousand Million Cubic Feet
UDD	Urban Development Department
UFW	Unaccounted for Water
ULB	Urban Local Body
USC	Ultra Super Critical
WRD	Water Resources Department
WRG	Water Resources Group
ZLD	Zero Liquid Discharge

Foreword

Water is linked to every aspect of human life. Depleting water resources is resulting in a continuous decline in per capita availability and becoming a matter of concern. Increase in population, urbanization and rapid industrialization are putting this resource under stress. As a result of population growth, per capita water availability for Karnataka has been declining, as a result of which, the State could be classified as experiencing “Water Stress”. The growing gap between supply and the demand for water is forcing the State to find new ways of achieving higher growth without using more water.

In this context, the 2030 Water Resources Group (2030 WRG) and the Government of Karnataka have come together in a partnership to understand the scale and nature of this challenge as well as identify solutions for addressing it. This report is an important milestone in this partnership and it contains detailed analysis of the growing demand supply gap for water in urban and industrial sectors by 2030. It also identifies various solutions and analyses them in two dimensions - cost and water availability – to enable meaningful prioritization. The report also identifies institutional, policy and regulatory changes required to enable implementation of the various solutions.

The water sector transformation requires collaboration between the government - to provide sound policies and regulation, private sector - to provide innovation, technology and management expertise, and the civil society - to provide civil oversight and inputs for a smooth transformation. It is hoped that this report would be instrumental in bringing all stakeholders on the table for a meaningful discussion on water sector reform. 2030 WRG and Government of Karnataka would work together to implement many of the recommendations emanating from the report to support over 60 Million citizens of Karnataka in their quest for rapid economic growth for which water is a significant enabler.

Executive Summary

Introduction

Water is crucial to support the economic growth aspirations of the state of Karnataka. The two largest and economically most important river basins of Karnataka – the Krishna and the Cauvery basins – have reached the point at which water demand exceeds supply. This report examines the challenge of meeting future urban and industrial water demands and presents ways in which the Government of Karnataka can prepare to address it.

Water Demand in the Urban Sector and Recommended Priorities

The total population of Karnataka is projected to increase from about 61 million in 2011¹ to 80 million by 2030. The total demand for domestic consumption of water in urban areas is projected to increase from 46 thousand million cubic feet (TMC) per year in 2011 to about 84 TMC by 2030.² An **additional supply of about 49 TMC annually** would be needed to close the demand-supply gap. The **Greater Bangalore region** will account for **two-thirds of the additional water** requirement and hence it requires significant attention from policymakers.

Hydro-cost analysis for urban sector

The water availability cost analysis can be used to evaluate available solutions to meet the demand-supply gap. Key observations from the analysis carried out for urban sector are given below:

- ❑ **Water use efficiency** – Government should undertake efforts to manage water demand in the Greater Bangalore Region through increased water efficiency measures by consumers. Reduction of physical water losses or unaccounted for water (UFW) reduction is another cost-effective measure to increase water use efficiency. UFW reduction projects with private sector participation, similar to ones currently being pursued in Bangalore, may be considered in other large cities too. UFW reduction projects are relatively less expensive per unit of water saved and can be the building blocks on which a subsequent switch to 24 X 7 systems can be planned.
- ❑ **Wastewater Reuse** - Wastewater reuse can be less expensive than supply augmentation especially if wastewater network systems and treatment plants are specifically planned and designed for re-use (due to reduced water transportation costs). Policy measures are required to incentivize reuse of wastewater by industries.
- ❑ **Water Conservation** - Rainwater harvesting is relatively inexpensive from a life-cycle cost perspective; however, the adoption is low, since the entire cost is presently borne by the consumers. Policymakers should consider focussing on rainwater harvesting, possibly through incentives and subsidies, in areas having low groundwater levels. Measures such as remodelling storm water drains and lake rejuvenation can also be pursued to reduce dependence on increasingly expensive, external water sources.

The Government should also examine measures other than primary source augmentation, particularly in areas already covered by water supply schemes. An **Integrated Urban Water Management** approach which focuses on water demand management and considers all water sources (rainwater, wastewater and groundwater) should be adopted. To the extent possible, the Government may try and restrict primary source augmentation measures and only extend coverage to rapidly expanding cities.

¹ Census of India 2011

² Based on water requirement norms prevalent in the State (norm of 150 lpcd (litres per capita per day) for Bangalore Metropolitan area, 135 lpcd for other Municipal Corporations and 100 lpcd for other towns).

Water Demand in the Urban Sector and Recommended Priorities

The total demand of water in the industrial sector could **increase more than three times**, from about 26 TMC/year in 2011 to 85 TMC in 2030. The power sector accounts for about half of this water demand with a potential increased requirement of about 34 TMC. Water demand from the steel sector, could rise from about 2.7 TMC/year to 10 TMC. In terms of regional distribution, close to **90 percent of industrial water demand** is in the **Krishna basin**. This fact reflects the need to focus on industrial water availability in this basin (especially for the steel sector in Bellary region) in the medium term. Ensuring water **availability in the dry season** is especially crucial for continuous operation of power plants and other industrial activities.

Hydro-cost analysis for the Industrial Sector

The water availability cost analysis for Karnataka's industrial sector focuses on specific solutions for water efficiency in large-water consuming sectors (thermal power and steel). The analysis also looks at generic solutions, such as industrial rainwater harvesting, reuse of wastewater and Zero Liquid Discharge for other sectors.

- ❑ It is possible to reduce the water demand from about 45 TMC for the power sector in the year 2030 to about 26 TMC if all power plants operate at benchmark water efficiency levels. Solutions are currently available, such as ash water recycling and increasing Cycles of Concentration, that save large quantities of water with very little cost. In addition, a number of several policy options pertaining to (a) choice of technology (super critical and ultra super critical), (b) choice of cooling systems (dry cooling), and (c) location of the plants near the sea that can all reduce fresh water requirements for power plants. **Integrated energy-water planning** is also important, considering the strong inter-linkages between the two sectors.
- ❑ Similarly, if steel plants operate at desired efficiency standards, the water demand, which is estimated to be 10 TMC in the year 2030 (only for steel production), could be brought down to some extent to about 7.5 TMC.
- ❑ The Government could adopt water reduction targets of about 20% in other sectors.

The incentives for water efficiency in the industrial sector are dependent on the cost of water, which is dependent on **tariffs** and water sourcing arrangements. Industrial consumers see vast **differences in the cost of water** (including raw water tariff, capital cost for setting up sourcing arrangements and operations cost due to pumping requirements), thereby suggesting a **need for rationalization**.

Converting Solutions into Actionable Strategies

Our recommendations have been categorized into three broad groups.

Key Sectoral Priorities - Certain sectoral priorities have emerged for responsible use of water in the domestic and industrial sectors. These are actions that need to be undertaken by policy makers in each sector to manage and meet additional water demand in a sustainable manner.



Strengthened Governance – Implementation of sectoral priorities must be supported by a **facilitative framework of governance** for Karnataka's water sector. This new framework would institutionalize the focus on water efficiency in all water use sectors, rely on sound economic principles for issues such as pricing and allocation of water and most importantly base its decision on sound data.

Enablers for Transformation – Policy makers have been aware of at least some of the solutions presented in the report; however, the key challenge lies in actually implementing solutions. Individual reform efforts tend to falter due to lack of wide stakeholder ownership and changes in leadership. The private sector has to play a critical role as a responsible water user, driver of water use efficiency in the basin through “Beyond-the-fence” measures and technology and service provider in the water sector.

The diagram overleaf presents our recommendations, primary responsibility of each recommendation and key stakeholders. It also indicates the time-frame for implementation of each stakeholder based on following categorization:

- **Ongoing** – These are initiatives which are currently being implemented by the Government and need to be strengthened or expanded in scope at the earliest.

- **Short Term** – These are measures that need to be implemented by Government of Karnataka in the next 1- 2 years.
- **Medium Term** – These are measures which should be evaluated more carefully and implemented in the medium term after careful diligence and planning. The government could target to implement these measures in the next 3 to 5 years.

	Recommendation	Time Frame	Water Resources Department	Urban Development Department	Industries and Commerce Department	Energy Department	Agriculture Department	Private Sector	Civil Society
Urban	U.1 - Create decentralized integrated water security plans for Bangalore	Short Term							
	U.2 - Drive water use efficiency in Bangalore	Short Term							
	U.3 - Launch Integrated Urban Water Management programs in select cities	Ongoing							
	U.4 - Plan consciously for wastewater recycling and reuse	Ongoing							
	U.5 - Maintain focus on UFW reduction programs	Ongoing							
Industries	I.1 - Rationalize water tariff structures based on sound economic principles	Short Term							
	I.2 - Integrated Energy – Water planning for effective decision making	Short Term							
	I.3 - Create a plan for industrial water in Bellary Region	Medium Term							
Governance	G.1 - Strengthen data available for effective water management	Short Term							
	G.2 - Create a Karnataka State Bureau of Water Efficiency	Short Term							
	G.3 - Lay foundations for the State Water Regulator	Medium Term							
Enablers of Transformation	T.1 - Launch a Multi-stakeholder platform to guide sector transformation	Short Term							
	T.2 - Channelize private sector resources and expertise in select strategic areas	Ongoing							
Legend  Primary Responsibility  Key Stakeholders									

As the above figure shows, most of the recommendations involve multiple stakeholders. Therefore, as an immediate next step, the State may create a **multi-stakeholder platform** that brings all stakeholders together in a structured manner to prioritize recommendations, find technical and financial resources required for implementation, provide handholding support and ensure that the entire reform program enjoys broad based support from the start. Such a platform can be the key enabler that this transformation effort requires.

1 Diagnosing the Challenge

1.1 Water resources challenge in Karnataka

Karnataka has a total population of 61 million, as per the 2011 Census of India. Karnataka is the ninth largest state in terms of population with 5 percent of India's population and 5.8 percent of the country's geographic area³. To put this in context, more people live in Karnataka than in countries such as Italy, Spain, Argentina and Canada⁴.

Like Karnataka, India as a whole has witnessed rapid growth in the last decade, with an average economic growth rate of over 8 percent per annum⁵. Karnataka is an important state for the country's overall economic performance since it contributes to about 6 percent of country's Gross Domestic Product (GDP) and 13 percent of India's exports. While there has been a recent decline in the rate of growth, the Planning Commission of India has set the target of 8 percent growth for the country in the twelfth five year plan (2012-2017).⁶

For these goals to be achieved, economic growth will need to be supported by growth in all three sectors of the economy – agriculture, industry and services. Higher growth, however, means greater water requirements for these sectors. Higher demands will be placed on water for irrigation, for process and cooling purposes in industry and for domestic consumption in urban areas – which are primary hubs for the services sector.

Karnataka exemplifies the particular problems India as a whole faces with respect to water resources, namely significant regional and temporal disparities in water availability. The total water availability of Karnataka is in excess of 3,200 TMC which is approximately 1,500 cubic metres per person per year for all water uses including food production. As per the Falkenmark indicator⁷ which is a widely used indicator to measure water scarcity, Karnataka would be classified as experiencing "Water Stress". However, closer examination of regional distribution of water resources tells another story. More than 2,000 TMC of water is available in West Flowing Rivers emanating from the ecologically sensitive Western Ghats Region. These are a collection of rivers that travel very short distances and rapidly discharge in the Arabian Sea, and are presently not utilisable except for a small percentage due to limited potential for use. The industrial and urban growth is primarily concentrated in the Krishna and Cauvery basins due to various factors. Thus, while the water resources are theoretically available to the state of Karnataka, their utilization potential, is limited due to unfavourable distribution of water resources and technological, environmental and cost constraints for inter-basin river transfers. When one considers only usable water, the per capita availability falls below 1,000 cubic metres per person per year. Based on this assessment Karnataka would be classified as a region experiencing "Water Scarcity". This situation implies that the total freshwater availability is increasingly insufficient to meet the needs of all stakeholders dependent on water. This report

³ Census of India, 2011

⁴ "2013, World Population Data Sheet", Population Reference Bureau

⁵ Central Statistical Organization, Government of India

⁶ "Twelfth Five Year Plan (2012 – 2017), Faster, More Inclusive and Sustainable Growth" by Planning Commission Government of India, 2013

⁷ "A Review of Water Scarcity Indices and Methodologies" by Sustainability Consortium – April 2011

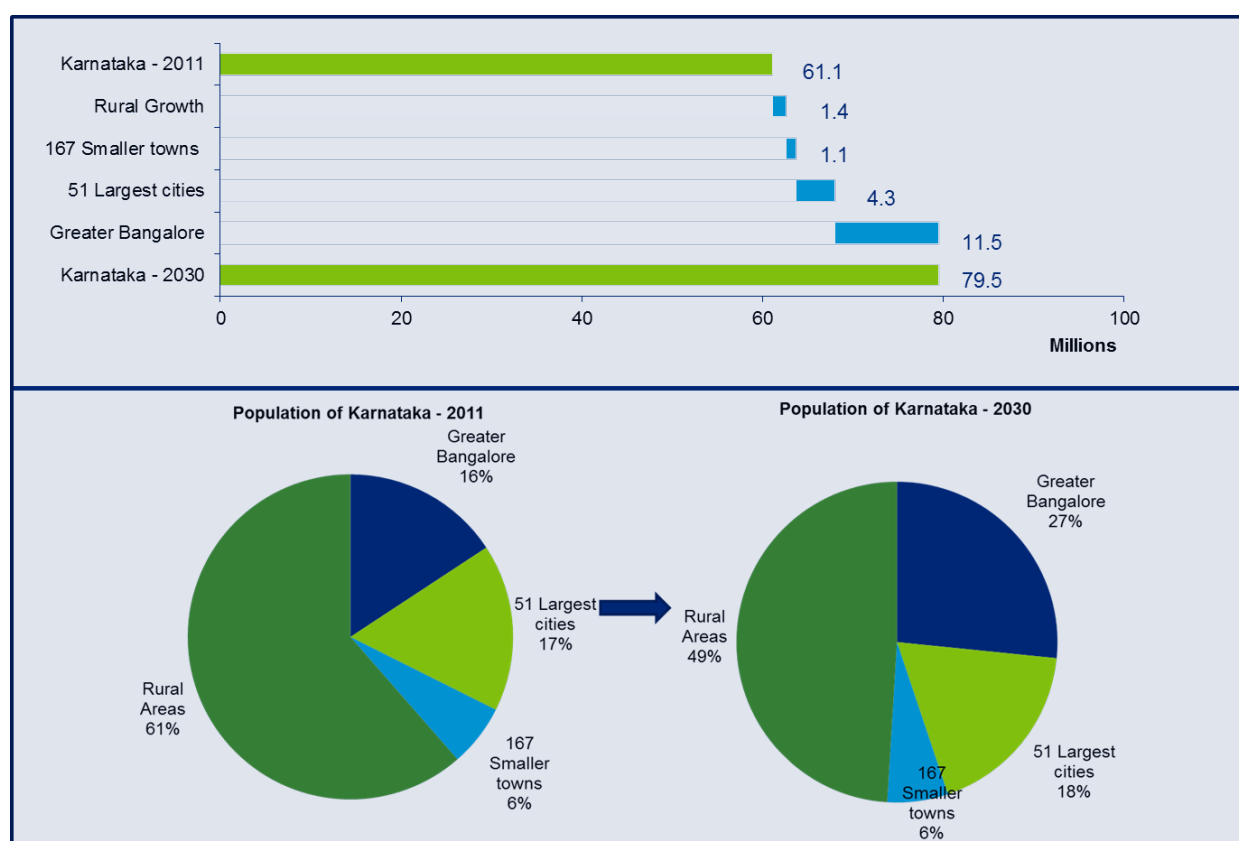
examines the scale of this challenge from the perspective of water demand from industrial and urban sector by 2030 and presents ways in which the Government of Karnataka can prepare for this challenge.

In addition, water quality issues are further reducing the effective availability of water. Surface water bodies are getting impacted due to increasing pollution load from untreated municipal sewage and industrial effluents. The Bio-Mapping report on major rivers of Karnataka by KSPCB has indicated changes in environmental quality of water sources especially in the industrialised regions. While facing severe depletion of ground water table due to over-exploitation on the one hand, the state is also facing rapidly growing ground water pollution in many parts. About 64 of the 234 watersheds have serious water quality problems in the state as per the recent analysis of ground water samples by the Department of Mines and Geology. Ground water is polluted with excess concentration fluoride, arsenic, iron, nitrate and salinity due to both anthropogenic and geogenic factors in parts of the State.⁸

1.2 Water demand in the Urban Sector

The demand for domestic consumption (both urban and rural) is largely determined by population and the geographical distribution of population (the norms for per capita water requirements are different for rural areas and towns/cities). In the graph below, we present the population growth forecasts for the year 2030 and distribution of the growth based on past growth patterns in recent decades.

Figure 1: Population projections for Karnataka - 2030



Source: Census of India, Deloitte Analysis

As per these estimates, if the past growth trends continue, the total population of Karnataka will increase from about 60 Million in 2011 to 80 Million by 2030. The population projections have been carried out

⁸ Socio-economic Review of Karnataka - 2011

separately for 1) Greater Bangalore region 2) the largest 51 cities (Municipal Corporations, TMCs -Town Municipal Councils- and CMCs-City Municipal Councils). 3) other urban areas 4) rural areas. As per these estimates, if the existing urbanization trend in Karnataka continues, the state can expect to reach urbanization levels of about 50 percent by 2030 from current levels of about 39 percent. **However, unless concerted policy measures are taken for balanced regional growth, the Greater Bangalore area – which has become the hub of economic activity in recent years – is likely to add another 11.5 million citizens by 2030.** The total population of Greater Bangalore would therefore be more than 20 Million by 2030. A recent report prepared by Bangalore Water Supply and Sewerage Board (Bangalore Water Supply & Sewerage Board) also projects water needs in Bangalore based on very similar population estimates.

A significant portion of this population growth in the city is due migration rather than natural population growth. Therefore, what effectively drives up the water demand is a) movement of more people into urban areas and b) higher norms for water supply applicable based on metropolitan norms. An analysis of urban water demand based on the applicable norms for 2030 indicates the results are shown in the graph. The population growth of rural areas is negligible and hence the focus of the report is on water demand for urban areas.

Figure 2: Water Demand in Urban sector in Karnataka



Source: Deloitte Analysis, Karnataka Urban Water Supply and Drainage Board (KUWSDB), Bangalore Water Supply & Sewerage Board (BWSSB)

Note: Please note that supply indicates present supply and not an estimate for the future supply.

As may be seen from the chart, it is estimated that **the total demand for domestic consumption in urban areas would increase from 46 TMC in the year 2011 to about 84 TMC in the year 2030 in a Business-As-Usual (BAU) scenario.** This scenario does not assume gains through water efficiency improvement nor reduction of water losses. As against the demand of 46 TMC, the supply from Government sources is about 35 TMC today resulting in a gap of about 11 TMC. Inadequate water source availability, inability to match investments in water supply (bulk water and distribution network) with growth of population, high levels of NRW as well as challenges in governance and policy arrangements are crucial reasons for this gap to have

emerged. To cope with this, citizens have resorted to private arrangements dependent largely on ground water which has resulted in excessive depletion of ground water within city boundaries in several large and medium sized cities in the State.

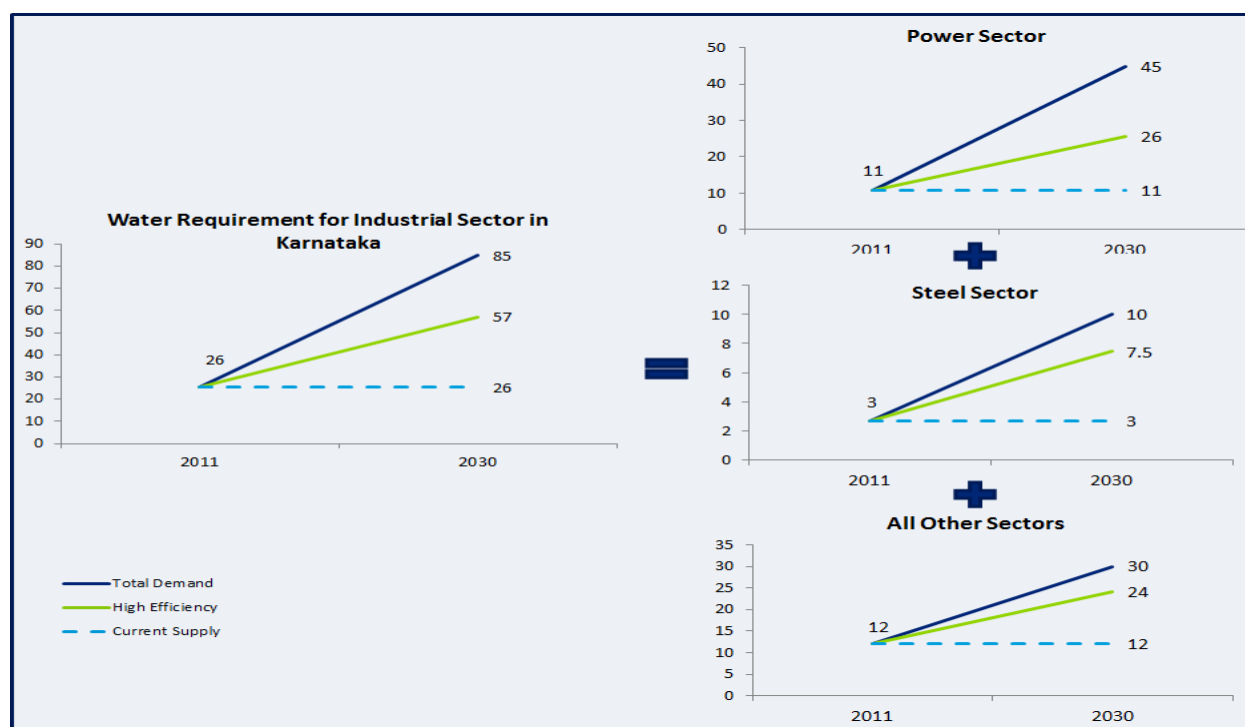
Out of this gap of 49 TMC in 2030 (vis-à-vis existing supply levels), 33 TMC is likely to be in the Greater Bangalore area alone. An additional 16 TMC of demand growth would be split between the remaining 210+ cities and towns with the majority of growth concentrated in the 51 largest cities. There are several implications for this demand – supply situation.

- a) **Bangalore is likely to account for about two-third of urban water demand by 2030 and hence needs highest attention of policy-makers.** It is quite apparent that the government must concentrate significant energy and resources on the city of Bangalore as it is likely to account for more than two-third of the additional demand for urban water in the Karnataka state. Bangalore also is a hub of commercial and industrial activity (especially the IT and other services sectors) which places additional demands on city's water requirements.
- b) **Consumptive demand for water is only about 20%; Water supplied to urban areas is not consumed fully but about 80% of the water supplied is available as wastewater return flows. Therefore the consumptive demand for water in urban sector is only about 20% of the freshwater withdrawals. This emphasizes the need to sharpen focus on effective wastewater management and reuse-** While the total gap is about 49 TMC (vis-à-vis existing supply), actual growth in consumptive demand would be about 10 TMC (at 20 percent of the total demand for consumptive use) only. However, the implicit assumption is that remaining 80 percent is put to some alternative use after treatment. Clearly, the utilization of wastewater either for agriculture, industry, domestic use – or to recharge groundwater in a sustainable manner after adequate treatment – is an extremely important element of the equation, which moderates the demand from about 50 TMC to 10 TMC.
- c) **Wastewater management is also critical from the perspective of sustainability -** The manner in which government manages wastewater is critical, not only from the point of view of ensuring its further utilization but also from the point of view of sustainability. Wastewater, which is disposed untreated in lakes, valleys and rivers, contaminates the surface and groundwater sources. Thus, instead of augmenting utilizable water sources, sewage may further reduce utilizable water resources. Evidence is emerging that areas around Bangalore are increasingly facing groundwater quality problems. The city of Bangalore generates over 1200 Million Litres Per Day(MLD) of wastewater but the present treatment capacity is about 721 MLD. However, the water that reaches these treatment plants is only about 300 MLD⁹
- d) **There are significant variations in water supply availability across urban areas reflecting the need to focus attention on select medium and small cities facing acute water scarcity -** There are large variations in the quality of water service delivery across Urban Local Bodies (ULBs). None of the cities have water availability 24 hours a day seven days a week, as is the case in most of India (even though important pilot initiatives have been initiated), In addition, there is significant disparity in terms of quantity, in making even intermittent water supply available. For example, out of the 51 largest cities about one-third receive water only once in three days and about a third of cities receive water alternate days. And only a third of cities receive municipal water on a daily basis. While Bangalore needs to receive significant attention, there is a simultaneous urgent need to increase water service delivery effectiveness in many other medium and small cities, as well.

1.3 Water Demand for the Industrial Sector

In Karnataka, thermal power production and steel manufacturing are the two largest industrial water consuming sectors. The graph below presents demand forecasts for industrial sector as a whole and the break-up between power, steel and other sectors.

⁹ "Identification of sources for sustainable water supply to Greater Bangalore" – Report of the Expert Committee Constituted by Government of Karnataka

Figure 3: Demand Supply projections for Industrial sector in Karnataka

Source: Energy Department, Department of Commerce and Industries, Deloitte Analysis¹⁰

As can be seen from figure 3, the total consumption of water in the industrial sector could increase from about 26 TMC to 85 TMC in 2030 in the BAU scenario. Power sector accounts for about 50 percent of the water demand.

While the steel sector may witness some slowing down of activity due to a recent mining restrictions imposed by the Supreme Court, it is reasonable to assume that activity will significantly rise once these restrictions are removed. The overall increase in water requirement from steel sector is expected to rise from about 2.7 TMC to 10 TMC in a Business-As-Usual scenario. While there is no reliable data available for industrial water use in other sectors, we estimate this to be in the range of about 12 TMC based on discussions with different stakeholders and reasonable assumptions on groundwater withdrawals for industrial use. The key other sectors consuming water in Karnataka are Sugar, Cement and textiles. IT and ITES sectors are presently largely located in Bangalore and their water demand is largely met through allocations to the city of Bangalore.

At present there is no mechanism to formally capture industry's perception of business risk related to water. A recent FICCI and HSBC survey on Industry's perception of business risk at the country level identified that about 60% of respondents felt that availability of water is impacting their business today. This figure rises to about 87% when respondents are asked about the likely impact of water availability on business after ten years. While this study is focussed at the country level, it does provide an indication of the risks related to water availability for doing business in India.

Some key considerations related to the pattern of demand growth are as follows:

- a) **Industrial water demand is pre-dominantly in Krishna basin** - Most of the water demand in the industrial sector is concentrated in the Krishna basin due to various reasons including availability of raw material, land etc. The Government of Karnataka has received several applications from different industries during the recent Global Investor Meets. A broad analysis carried out by the Desai committee which was constituted by Government of Karnataka to examine options for industrial water

supply in 2010 shows that about 90 percent of the water demand was in the Krishna basin. This reflects the need to focus on higher industrial water availability in Krishna basin not only from the perspective of allocations in the plans but also storage for industrial water.

- b) **Consumptive use of water in industry may be lower than the freshwater withdrawals; however it may not be as low as 2.5 percent due to increasing focus on re-use and Zero Liquid Discharge** - Due to implementation of closed loop cycle methodologies in industrial cooling applications, the return flows available are reduced substantially. This is especially the case in the power and steel sectors. In addition, due to pressure from by Karnataka State Pollution Control Board, industries reuse the wastewater generated within their plants in different applications, such as gardening, dust suppression etc. Therefore, while it is difficult to make an accurate estimation for the return flows available from industrial sector due to lack of data, it is unlikely to be significant from overall water resources perspective. The government also does not monitor the quantity of return flows but largely focuses its efforts to monitor the quality of wastewater discharge from the perspective of pollution control.
- c) **Ensuring water availability in lean season is very important which is proving to be increasingly challenging** - There is an additional challenge related to storage capacity for industrial water to ensure availability of water in lean season. The existing storages in the Krishna basin have been created largely for irrigation purposes. Furthermore, the storage capacity of these structures is diminished due to siltation. Therefore it is difficult for Government to provide allocations from the irrigation dams. The Government also finds it increasingly difficult to maintain river flows even in good monsoon years towards the end of the summer season. The current approach followed by the Government is to allocate water downstream of dams so as to not impact irrigation requirements (which has a higher priority as per national as well as Karnataka state water policies). This situation requires industrial facilities to create individual pondages in which they store water within their own premises for their requirements during the summer. The result is very high expenditures towards creating storage ponds and increased land needs per project.

1.4 Summary

In this chapter, an attempt estimate was made of the additional water demand for freshwater withdrawal as well as consumptive use in both urban and industrial sectors. Total demand from urban and industrial sectors is expected to rise rapidly to about 169 TMC in 2030 from current level of 72 TMC. The next chapter explores some of the solutions to reduce the demand to the extent possible and meet the resultant demand-supply gap.

2 Exploring the Range of Solutions through Hydro-Cost Analysis

2.1 Introduction

As discussed in the previous chapter, Karnataka may experience significant increase in water demand in the urban and industrial sectors. The focus of this chapter is to identify the various solutions and provide a framework for comparing these solutions. An analysis of the life-cycle costs of various solutions have been carried out to facilitate comparison.

2.2 Hydro-Cost Analysis

The water availability cost analysis can be used to prioritize available solutions and can be an important input to the decision making process within Government of Karnataka and with other important stakeholders. The horizontal axis represents the amount of water made available by each solution, while the vertical axis represents the life-cycle cost per unit of water available through each solution. A water availability cost analysis has been prepared separately for urban and industrial sectors with inputs from officials Bangalore Water Supply & Sewerage Board (BWSSB), Karnataka Urban Water Supply and Drainage Board (KUWSDB), Urban Development Department (UDD), Water Resources Department (WRD), Department of Industries and Commerce (DIC), Karnataka Industrial Areas Development Board (KIADB), Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC) etc. In addition to the inputs obtained from government officials, field visits were conducted with co-operation from Karnataka Power Corporation Limited (KPCL), JSW steel and select other private players to obtain other relevant inputs.

2.3 Hydro-cost analysis for the Urban Sector

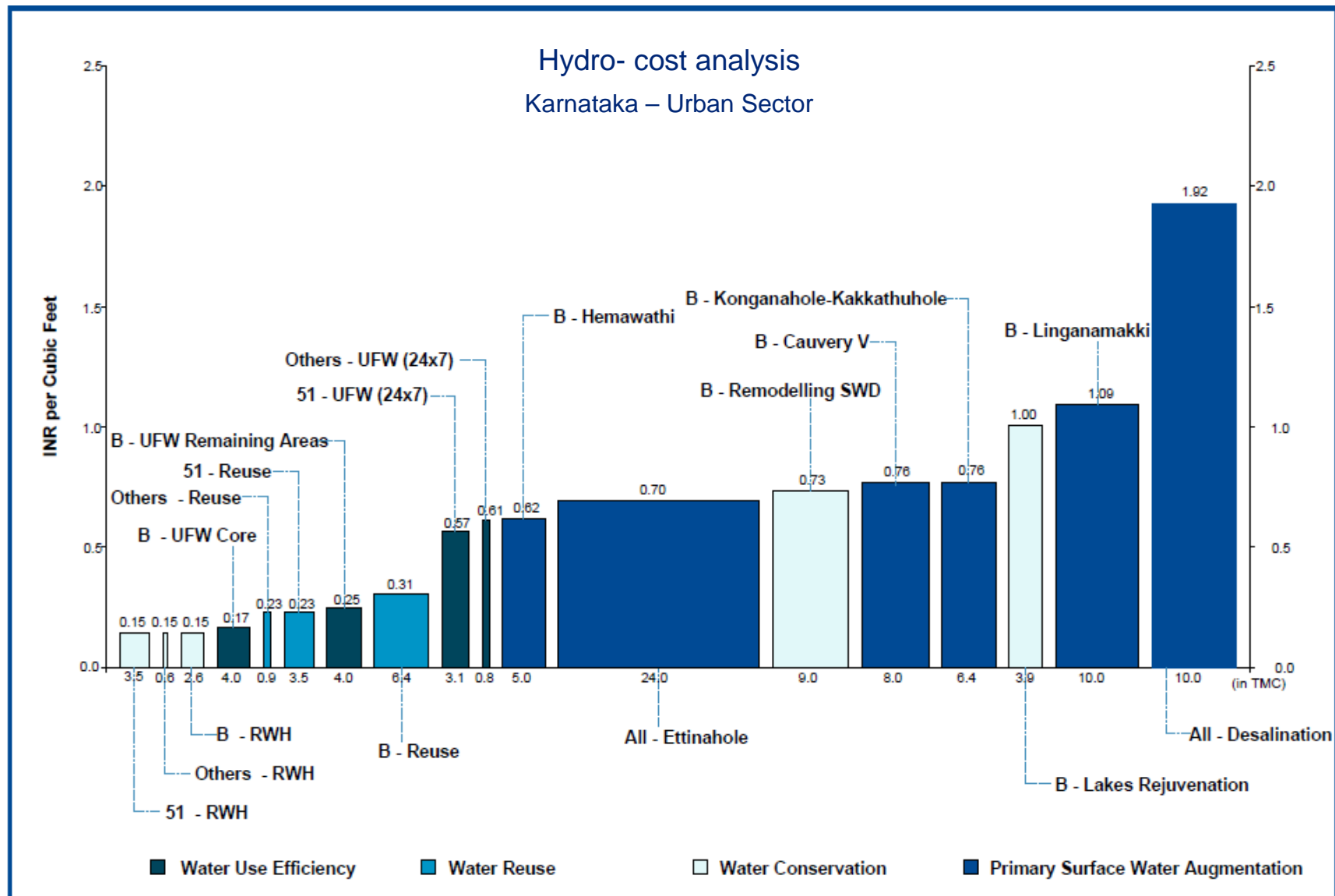
The solutions have been categorized in following categories.

- **Water Use Efficiency** – In the urban context these pertain to UFW reduction. We have presented the analysis separately for Bangalore, for 51 largest cities and for the remaining cities.
- **Water Conservation** – Solutions such as Rainwater Harvesting, remodeling Storm Water Drainage (SWD) for groundwater recharge, lake rejuvenation etc. have been categorized as water conservation solutions.
- **Water Reuse** - Recycling and reuse of water within urban sector itself has been presented as Water Reuse category
- **Primary surface water augmentation** – Making available additional water through tapping surface water resources has been categorized as primary surface water augmentation.

Details of assumptions taken to perform the analysis have been presented in Annexure – 3.

The diagram overleaf presents the output of the water availability cost analysis for urban sector. The diagram represents the costs of implementing various solutions.

Figure 4: Hydro- cost analysis for the urban sector in Karnataka



Note: 1) Establishment costs (staffing cost, office expenditure) have not been considered for any of the solutions.

2) The quantity of water saved through different solutions is not necessarily cumulative.

Legend:		
B – Bangalore ; 51 – 51 Largest Cities of Karnataka ; Others – 167 Other smaller towns; All – All categories		
UFW – Unaccounted for Water	Water Use Efficiency	Reducing water losses due to physical leakages, faulty metering, unmetered connections etc.
RWH – Rainwater Harvesting	Water Conservation	Collection of rainwater on rooftops for domestic use
Lake Rejuvenation	Water Conservation	Rejuvenating lakes for groundwater recharge
Remodelling Storm Water Drains	Water Conservation	Re-designing, re-laying and improvement in the drainage system
Reuse of Wastewater	Water Reuse	Treatment & re-use of water-water generated in urban areas
Hemavathi	Primary surface water augmentation	Transfer of water from Hemavathi reservoir to Arkavathi catchment for additional Bangalore city water supply
Ettinahole	Primary surface water augmentation	Diversion of 24 TMC of water from Ettinahole for water supply to the districts of Kolar, Bangalore Rural, Chickballapur & Tumkur & Bangalore City.
Cauvery-V	Primary surface water augmentation	Unallocated water of 12.88 TMC for additional water supply to Bangalore city under Cauvery Water Supply Scheme
Linganamakki	Primary surface water augmentation	Diversion of water from the existing hydro-power reservoir Linganamakki for Bangalore city
Konganahole & Kakkathuhole	Primary surface water augmentation	Diversion of 10 TMC of water from Konganahole & Kakkathuhole streams in the Western Ghats to Cauvery Basin.
Desalination	Primary surface water augmentation	Treating sea-water for various purposes

Source: Solution set for Bangalore city considered from the report “Identification of sources for sustainable water supply to Greater Bangalore” – Report of the Expert Committee Constituted by Government of Karnataka Solutions for Bangalore city; other solutions based on industry practice, discussions and Deloitte analysis. Please see Annexure 8 for key assumptions for the cost analysis

2.3.1 Interpreting the hydro- cost analysis

Following observations would be useful while interpreting the hydro- cost analysis.

- The Hydro-cost analysis captures benefits of each solution as the amount of water made available by each measure to close the supply-demand gap on the horizontal axis. The vertical axis shows the cost per unit through each measure per year. There are additional quantitative and qualitative benefits of implementing some of the solutions. For example, wastewater reuse would reduce the water pollution in surface and ground water sources or reduced need for investments in household storage if supply frequency is improved etc. However, such benefits have not been captured in this present study.
- **The cost analysis, is not prescriptive.** It does not automatically represent the suggested prioritization since a range of other considerations such as difficulty of implementation etc. must be considered. Rather, it is a tool to help decision-makers understand and compare different options for meeting the demand under a given demand projection.
- **The cost analysis does not include or evaluate policies that would be necessary to enable, incentivize, or enforce the adoption of the measures.** Rather, it provides information on what the cost would be of adopting a set of technical measures, which can be used for informed policy design.
- **The cost analysis does not attempt to comment upon technical feasibility of the solutions.** Many of the solutions discussed above (especially related to primary source augmentation) have known technical challenges and hence are considered not practical at least for the time being.
- **The costs and amount of water available are not to be considered as additive.** The objective of the cost analysis is to identify solutions that have high potential in terms of making additional water available and compare the solutions in terms of cost with reference to existing alternatives. The solutions are in many cases inter-connected and hence these are not additive.
- **The cost analysis is not static but dynamic in nature.** It is important to recognize that cost curve presents water saving opportunities and associated costs as assessed on a specific time. The economies are dynamic in nature and not only demand and supply but cost and water saving opportunities shift over a period of time. Therefore it would be appropriate to periodically reassess the situation.

2.3.2 Implications of the analysis for the Urban Sector

- **Water Use Efficiency Measures** – In the urban sector in Karnataka, there may be limited opportunities to reduce consumption of water as most of the cities do not even meet normative supply requirements of water. While there may be few profligate users, by and large, reduction of physical losses or UFW reduction is the most important measures to increase water use efficiency of the cities. Cities of Karnataka have varying degrees of water losses. While no accurate estimates are available, in our estimate about 12 TMC of water can be saved if physical losses are brought down to their minimum level. The Government of Karnataka has one of the most extensive programs for UFW reduction for Bangalore through private sector participation. The Government of Karnataka has now mandated that all new investments in water supply schemes will be done through 24 X 7 systems (with resultant focus on water loss reduction) with pilot projects already operational in the cities of Belgaum, Hubli-Dharwad and Gulbarga. A citywide effort to implement 24 X 7 project is also underway in another large city, i.e. Mysore.

The cost analysis shows that water use efficiency measures are amongst the least expensive options when life-cycle cost approach is followed for comparison. Since 24 X 7 projects aim to achieve overall service delivery improvements this approach is more expensive as can be seen from the cost analysis than UFW reduction projects.

Key implications for policy – Water use efficiency measures must continue to be pursued with greater focus as they appear as amongst the more cost effective solutions. If availability of funds is a constraint to up-scale the efforts in other towns, then UFW reduction projects may be considered instead of 24 X 7 projects to reduce physical losses of water.

- **Wastewater Reuse** – This is an important area, as discussed in the earlier section. Unless wastewater is treated and reused effectively, the non-consumptive part of water supplied to the city may pollute the surface and groundwater sources rather than supplementing it. It is therefore important to ensure that all wastewater generated is treated not only from the perspective of making additional water available but also to ensure sustainability of water use from other sources.

A total of 11 TMC of water can be made available for reuse, if we target to reuse about 20 percent of wastewater generated as is the norm set by Ministry of Urban Development as service level benchmarks. The water can be used within the urban sector (through dual piping system and for gardening etc.) or to supply to industries as is being attempted in Bangalore through efforts of Karnataka Industrial Areas Development Board and Bangalore Water Supply & Sewerage Board.

Key implications for policy – Wastewater reuse is less expensive than supply augmentation and therefore must be pursued as an explicit objective. This helps not only in augmenting availability of water but also reducing pollution of water systems.

- **Water Conservation Measures such as Rainwater Harvesting, Lake Rejuvenation** - Water conservation measures occupy the entire cost spectrum. While rooftop rainwater harvesting measures are the most cost-effective when life-cycle cost is taken into consideration, lake restoration projects and remodeling storm water drains to artificially recharge groundwater are much more costly. The city of Bangalore has taken several steps for rainwater harvesting including mandatory installation of Rain Water Harvesting (RWH) systems with rooftop size above 2400 sq. ft. In sum the total potential for rooftop rainwater harvesting is about 7 TMC (Bangalore 3 TMC, 51 large cities – 3.5 TMC and other cities about 0.5 TMC). Considering the cost effectiveness of making water available through RWH systems, there is a need to utilize full potential at least in Bangalore.

Key Implications for Policy – There is a need to increase focus on cost effective measures such as Rainwater Harvesting possibly through capital subsidy. Measures like remodeling storm water drains and lake rejuvenation, while expensive, should still be pursued to increase groundwater recharge.

Primary Source Augmentation Measures – As can be seen from the graph primary source augmentation solutions are the most expensive solutions. As city population and areas expand there is an inevitable need to supply more water, which would require primary source augmentation. However, it is important to ensure that an integrated approach is taken which reduces the need for primary source augmentation in existing areas through other measures. Our analysis shows that other measures can theoretically supply 30 TMC out of 33 TMC of total additional demand (including demand for new areas) for Greater Bangalore region, 10 TMC out of 13 TMC of additional demand for

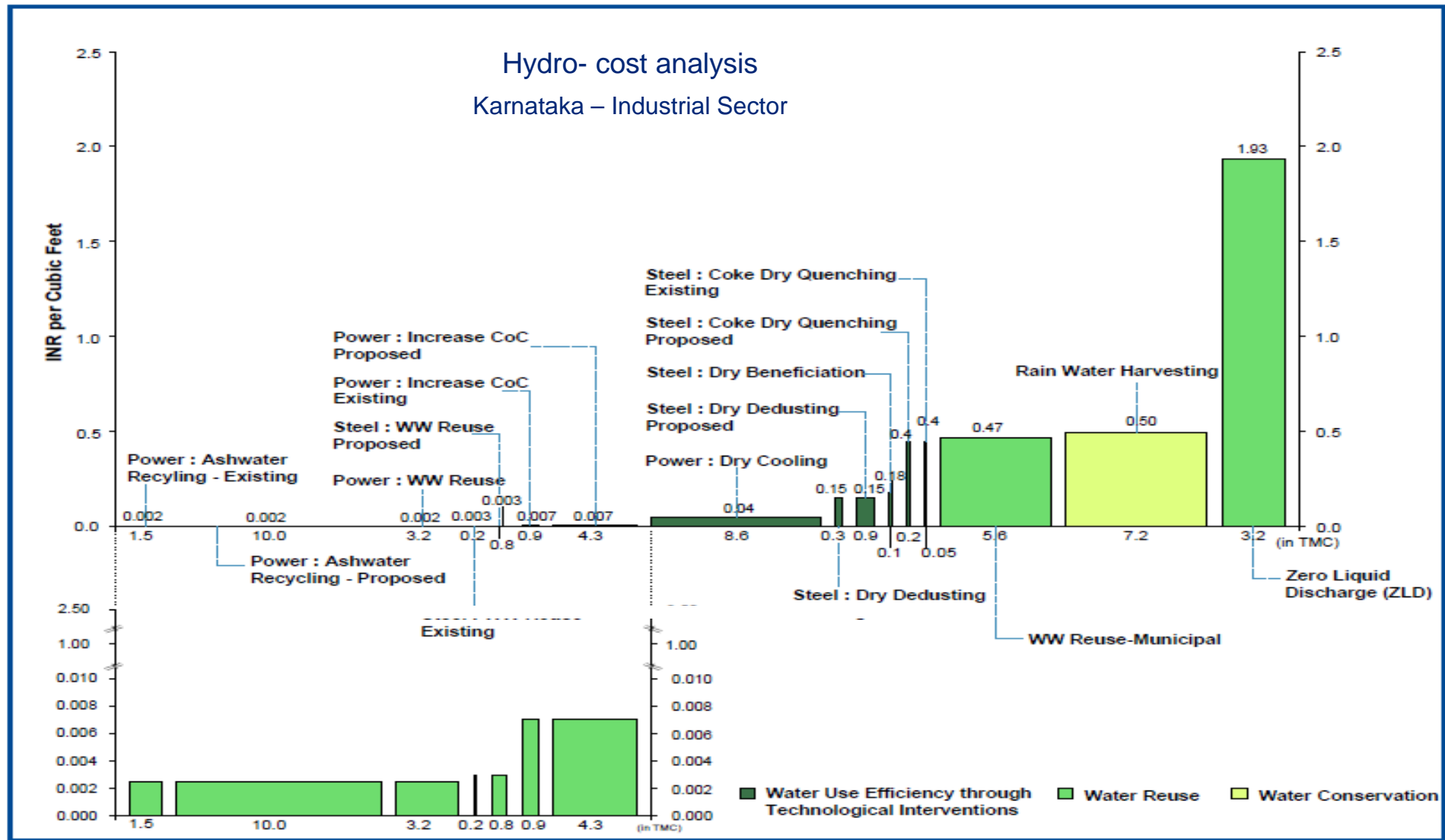
51 large cities and 2 TMC out of 3 TMC of additional demand in other smaller towns if the full potential is exploited.

Key Implications for Policy – Focus on meeting the additional demand in already covered areas through measures other than primary source augmentation.

2.4 Hydro- cost analysis for the industrial sector

The following diagram presents the cost analysis for the industrial sector in Karnataka. It focuses on large-water consuming sectors such as thermal power and steel. Water demand from other sectors such as cement, sugar, textiles etc. would also be significant by 2030; therefore, generic solutions such as industrial rainwater harvesting, reuse of wastewater and Zero Liquid Discharge (ZLD) methods have been considered in the cost analysis for these other sectors.

Figure 5: Hydro-cost analysis for the industrial sector in Karnataka



Note: The quantity of water saved through different solutions is not necessarily cumulative.

Legend:		
Power: Increase (CoC): Cycles of Concentration	Water Use efficiency	Increasing COC (3 to 5) to reduce blow down water quantity
Power: Dry cooling	Water Use efficiency	Alternative to water-cooling system by using air cooled condensers to cool the steam exiting a turbine in TPP.
Power: Recycling of Ash Water	Water Reuse	Reuse of decanted water after ash gets settled in ash settling ponds
Power: WW-Wastewater reuse	Water Reuse	Reuse of blow down water & other processes waste water generated during power production in TPP.
Power: Ultra Super Critical Technology (USC)	Water Use efficiency	USC Technology operating at increasingly higher temperatures and pressures to achieve higher efficiencies thereby reducing water consumption.
Steel: Coke Dry Quenching (CDQ)	Water Use efficiency	Alternative to wet quenching- coke cooled using an inert gas instead of water.
Steel: Dry De-dusting of Blast Furnace Gas	Water Use efficiency	Alternative to water scrubbing to remove Blast Furnace Gas (BFG) – dry methods such as electrostatic precipitator or a bag filter employed to clean the BFG.
Steel: WW-Wastewater reuse in industrial processes (excluding RWH)	Water Reuse	Reuse of wastewater generated during the steel production process. Includes reuse of blow down water from various steel making processes, recovery & reuse of backwash water & water from sludge, Condensate recovery etc.
Steel: Dry beneficiation	Water Use efficiency	Alternative to iron ore washing to remove impurities from wet processes to dry methods.
Rainwater Harvesting	Water Conservation	Collection, storage and reuse of rainwater that runs off from roof tops, paved areas, etc. in industry campuses /units
Municipal Waste Water for Industrial Re-use	Water Reuse	Tertiary Treatment of municipal waste water through stronger and more advanced treatment systems such as membranes filtration, de-chlorination, reverse osmosis etc.
ZLD-Zero Liquid Discharge	Water Reuse /Water Use efficiency	Advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater effluent produced.

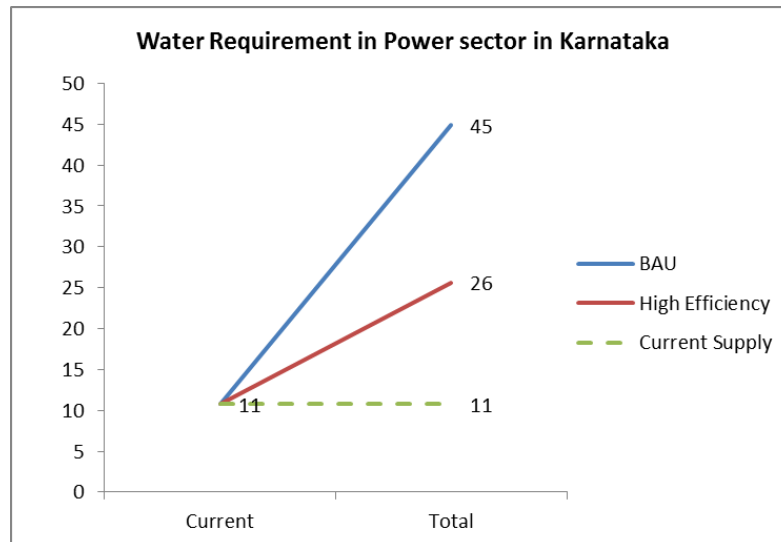
Source: Solution set prepared through discussions with experts and secondary research on water efficiency measures in power and steel sector and Deloitte analysis. Please see Annexure 8 for key assumptions for the Cost analysis

2.4.1 Interpreting the hydro- cost analysis

As seen in the previous section the total industrial demand is expected to increase from about 25 TMC to 85 TMC resulting in a gap of about 60 TMC. If we add up all industrial solutions presented above the total water saving potential is about 47 TMC. However, as many of these solutions operate on the same demand drivers, it may not be possible to save water through a particular solution, once a different solution has been implemented. In other words, there is an element of interplay between water saving potential of different solutions. For example, if we adopt dry cooling power plants, it may not be possible to implement solutions that reduce cooling water requirements, such as Increasing Cycles of Concentration (CoC) as the dry cooling systems don't use water in the first place. The following are some of the important observations from the industrial sector cost analysis.

Water efficiency in the Power sector

Karnataka state has several power plants both in the public and private sector as well as for captive use. Based on the discussions and site visits carried out, it is understood that the specific water consumption of power plants in Karnataka could be in the range between 6 to 8 m³/MW/Hr. When compared with industry best practices, there appears to be scope for improvement. The cost analysis shows the various solutions to reduce specific water consumption in power plants along with associated quantity and cost. The cost analysis shows that measures such as recycling ashwater and increasing CoC virtually cost nothing but save large quantities of water. **Based on our analysis, it is possible to reduce the water demand from about 45 TMC for the power sector in the year 2030 (under the BAU scenario) to about 26 TMC if all future power plants operate at benchmark water efficiency levels.** This scenario doesn't assume implementation of major technological changes such as dry cooling systems or super critical and ultra super critical technologies. By simple "within the fence" measures such as increasing cycles-of-concentration, recycling of ashwater, reuse of other wastewater etc., a reduction of demand by about 19 TMC can be achieved by the year 2030 as shown in the graph below. Further details of these measures are given in the annexure on power sector.

Figure 6: Water requirement for power sector in India in 2030 – Different Scenarios

Source: Deloitte Analysis

Additionally, as the cost analysis shows, many of these solutions are very low cost measures when considering unit cost of the measure based on life cycle cost perspective. Many of these don't get implemented due to following reasons.

- **Low cost of water** - If cost of water to the power plant is low because of low tariffs and transportation cost due to direct access, there is limited incentive to invest in water efficiency measures.
- **Limited understanding of water saving potential in absence of external water audits** - Since none of the power plants conduct external water audits, they may not aware of the water saving opportunities and associated costs which can hinder informed and rational decision making.
- **Institutional barriers that limit focus on efficiency** - There could be institutional reasons for reluctance to undertake these initiatives as well.

This shows that significant reduction of water use in the power sector is achievable simply by adopting cost-effective water efficiency measures in existing and future projects – provided government sets in place adequate mechanisms to incentivize the same.

Key Implications for Policy: - Encourage power plants in Karnataka to be more water efficient and operate at highest water efficiency standards in India.

Water efficiency in the Steel sector

Karnataka has large deposits of iron ore mines in the Bellary region in the Krishna river basin, which has attracted some of the largest steel players in the country. Government of Karnataka has received several large investment proposals to set up steel plants in Bellary, and the cumulative water requirement of these proposals is about 27 TMC (including requirements for integrated power plants). A few of these projects are witnessing slow implementation due to various reasons such as unavailability of land or raw material. Considering these factors, we have estimated that actual incremental demand (only for steel production) could be about around 10 TMC in the year 2030.

Before actually analysing the various water efficiency measures in the steel sector, it would be important to examine the existing water sourcing arrangements for steel plants operating in the Bellary region as it provides useful inferences to the inherent incentives for water efficiency in the steel sector. Steel plants in the Bellary region have made elaborate arrangements to ensure water security especially in the lean season. Due to inadequate availability of the water at the closest surface water source – the Tunga Bhadra dam – the Government has asked industries to draw water from downstream of the Almatti dam, which is more than 170 km away. The following exhibit presents JSW Steel's efforts to ensure water security for their Integrated Steel Plant in Bellary.

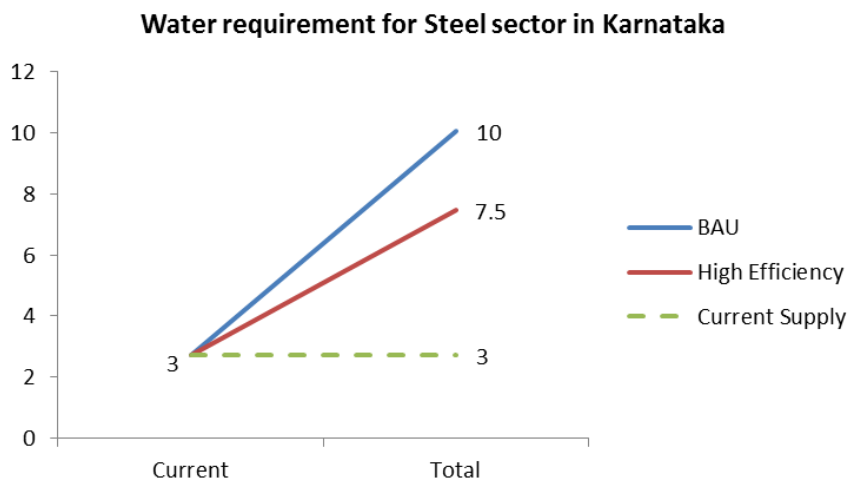
Water Security Efforts by JSW

JSW has expanded its facilities in different phases over the last decade, and currently their capacity stands at 10 MTPA with plans for future expansion up to 16 MTPA. They have two water sources. Initially they had been allotted about 1 TMC water from Tunga Bhadra dam which is about 40 km away. For their expansion, JSW was allotted water from downstream of Almatti dam about 170 km away. JSW has set-up a dedicated pipeline for bringing about 2 TMC of water from Almatti dam at a cost of 600 crores (about USD 100 million). Since the government is unable to guarantee adequate water flow from the Krishna River in the summer months, JSW has also been asked to create storage facility for their requirements during the summer (which has been made a standard requirement for all industries seeking surface water from Water Resources Department in recent years). Since the total water requirement of JSW is likely to be more than 3 TMC considering their expansion plans, they are in the process of creating a dedicated water reservoir on more than 600 acres of land in the vicinity of their plant, for which land acquisition is under way. The total project cost for creating this storage would be around 200 crores (about USD 30 million).

It is likely the government may require all large water consumers to create their own water infrastructure similar to JSW steel. The smaller sponge iron units use a combination of groundwater, local water bodies and rainwater harvesting to meet their requirements. In addition, the steel plants have recently shown an interest in purchasing secondary-treated, municipal wastewater from Bellary to meet their growing requirements, because this is the only source that guarantees water availability on all 365 days. This illustrates that there are strong incentives for the industries to reduce dependence on water for production in their interest. In addition, since cost of water could be very high for large users, many of the water efficiency measures have short payback periods. This perhaps is an important reason why the specific water consumption of JSW steel (about 3 m³/ tcs) is very close to national best practices and moving towards international best practices.

Assuming that all steel plants operate at desired efficiency standards, the water demand which is 10 TMC in the year 2030 (only for steel production) could be brought down to about 7.5 TMC as shown in graph below.

Figure 7: Water requirement for Steel sector in Karnataka in different scenarios



Source: Deloitte Analysis

Some of the key observations based on detailed understanding of water use in Steel sector are summarized below:

- **Steel sector has high implicit incentives for water efficiency** – Cost of water is high for large integrated steel plants not due to high tariffs but due to high water transportation costs and storage costs. This creates the implicit incentives for reduction of water consumption.
- **Large players like JSW have rigorous internal processes to increase water efficiency but even they do not practice regular external water audits** – The culture of getting external water audits which can identify measures to increase water efficiency is not observed in the industry.

- **Water security especially during the lean season is a high priority concern for steel sector** – Willingness of industry to purchase municipal wastewater due to availability throughout the year is a clear indication of the high priority steel sector accords to water security.
- **Steel players who have proposed to set-up plants would benefit from a futuristic planning through public-private partnership which reduces overall cost of water (even if it means higher water tariffs)** – The existing approach of requiring all industries to create individual ponds is very expensive and sub-optimal. There is a need for a collaborative planning to create a sustainable mechanism to ensure water security for steel sector and other industries in the region.

Key Implications for Policy: - Industrial water security for steel sector through collaborative action in the medium term; Increasing water efficiency through ever tightening water efficiency norms

Other sectors

In addition to power and steel sectors, there are many other large, medium and small scale enterprises located in clusters across Karnataka state. Many of these units do not consume large quantities of water individually but collectively their water consumption may be significant. While accurate data about water usage efficiency in other industries is not available, government could target water efficiency by about 20% till 2030 in all other sectors.

Another important issue from a water resources perspective is the quality and quantity of wastewater discharge from these industries. Many sectors such as textiles, chemicals, paints and dyes release significant pollutants that pollute water resources.

Industrial rainwater harvesting, reuse of municipal wastewater and zero liquid discharge are solutions that appear to be expensive as per the cost analysis. However, their adoption is not dependent on their absolute cost but cost relative to the alternative sources of water available. For example, a group of industries that depend on groundwater (and hence do not have to pay raw water tariff or do not incur any costs related to pumping water over long distances) may find adopting any of these measures unviable. However, any industry that pays high cost of water (payment to agencies such as the Bangalore Water Supply & Sewerage Board or transporting water over long distances) may find it economically viable to adopt such measures and reduce water consumption. Following are other important observations on these measures:

- Reuse of municipal wastewater can be important in areas where availability of surface water or groundwater is limited. It is also interesting to note that cost of treating municipal wastewater is lower than industrial wastewater; however, overall cost goes up due to higher transportation requirements. By careful planning of location of STPs and industrial areas, cost of reusing municipal wastewater in industries can be brought down substantially.
- Industrial Rainwater harvesting is more expensive and therefore may be of focus in areas where industries heavily depend on groundwater and groundwater is over-exploited considering all uses.
- Zero liquid discharge is the most expensive solution as per the cost analysis and may be pursued in sectors where other alternatives for safe evacuation of wastewater are not feasible.

Key Implications for Policy: Detailed understanding is required on cases where such measures should be pursued with higher focus. This understanding must be based on a more detailed and granular understanding of water demand, supply and pollution characteristics of individual sectors and in specific industrial estates. At present, there is very limited information in usable form which can aid decision making. There is a need to strengthen data management architecture to enable a more nuanced regulation.

2.5 Summary

In this chapter we have explored the various solutions and identify various drivers for adoption of these measures. Based on the comprehensive analysis of various solutions to meet the demand supply gap in urban and industrial sectors, it emerges that there are several solutions to reduce the gap in both sectors, but the nature of solutions that are likely to be effective is very different. The chapter has also highlighted key implications for policy for each of the sectors. In the next section, we propose measures that can address the priorities that have emerged.

3 Converting Solutions into Actionable Strategies

3.1 Introduction

Meeting the future demand of water requires actions in urban and industrial sectors to improve water management as well as strategic improvements in framework of governance for overall water resource management. This chapter highlights key priorities emerging for urban and industrial sectors to meet the demand – supply gap by 2030. We have categorized the recommendations in three broad categories:

- a) **Ongoing** – These are initiatives which are currently being implemented by government and need to be strengthened or expanded in scope as soon as possible.
- b) **Short Term** – These are measures that need to be implemented by Government of Karnataka in the next 1- 2 years.
- c) **Medium Term** – These are measures which should be evaluated more carefully and implemented in the medium term after careful diligence and planning. The government could target to implement these measures in the next 3 to 5 years.

3.2 Key Priorities for Water Supply in Urban Sector

Unlike the agricultural and industrial sectors, opportunities to implement technological fixes to increase water efficiency in the urban sector are limited. Per capita water supply in most cities in Karnataka is below normative standards set by the state and national governments. Therefore many cities face unmet demand as can be seen from the demand-supply analysis presented earlier. Therefore, going forward, there is limited opportunity for reducing water consumption per se.

In fact, about 80 percent of the freshwater withdrawal is available as wastewater that can be put to further use as seen earlier. Cities also have additional water resources in terms of rainwater and groundwater. Many cities waste as much as one third of the water they receive through physical leakages in the network. Conjunctive use of all the resources along with reduction in physical losses of water can help cities meet the additional demand without looking for additional new sources. Therefore the challenge for water resource management in the urban sector is effective water management. The role of the utilities needs to change from creators of primary water source augmentation infrastructure (as is largely today) to effective managers of water from various sources, including groundwater, rainwater and wastewater. In this section we present key ideas towards this objective.

U.1 - Create decentralized integrated water security plans for Bangalore

Short Term

Water is essentially a local challenge and so efficiency gains through water savings in one area cannot be redeployed elsewhere (especially in a completely different river basin or sub-basin or between uses of different sources of water). Therefore there is a need to create sub-regional water security plans.

Water management in Bangalore faces several institutional challenges and overlaps which constrains the effectiveness of government action, especially in areas such as groundwater management and lakes rehabilitation. To sustain the long term growth of Bangalore city, it is suggested to create either a division or sub-division wise “**Water security Joint Action Task Forces**” where officials of BWSSB, other government organizations such as BBMP, BDA, reputed private sector organizations, civil society and local representatives can come together for collective action. The objective of this task force would be to create

and implement medium term water security plans for the division or sub-division considering the scope of further development of that area from urban perspective and status of existing “water infrastructure – both natural and man-made”. These plans can include groundwater management, lakes rehabilitation, rainwater harvesting, artificial groundwater recharge, wastewater treatment and reuse as essential components to long term water security (in addition to surface water resources augmentation) as relevant in the local context of that division or sub-division. At present there are several government organizations such as BWSSB, BBMP, BDA, Mines and Geology department etc. involved in different aspects of water value chain. Such task force can play an important co-ordination role not only within government but also with multiple stakeholders which have a key stake in ensuring sustainable water availability. Such a task force can not only guide availability of water but also assist in larger theme of urbanization which perhaps needs to be guided by water availability as a central concern amongst others. Private sector should not only contribute ideas and technologies but also financial resources which are discussed in subsequent sections. The role of civil society needs to be strengthened in all aspects of water management, including planning and design of water supply schemes as well as operations and maintenance post implementation. To achieve this, civil society members needs to be given adequate representation in the Water Security Joint Action Task Forces along with Government and Private sector organizations. Additionally, a robust set of guidelines need to be prepared by the government to ensure uniformity and purposefulness of the plans prepared.

Action Items:

- Create division or sub-division wise “Water Security Joint Action Task Forces”
- Develop decentralized water security plans based on robust guidelines prepared by the Government

Key Stakeholders:

- BWSSB, BBMP, BDA, Mines and Geology department, Private sector organizations, Industry associations such as CII, NGOs, Resident Welfare Associations etc.

U.2 - Drive water use efficiency in Bangalore

Short Term

Sizable water savings can be achieved by targeting heavy water consumers in large cities such as Bangalore. These could be aimed at users such as Hotels, Restaurants, Offices, Hospitals and other institutions as well as residential consumers. A well thought-out program combining various economic instruments such as tariffs and taxes, oversight, advocacy and introduction of water efficient devices should be planned for Bangalore as a start. Singapore has embarked on an ambitious program to reduce per capita water demand which shows that results can be achieved through focused effort. Though many conditions that led to the success of the program in Singapore are not applicable in Bangalore, it still provides a useful case study towards how a successful public engagement program targeting water use efficiency can be designed in Bangalore.

Water Demand Management Strategy - Singapore

The Public Utilities Board (PUB), Singapore's national water agency, has recognised that projected population growth will lead to increased future water demand. Key to managing demand is facilitating behaviour change in water use and consumption. The campaign to manage demand is known as the 3P approach and encourages everyone (People, Public, and Private) to take ownership of water resource management. This concept is embodied in PUB's tagline - Water for All: Conserve, Value, Enjoy. Central to this new approach is the Active, Beautiful, Clean Waters (ABC Waters) Programme which is enhancing Singapore's water infrastructure bringing people closer to water, so they better appreciate, cherish and ultimately value water. Water conservation programmes have encouraged industries and households to use water wisely, and save 10% of their water use, and 10 litres of water a day respectively. Per capita water use has fallen from 165 litres/day in 2003 to 155 litres/day in 2013 and the aim is to achieve 147 litres/day by 2020.

Key Elements of the Program

- Community engagement through; Water Efficient Homes (WEH) and development of ownership through the Active Beautiful Clean (ABC) waters programme.
- Pricing restructure, upgrading the metering system and legislative measures.
- Water Efficiency Fund to encourage companies to manage demand.

Source: Adapted from 2030 WRG - Managing Water Use in Scarce Environments - A Catalogue of Case Studies

We suggest a four point program for Bangalore to encourage water efficiency and conservation.

- **Water Audits for Bulk Consumers** – The Bangalore Water Supply & Sewerage Board has computerized accounts of water consumption by all individual connections. The data can be used to identify important and excessive users of water in each division and sub-division and focus attention to reduce their water consumption. As discussed subsequently, a Karnataka State Bureau of Water Efficiency should be constituted that (1) conducts water audits for large consumers; (2) provides recommendations for achieving reduction in water consumption; and (3) tracks the implementation of such recommendations in subsequent audits.
- **Water efficient Devices and Technologies** – The Water Efficiency Bureau can certify devices such as faucets, shower heads and toilets for water efficiency similar to energy efficiency labelling conducted for air conditioners and refrigerators. In developed countries, the utilities work with bulk users to guide them to right suppliers of water efficient equipment.
- **Water Tariffs** - Pricing of water acts as an important economic incentive to increase consumer consciousness and induce action about conserving water. Tariffs also act as an incentive to adopt water saving technologies by reducing the payback periods of such measures. There is an additional dimension of ensuring financial sustainability of Bangalore Water Supply & Sewerage Board, which cannot be assured without periodic revision of tariffs. While it is recognized that the city of Bangalore has the amongst the highest water tariffs in the country, they have not been revised since 2005, while the costs continue to rise. Analysis of Bangalore Water Supply & Sewerage Board accounts reveals that their operating surplus is reducing year-on-year; consequently, the board is losing its financial bandwidth to support any additional initiatives. An automatic provision could be considered to escalate water tariffs based on an index comprising of energy and staffing costs as input variables to ensure that increases in revenues at least match the increases in costs. Such a provision enables the users to be aware of predictable and gradual tariff increases in advance and hence plan accordingly – rather than be forced to accept sudden and high increases in tariffs.
- **Public Awareness** - In addition, a general public awareness campaign could be launched to increase civic awareness about water scarcity in the city, emphasizing important consumer behaviors. An engaged citizenry is important for achieving any water sector reform, and it is never too early to start a dialogue. The Bureau should work with Joint Water Security Task Forces proposed earlier as organizations through which awareness is generated in each division or sub-division based on local priorities and context.

Action Items:

- Create a Karnataka Bureau of Water Efficiency with an urban division that focuses on three activities:
 - Water audits for bulk water consumers in each division and sub-division
 - Water efficiency labeling for devices such as toilets, shower heads and faucets
 - Public awareness campaigns to promote desired behaviors for water conservation

- Provide built-in provisions for yearly tariff increases in water rates based on a composite index

Key Stakeholders:

- Urban wing of Karnataka State Bureau of Water Efficiency (To be created), BWSSB, Resident Welfare Associations, NGOs, Private Sector (Bulk water users)

U.3 - Launch Integrated Urban Water Management programs in select cities

Ongoing

While surface water source augmentation remains an important option since urban areas are expanding rapidly, the utilities must try and ensure that cities overall dependence on such sources reduces over a period of time. This calls for a different mindset, with a focus on small initiatives that are local in nature, with citizen co-operation to capture rainwater, utilize treated wastewater or promote water conservation. The Government of Karnataka already has supported such a project on a pilot scale led by a leading NGO called Arghyam in the town of Mulbagal in the Kolar district. The project has achieved reasonable success over a five year period. One of the important findings of the pilot project is how such a transformation requires long term commitment in terms of attention, resources, technical skills and motivation.

Considering the acute water scarcity experienced by large number of cities in Karnataka, such projects should be initiated through government support (possibly with the help of multi-lateral agencies and Non-Governmental Organization (NGOs) in districts facing chronic water shortages. The likelihood of citizen awareness, political support as well as impact of interventions is much higher in these areas. The government should identify at least 10 small to medium size cities where such a program could be rolled out. To create economies of scale, the staff for such a project can be housed at the state level (e.g.: a Project Support Unit) along with a representative in each of the cities. As in the pilot project at Mulbagal the government should leverage technical expertise available in various organizations – such as Indian Institute of Science, Bangalore (IISC) – and the social capacity of NGOs for mobilization. The project could be conceptualized on a rolling support basis, which can take up additional towns as more and more towns stabilize in terms of execution bandwidth requirements. To bring momentum and faster impact, government may consider utilizing services of experienced private sector organizations at the state level.

Action Items:

- Initiate a state-driven program for Integrated Urban Water Management in ten small to medium towns;
- Create a hub and spoke model where technical expertise is shared at the state project support unit with permanent local representation at the city level for affecting change management;

Key Stakeholders:

- UDD, NGOs and Civil Society Representatives, Private Sector – Support through CSR

U.4 - Plan consciously for wastewater recycling and reuse

Ongoing

The city of Bangalore is beginning to realize the value of wastewater for economic use. Bangalore Water Supply & Sewerage Board and Karnataka Industrial Areas Development Board have initiated projects to treat wastewater and supply to industries that are beginning to run out of groundwater and other water sources. However this reuse of wastewater, post tertiary treatment, is often being planned as an after-thought. What is needed is a radical shift in approach where all decisions related to wastewater network and treatment are driven with reuse potential as a primary objective.

At present, whenever any wastewater collection and treatment decisions are made, factors such as cost, location, availability of land, topography and post treatment evacuation into streams are taken into consideration. This results in sub-optimal designs where water is available post treatment in a location where there is no economical use. Experience of cities like Bellary show that the wastewater has economic use and it can, at the minimum, cover the cost of Operations & Maintenance (O&M) for treatment plant if reused in industrial sectors. In our discussions, private players in water and wastewater space have

indicated an interest in working on PPP arrangements to collect, treat and supply treated wastewater to industries. The government must explore such opportunities to reduce funding support required and leverage operational efficiencies of private sector players.

It is clear that cities must think through the plan for reuse for affordability and sustainability. The diverse options for reuse must be factored in the analysis at the planning state. When only 20 percent of the water is allocated to urban sector as consumptive use, there is an implicit assumption that remaining 80 percent of water can be put to good use. This can be done through mechanisms that actively promote wastewater reuse in all possible applications. Officials from the Government organizations are sensitive with respect to the need for reuse, however, there are very limited successful examples of such initiatives on ground on account of lack of willingness of industries to use recycled wastewater. Perhaps a policy shift is required to incentivize industries to co-operate in this regard.

An additional concern that has resurfaced in this context (based on discussions with stakeholders) is the smooth co-ordination and co-operation between BWSSB and KIADB (and also BBMP, BDA to some extent) for industrial water reuse. Our earlier recommendation on creating decentralized water security task forces can possibly be the mechanism which can facilitate such co-ordination and co-operation.

Action Items:

- Create a plan to sustainably utilize 100 percent wastewater for all cities in the next five years. In Bangalore, this should be folded into decentralized water security plans earlier.
- Ensure all wastewater treatment projects provide for a detailed analysis of alternative uses and arrive at final decision based on financial and sustainability considerations.
- Incentive industry to use wastewater through appropriate policy measures

Responsibility:

- UDD, BWSSB, KUWSDB, KUIDFC, KIADB, Private Sector

U.5 - Focus on UFW reduction programs

Ongoing

Bangalore Water Supply & Sewerage Board (BWSSB) has initiated UFW reduction projects through private sector participation in the city of Bangalore. This is first-of-its-kind project in India where private sector expertise is being used to track and repair water leakages in a city. BWSSB needs to arrange funding for remaining projects to cover the entire Board's jurisdiction area. Additionally it must set-up mechanisms to ensure that either through direct involvement of the private player or through intensive capacity building efforts, UFW levels do not rise after project periods are over.

In other towns, Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC) has adopted a slightly different approach for UFW reduction. They have initiated pilots for 24 X 7 water supply services in three cities of Belgaum, Gulbarga and Hubli-Dharwad. Additionally, a large 24 X 7 project is also being executed in Mysore. KUIDFC plans to implement all water supply schemes on 24 X 7 basis from now on. As no 24 X 7 project can sustain if water losses are high due to physical leakages, all such projects invariably need to reduce physical losses of water substantially. Of course the financial costs of 24 X 7 projects are higher as compared to UFW reduction projects for saving an additional unit of water as seen in the cost analysis. It is suggested that government continue to build on the efforts underway and gain momentum for a much larger roll-out. Based on relative success of both types of projects, a future plan can be chalked out for extending such projects to at least the large corporations in next five years.

Action Items:

- Expand coverage of UFW reduction projects in Bangalore;
- Cover all major corporations with either UFW reduction or 24 X 7 projects in the next five years;
- Gradually extend the reach of such projects to all 51 largest ULBs in the medium term.

Key Stakeholders:

- UDD, BWSSB, KUWSDB, KUIDFC, Private Sector

3.3 Key Priorities for Water Supply in Industrial Sector

As industrial growth increases, it is important that industry adopt the best international practices to improve water use efficiency. The government has a limited direct role to play in industrial water efficiency as compared to urban sector; however, it can create an enabling environment that encourages water efficiency. In the power sector, the government does have a more active role since many of the largest power plants are owned and operated by public sector entities.

As with urban sector, the focus of water efficiency in the industrial sector is critical not only from the purpose of reducing freshwater consumption, but also in terms of reducing water pollution. Many measures that reduce water consumption also reduce water pollution (such as recycling or water efficient technologies). In that context, the measures suggested here may assume higher significance than solely reducing the demand-supply gap by 2030 (which is the main purpose of this report).

In this section, we examine key suggestions for improving the policy, regulatory and institutional frameworks to encourage industry to improve water use efficiency in existing as well as new plants.

I.1 - Rationalize water tariff structures based on sound economic principles

Short Term

The role played by economic signals (either through incentives or disincentives) is important in affecting behavior change especially for stakeholder groups like industries which are sensitive to such signals.

The current regime of water charges presents inconsistent signals across different user segments. For examples, industrial and commercial users that are supplied water by either Bangalore Water Supply & Sewerage Board or Karnataka Industrial Areas Development Board pay water charges ranging from about 60 Rs. / KL (top slab rate for Bangalore Water Supply & Sewerage Board) to Rs. 10 / KL (Rate for Karnataka Industrial Areas Development Board).

The raw water tariff charged by WRD is Rs. 1800 per Million Cubic Feet (5 paise per KL) if water is drawn from natural waterways, rivers or streams for industrial use and Rs. 3200 per Million Cubic Feet (9 paise per KL) if water is drawn from canal, tank reservoir, anicut, pond etc.

At the other end of the spectrum, industries which use groundwater do not have to pay any charge to any agency and the cost of water for them is only determined by cost of water extraction.

There are some other states that have adopted a more granular form of tariff. For example, Government of Maharashtra follows the following tariff structure for industrial consumers.

Table 1: Water tariff structure for Industrial Water in Maharashtra

Type of Water Supply	Process Water Rs. / KL	Raw Material Rs. / KL
Assured Water Supply Major/Medium reservoir/storage tank without canal/	3.2	16
Regulated Water Supply with Transmission Loss Regulated river portion below dam/canal lift / K.T. weir with back up reservoir / tail race from reservoir	6.4	32
Partly Assured Water Supply Minor reservoir with canal / K.T. weir without back up reservoir/ unregulated rivers without even any K.T. weir or in unregulated river portion flowing within a command area where there is no bandhara or K.T. weir	1.6	8
Reservoir Constructed by the Water User Entity / User Entity Shared Proportional cost Water user agency has shared proportional cost of infrastructure or constructed dam/bandhara/ katcha bandhara/ K.T. weir at own cost	1.07	5.35

Source: Water Resource Department, Government of Maharashtra

In the tariff structure adopted by Government of Maharashtra, a distinction is made between different levels of support / assurances provided by government for water supply and the purpose of water consumption in the industries (weather process water or raw water). This is an attempt to reflect the true economic costs of water from the perspective of supply as well as from the perspective of the user – depending on the circumstances and nature of industries.

In addition, the quantum of wastewater cess is not enough of a disincentive for industries to reduce water pollution.

Government of Karnataka may examine water rates adopted by other states such as Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu along with identifying key parameters on which different water pricing structures could be set-up. The objectives of rationalizing tariffs would be multiple:

- a) Encourage industries to reduce water consumption and wastewater discharge;
- b) Provide signals to water users on relative water scarcity depending on assurance of supply, ultimate use of water as well as scarcity of water in the basin;
- c) Generate financial resources to invest in water efficiency and sustainability activities. The government may create a Karnataka Water Efficiency Fund to channel such resources specifically for water efficiency initiatives in all three sectors through the Water Efficiency Bureau.

The tariff structure should reflect true economic costs for provision of water to industry. In addition, to incentivize industries to use wastewater, as per the present thinking of Government of Karnataka, appropriate economic signals need to be given. For example, price of treated wastewater should be lower than freshwater supply which would incentivize industry to come forward for water reuse programs.

It may be noted that tariffs beyond a certain limit may have adverse consequences. For example, the state of Karnataka may be less competitiveness vis-a-vis competing states for potential investments or users may decide to opt for groundwater instead of surface water. Therefore, designing an effective tariff structure must be done with adequate analysis.

Action Points:

- Carry out a detailed analysis on competitive tariff structure to reflect true cost and value of water

Key Stakeholders:

- WRD, DIC, KIADB, Industries wing of Water Efficiency Bureau

I.2 - Integrated Energy – Water planning for effective decision making

Short Term

The tradeoffs between energy and water have become increasingly important as demand for both resources increase and governments continue to struggle to ensure reliable supply to meet sectoral needs. As almost all energy generation processes require significant amounts of water, and water requires energy for treatment and transport, these two resources are inextricably linked. Therefore, policy decisions in the energy sector have wide-reaching implications for water and urban sector and vice-versa. For example, for future planning in the energy sector the Government has to consider the following questions, all of which have implications for water sector:

- How much power to generate in the state vis-à-vis how much to import?
- What would be energy mix? Specifically how much power to be generated through hydro-power and how much to generate through thermal power?
- What would be the location for thermal power plants? Can thermal power plants be set-up near the coast to utilize imported coal and sea water?
- What would be the optimal choice of technology (sub-critical / super critical and ultra super critical) for coal-based thermal power plants?
- What would be the cooling technologies in thermal power plants (Dry cooling / Wet cooling)?

Many of these questions represent various types of trade-off. For example:

- Importing power from other states may obviate the need to provide for water, land and other infrastructure for the power plants in the state, but it may leave the state vulnerable to supply and pricing shocks.
- While hydro-power generation may not be a “consumptive” use of water, it does alter the usability of water. For example, the Linganamakki reservoir has been created for hydropower generation. The water from the reservoir can be used for alternative purposes such as domestic consumption. In fact, the report prepared by committee constituted for Bangalore water security for 2050 argues that hydro-power generation from the reservoir be reduced to supply water to the city of Bangalore as there are alternatives for generation of power – but there are no substitutes for making available additional water for domestic consumption.
- While locating thermal power plants near the sea-coast to use sea-water for cooling may solve water challenges, it may create new challenges. For example, can imported coal be cost competitive? Can adequate land be made available in the region? Is there availability of adequate evacuation infrastructure? Can the power plant be constructed in an eco-sensitive zone?
- Adoption of super critical technology has been found to be efficient and effective from all perspectives and is recommended by the Planning Commission in the 12th Five Year Plan. Adoption of Ultra Super Critical Technology needs to be proven more in Indian conditions before large scale implementation can be suggested.
- A study conducted by the Central Electrical Authority on Dry cooling systems found that installation of dry cooling systems can potentially reduce the consumptive water requirement of a 2X500 MW power plant by about 80 percent. But it also reduces the unit output by about 7 percent and reduces the thermal efficiency by about 2.5 percentage points (from 38 percent to 35.5 percent). As per the Tariff Model based on Central Electricity Regulatory Commission (CERC) Regulations for 2009- 14, this has the implication of raising the power tariffs by about 8 to 9 percent of levelised tariff.

There has been a tendency in the past for a planning approach to have a narrower focus. Due to absence of integrated planning around energy – water management, an integrated energy-water modelling framework needs to be created to address the shared needs of energy and water producers, resource managers, regulators and decision makers at all levels. A recent report¹¹ suggests that, amongst the existing modelling frameworks and approaches for energy and water, a promising model is a nested approach that incorporates water resources and uses into existing energy planning models.

In addition, the proposed modelling frameworks would require factoring in long-term effects of climate change and food security. Improved modelling will ensure that power plants are more strategically located and that they implement technologies that increase energy and water efficiency. The energy – water nexus can be addressed more effectively through enhanced stakeholder collaboration.

Action Points:

- Elevate considerations about water in the planning process for energy production in the state;
- Initiate studies to factor in water in energy modelling frameworks.

Key Stakeholders:

- The Energy Department and The Water Resources Department

I.3 - Create a plan for industrial water in Bellary Region

Medium Term

¹¹ Thirsty Energy – The World Bank - 2013

The Bellary region is a hub for steel sector, and many large integrated steel projects have been proposed there. Many such large integrated projects require substantial quantities of water for steel production and captive power plants. The two reservoirs (Tunga Bhadra and Almatti) that provide water can no longer meet all the needs of such plants. In an earlier exhibit we described the approach JSW steel has adopted to ensure water security for its plant in Bellary. The present approach of the government is to allot water from downstream of reservoirs. Since the Krishna River is not a perennial river, this raises the question of how to make available water in lean periods. The Government has suggested the industries create pondage to meet their requirements in the lean periods. The cost for this is to be borne by the company, and it requires installation of individual pipelines that can transport water over a large distance at a significant cost. Moreover, it would require all companies to create individual pipelines and face associated challenges of right-of-way, clearances etc. In the absence of any alternative intervention it is likely that the present high cost approach would continue. However, the government can pro-actively consider alternative options:

- **Create a public – private – partnership model for industrial water infrastructure (storage and pipelines)** – Another option is to create a public-private-partnership model where a water service provider is encouraged to create infrastructure that is shared by all industrial users. The companies would pay the service provider a water tariff that would enable it to recover the investment cost and make a reasonable financial return. However, unless there is commitment by various companies to set up the plants and a financial cost sharing model worked out, this project will not take shape. Considering the uncertainty around availability of raw material due to mining restrictions many projects are progressing slowly. Thus, the interest of any private player in such a project may be limited unless there are assurances given by user industries.
- **Create a dedicated reservoir for industrial use near the Steel belt** - One approach could be to create a reservoir specifically for industrial use on the river Krishna at a suitable site. This was the approach suggested by an internal committee set-up to examine industrial water requirements. However, there is a question of how to fund such a reservoir as the Government may not be able to shoulder the entire financial burden.

There are no straightforward solutions and decision making requires careful analysis of all options considering the overall interests of the state and important stakeholders. It is therefore suggested that government initiate a specific study for industrial water security in Bellary region by bringing all relevant stakeholders on the discussion table.

Action Points:

- Create a medium term plan for industrial water security in Bellary region

Key Stakeholders:

- WRD, DIC, UDD, representatives of industries and civil society

3.4 Governance

Based on a review of present mechanisms to govern water resource management in urban and industrial sector, it is believed that there is a need to considerably strengthen the governance of the sector. The present arrangements suffer from inadequacy of data related to water availability and consumption, limited focus on water use efficiency and constraints in institutional frameworks to make decisions pertaining to water sector governance based on sound techno-economic rationale. The existing mechanisms will not be adequate as Karnataka aims for higher economic growth and hence needs to make available water for various economic activities as discussed in this report.

Experience of river basin development across the world shows, that in initial years of economic development, when water is abundantly available in the basin, the focus of governments is usually on engineering to utilize the available water. But as water basins turn water deficit due to high utilization, the focus needs to shift to management, regulation and reallocation. Some of the key indicators which can signal need for this shift are outlined below:

- High proportion of flow is already allocated to various sectors

- Rising economic value of water as signaled by various user segments especially urban and industrial consumers
- Shift of focus of groundwater from development to regulation
- Water pollution control becomes critical as pollution no longer gets diluted due to abundant flows. Emphasis on pollution control and clean-up.
- Higher conflicts over water between different users and uses of water
- Need for inter-sectoral planning and large complex infrastructure projects to make available additional water.

We believe that in all large river basins of Karnataka, indications are already emerging that signal the need for this shift. However, corresponding changes in management philosophy supported by underlying improvements in data and information systems, institutional focus and regulatory capabilities to enable this transition to sophisticated governance has yet not been initiated. In this section, we identify some of the key measures required to enable this shift. While the focus of this report is on urban and industrial sectors, the suggestions made are equally relevant for the agriculture sector.

G.1 - Strengthen data available for effective water management

Short Term

Effective policy intervention requires data on the sources and usage of water. Today, the availability of data for water consumption in agriculture, urban and industrial sector is very limited.

Groundwater use in urban areas – Need for stronger data management

In the case of urban water supply, cities have very limited understanding of the groundwater extraction, which could be supplying more than 20 percent of city's water requirements. City water agencies have preliminary estimates of groundwater that they officially supply through publicly owned tube-wells. But in the large cities there is often significant extraction of groundwater through private bore-wells that is completely unaccounted for. This results not only in inadequate management of groundwater, but also an inability of the cities to plan the capacity of the wastewater network (which cannot occur without accurate estimates of groundwater use). While the cities aim to cover all areas through piped water supply, groundwater is likely to remain an important source in the medium term, because infrastructure development lags real estate development in most cities in India. The present system of monitoring groundwater consists of about dozen bore-wells in large cities. Given extraction patterns, however, groundwater behaviour needs to be studied with much finer granularity inside the towns in order to be able to design for its sustainable use.

Effective governance require integrated data pertaining to water availability from all sources, relevant features of hydrology, hydrogeology, climate conditions and rainfall pattern, water demand by various users, reservoir management and operations, layout of physical assets and indicators for systems quality and efficiency. Even when data is available, it is not in a form that is easy to utilize. Most data and diagrams are in physical records and scattered through various organizations and offices even within the same organization. This data will be difficult to use for decision making until it is digitized and fed into a central decision support system.

Government of Karnataka has started an initiative on Integrated Water Resource Management through support of ADB. An Advanced Centre for Integrated Water Resource Management has been created under this partnership. It is suggested that as a key activity under this partnership, significant attention is given to data management and strengthening. This investment in strengthening the information base will help the government to (1) identify areas under severe water risk; (2) communicate the challenge to citizens to mobilize co-operation; and (3) channel resources more effectively. This will help the state government to take a more pro-active approach for various challenges.

Action Items:

- Develop a robust data collection, gathering and monitoring systems related for water governance

Key Stakeholders:

- WRD, UDD, Agriculture Department, DIC, Karnataka State Pollution Control Board, Mines and Geology Department, Private sector, civil society

G.2 – Create a Karnataka State Bureau of Water Efficiency

Short Term

Increasing water use efficiency and hence resultant increase in economic output per unit of water consumed is an important long term solution to ensuring water enabled growth. We have already examined the measures required to increase water use efficiency in Bangalore. Even in industrial sector, there is a need to ensure that industries use the best processes and technologies to reduce water consumption to the minimum extent possible. However, discussions with Department of Industries and Commerce (DIC) and Water Resources Department (WRD) have indicated that there are several constraints to achieving high water efficiency in industries. For example:

- a) Difficult to assess water requirements posed by industry in Common Application Form
- b) Limited understanding of industry benchmarks for water efficiency
- c) Inadequate monitoring of actual consumption of water by industry

These challenges are also recognized at the National level. The Ministry of Water Resources has recently contemplated creation of a Bureau of Water Efficiency along the lines of Bureau of Energy Efficiency, which has been fairly successful in generating momentum towards improving energy efficiency in the country. However, there is a need to recognize that while energy is a concurrent subject as per the Indian constitution, water is a state subject. Therefore the role of the central government in affecting legal and regulatory frameworks pertaining to water sector is fairly limited. It is therefore suggested that the Government of Karnataka take the lead in creating Karnataka State Bureau of Water efficiency in conjunction with efforts being made by the Central Government. This would generate valuable experience in driving the water use efficiency agenda at the state level which other states could benefit from. This will be an autonomous institution of the **Government of Karnataka in close partnership with industry** (through CII, FICCI or other industry associations) and other stakeholders, which will work in conjunction with national and international experts and combine efforts of the national and state bureaus to achieve the desired impact.

The initial objective of the State Bureau of Water Efficiency could be to increase water efficiency in all three sectors – agriculture, domestic and industry, by 20 percent as per the National Water Mission under the National Action Plan on Climate Change. The Bureau could have three broad divisions each dedicated to one sector: Agriculture, Industry and Domestic. We have outlined a few activities that can be carried out by the Bureau in the urban sector in Karnataka in the context of Bangalore city in the previous section. A range of activities that can be carried out by the Bureau in the industrial sector are outlined below.

- **Voluntary disclosure of consumption** – In the beginning, the government could begin by encouraging industries to disclose their water consumption on a voluntary basis. This includes disclosure of water sources, water quantity consumed, water consumption by activity and wastewater discharge (quality and quantity). This would create a culture for compiling and reporting water related data that facilitates the transition to mandatory external water audits.
- **Mandatory Water Audits** – The Bureau should require high water consuming industries to perform regular, external water audits and publish the findings in public domain. The bureau should ensure that this exercise is conducted periodically and include an “Actions Taken Report” based on previous audit.
- **Evolve Benchmarks for water consumption in select priority industries** – Based on consultation with the National Government and sector experts, the government should establish standards or benchmarks for water consumption in each industry.
- **Identify best practices in water efficiency in select industries to be made compulsory for adoption** – The Bureau can set targets for specific water consumption in select high priority sectors and identify best practices that must be adopted by the industry.
- **Establish economic instruments to encourage efficient use of water in industries and mobilize investments** – Economic instruments are very powerful in incentivizing investments and focus on

water use efficiency. The Bureau can use economic instruments such as tariffs, taxes, and incentives etc. to affect the desired behavioral changes in industries. The following box illustrates such an example supported by 2030 WRG in Conagua, Mexico

Tax System on water use in Conagua, Mexico

CONAGUA announced in 2011 a plan to work on a transformative water reform process in Mexico in order to enhance the enabling environment for sustainable water resource management, with strong emphasis on strengthening the financial water system. Within this context CONAGUA has identified the application of measures for efficient use of water, incentivized by a new tax law and financial instruments targeting large industrial water users. A more accurate water use measurement (by installation of water meters) and charging is estimated to generate investments in the Mexican water sector amounting to about 100 billion US dollars over the next decade. The necessary legal and regulatory reforms were approved in 2012 by the Mexican Congress.

In order to identify the right level (threshold) of the water tax, to incentivize the industry to invest in water savings and water use efficiency technologies, WRG supported the development of a quantifying tool. The tool could help CONAGUA in their quantification and decision making processes with regard to water valuation & pricing, water taxes and identifying economic Instruments for controlling water usage and pollution.

- **Establish awards / rewards mechanisms to encourage best performing industries** – The Bureau may also reward best practices through awards. This will create a positive atmosphere and healthy competition for adoption of the latest technologies. Industry associations like CII and FICCI already have water awards and sustainability awards which may be explored for a tie-up.
- **Publish best practices and Case studies** – Based on the submissions received from awards schemes, the bureau can create industry specific case studies for dissemination. Again CII and FICCI have some experience which can be useful.
- **Empanel technology and service providers in water efficiency** – There is a need to create a network of technology providers for water efficiency, conservation and reuse as well as services like water audits. The Bureau may provide information pertaining to reputed service providers and encourage them to set-up offices in Karnataka to create an enabling ecosystem so that industries can access high-quality products and services at a reasonable cost.

There are activities that can be planned for agriculture water efficiency as well based on the experience of WRD and Agriculture department. The Central Government has been encouraging the states to set up a water regulator. It would be important for any regulatory agency to base its decisions on sound data. A Karnataka State Water Efficiency Bureau may help lay the foundations for a regulator in the medium term.

Action Items:

- Set up a Karnataka State Bureau of Water Efficiency in consultation with the Central Government

Key Stakeholders:

- Government Representatives - Office of Chief Secretary, WRD, UDD, DIC, Energy Department, Agriculture Department
- Industry Representatives – CII, FICCI, other private sector organizations
- Civil Society – NGOs, Academic Institutions etc.

G.3 - Lay foundations for the State Water Regulator

Medium Term

Presently the Water Resource Department of Karnataka undertakes the complex techno-economical task of water sector governance and regulation involving decisions pertaining to:

- Determining allocations and entitlements;
- Setting tariffs ;
- Adjudicating over bulk transfer disputes;
- Water conservation and environmental flows;
- Management of demand of water in all sectors;

As the Water Resource Department also has the primary task of developing, maintaining and operating the irrigation systems of the state, the focus and attention paid to such complex techno-economical tasks is rather limited. Additionally, as department responsible for irrigation, it is difficult to play the role of a rational decision maker when decisions have to be made which involve multiple sectors.

Recognizing similar challenges across the country, the Government of India is encouraging states to create independent state water regulator. There are several advantages of creating a state level water regulator in theory. For example, independent regulation can help the process of decision making and enhance the techno-economic rationality of decisions that are taken. Similarly, regulators would make decisions based on evidence provided by, for example, state-wide information systems (as suggested earlier) rather than on intuition or ad-hoc decisions. Regulators generally take decisions based on wide stakeholder consultation which would enable them to understand and take account of views of different water users while taking decisions. Regulator can also monitor the performance of water service providers – both public and private - and protect consumer interests.

In practice, there are several challenges to operationalizing an independent regulatory framework that is effective in an increasing politically sensitive area such as water. The Central Government has created a model legal and institutional framework for creating an independent regulator for water sector, learning from the experience of Maharashtra and other international best practices, which could be adopted by the states. However, ground level experience of the Maharashtra water regulator is yet not conclusive in terms of its effectiveness. It is therefore suggested that the Government of Karnataka may wait for a few years before initiating concrete actions on setting up the regulator. However, the foundation for the regulator should be laid by studying experiences of different States and countries in water regulation as well as through creation of sound data and establishment of effective governance frameworks.

3.5 Enablers for Transformation

Karnataka requires a multi-year comprehensive program for transformation to enable better management, oversight and regulation necessary to meet the goals of meeting additional demand in a sustainable and ecologically sensitive manner for all users. Such efforts require continuous momentum despite changing priority and commitment based on changes in leadership – both political and administrative. Many a times, this proves difficult and many reform programs halt or loose pace during implementation. In this section, we identify key enablers which can enable and sustain the water sector transformation in Karnataka.

T.1 Launch a Multi-stakeholder platform to guide sector transformation

Short Term

Need for a multi-stakeholder platform

The water sector in Karnataka has a wide range of stakeholders that play an important role. All these user groups have important views that must be taken into consideration while designing the water sector transformation program. In the present arrangements, all the stakeholders take decisions and initiate activities based on their own specific domain without consulting the wider stakeholders. This process has several difficulties:

- When projects are implemented, there could be negative externalities which impact other stakeholders. Unless due consideration is given to all stakeholders there is a chance that the project may face resistance. For example, any plans to reuse wastewater must take into consideration the possible impact on downstream users as well.
- There could be synergies that can be leveraged if projects are planned through wider stakeholder consultation. For example, laying of sewerage pipelines and treatment of wastewater can be more effective if potential reuse options in industry are considered in advance.

- Without co-ordinated action, some activities may not see the desired result. For example, groundwater recharge through rainwater harvesting can be effective in showing visible results only if majority of properties (residential, commercial and institutional) in an area adopt it.

The multi-stakeholder platform would ensure that all stakeholders collectively decide and prioritize action plans. Early and effective engagement with stakeholders would also ensure that sector investments and reforms have a broad “buy-in” before implementation begins and therefore the chances of success are much higher.

Higher commitment to reform process and projects

In addition, a multi-stakeholder reform process or projects has much higher chances of completion since it is not anchored by one or two “Project Champions” and hence survives changes of leadership in key official positions. It is therefore recommended that Government of Karnataka create a multi-stakeholder platform to guide the sector transformation process outlined in this report.

Operationalizing the multi-stakeholder Platform

The diagram shows a possible operational model for the platform. The leadership council should meet periodically to set priorities, review progress and take decisions based on recommendations made by different working groups. The decisions taken by such meetings and discussions held should be made available to wider stakeholders through a website.

Through a CII initiative, a “Water Network” has recently been created comprising of various stakeholders. Government has also created an Advanced Centre for Integrated Water Resource Management (AC-IWRM) through support of ADB. It is suggested that synergies with these initiatives be explored while creating the multi-stakeholder platform.

The following are a few key guiding principles that need to be considered for successful implementation of the multi-stakeholder platform.

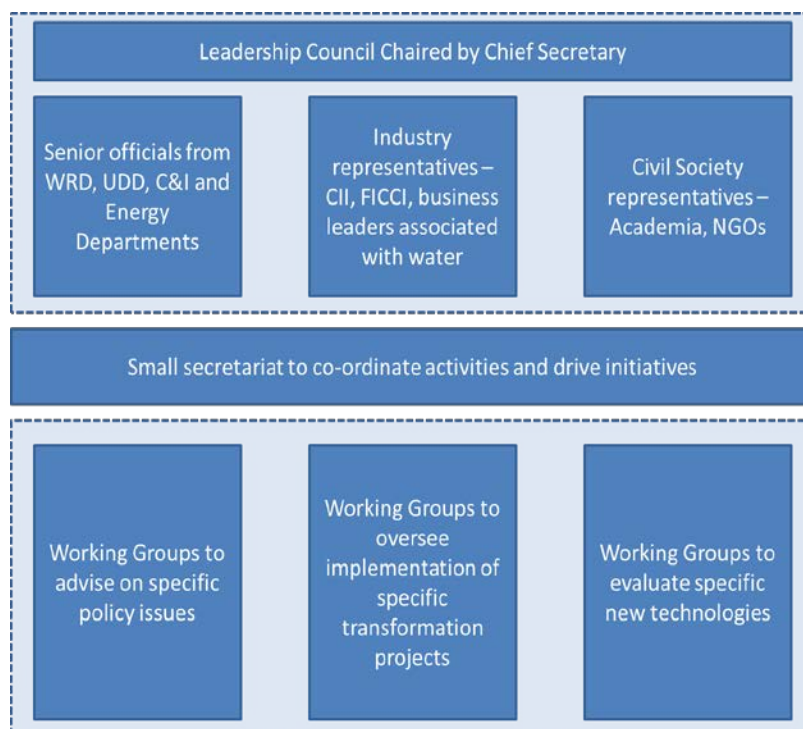
- **Stated and active commitment of senior leadership in Government**

– Since the water sector reform outlined requires resources, expertise and involvement of multiple departments of the state government, it is important that the platform be led by a very senior official of the government with power to mobilize the stakeholders and generate resources as required.

- **Formal definition of roles and responsibilities of the platform**

– A memorandum of understanding signed by all key stakeholders could lead to strong continued commitment.

- **Support of an executive secretariat** – It is crucial to have full-time, dedicated resources to coordinate the network and oversee the work from the design process through to the implementation phase. This does not need to be an elaborate organization, but a one or two



member support organization staffed by driven professionals with accountability for results would be very effective in generating and keeping the momentum.

- **Flexibility to create working groups to advice on specific policy issues, oversee transformative projects and evaluate innovative technologies** – The working groups of relevant stakeholders and experts would be the core bodies driving the work of the stakeholder platform and would be provided necessary funding to execute the tasks assigned.

Funding of the platform

All options to make available dedicated and reliable streams of funds to the platform must be explored. These include budgetary allocations from government, contributions from private sector through CSR funding and support of international development organizations.

Action Items:

- Create a multi-stakeholder platform with formal commitments from all agencies
- Create working groups for select identified themes

Key Stakeholders:

- Government Representatives - Office of Chief Secretary, WRD, UDD, DIC, Energy Department
- Industry Representatives – CII, FICCI, other private sector organizations
- Civil Society – NGOs, Academic Institutions etc.

T.2 - Channelize private sector resources and expertise in select strategic areas

Ongoing

The private sector has an important role to play in enabling the water efficiency transformation. The capacity of private sector to bring the latest technologies, research, resources (financial or otherwise), and management systems is significant and therefore it can be a powerful change agent. It is however, important that policy makers mobilize and channelize the private sector energies for water efficiency. This section outlines a framework in which Government of Karnataka can view its engagement with the private sector. From the water perspective, the private sector has two broad roles: 1) water user; 2) water technology and service provider

As water user

As shown in the previous chapter, the water requirements for industrial purposes would increase rapidly over the next decade and a half in a Business-as-usual scenario. There is a potential to increase the water efficiency in industrial use which can reduce the water requirements through “Within-the-fence” measures such as adopting water efficient technologies, wastewater recycling and reuse and water conservation measures which were discussed in the previous chapters in detail. In this context the State Bureau of Water Efficiency discussed earlier is an important measure. In addition, private sector can play an important role through “Beyond-the-fence” measures in increasing water efficiency.

Create sub-regional “water-security and sustainability” plans considering all possibilities

As large institutional users, the private sector can support the government in creating and implementing localized plans. Instances of such actions are already emerging in Karnataka. For example, JSW steel has prepared a regional water master plan to assist the local administration in mapping its water challenges. CII has recently launched a “Water Network” to mobilize action of a range of stakeholders towards water challenge. Most of these initiatives are in the purely private domain with little or no formal linkage to the Government which is the primary actor in water sector. Discussions with the stakeholders have revealed the need for a formal linkage through which skills, resources and strengths of both public and private sector can complement each other.

We have already outlined a role of large private sector users in the management of water in Bangalore through decentralized Joint Water Security Task Forces. It is also important to mobilize bulk users in non-

urban areas such as steel plants and power plants for creating sub-regional water security and sustainability plans in the watershed or river sub-basin of their operation. Such plans may include interventions in urban, agriculture and industrial uses.

Financing of the plans (development and implementation) can come from private sector and government depending on each action item. With recent introduction of government guidelines to deploy 2% of PAT as CSR, private sector can mobilize the necessary finances for water sector especially in the local area where they have an influence and long term interests.

Promote creation of sustainable supply-chains through increased water efficiency in water use in agriculture

As several reports and publications have pointed out, there is a considerable scope for increasing water use efficiency in agriculture sector in India. Many private sector organizations depend on agriculture sector for raw materials and therefore have a long term stake in promoting sustainable agriculture. Maharashtra has put in place a program of Public Private Partnership to increase agricultural productivity and is now mulling a similar program to increase water efficiency. The program envisages pooling of funds from public, private and individual farmers and leveraging management expertise of private sector to bring about a massive transformation. Government of Karnataka also has a large program for micro-irrigation to drive agriculture water efficiency but there are concerns regarding effective operations and maintenance of the assets created under this program. Government of Karnataka may consider a similar approach to Maharashtra by blending private sector management expertise within existing approach to drive agriculture water efficiency.

As technology and service provider

Government of Karnataka is at the fore-front of utilizing the services of private sector in the urban sector for technical expertise and service delivery. This report has also highlighted other areas where contribution of private sector in driving water use efficiency in all three sectors can be sought. Our discussions with State government have revealed additional areas where private sector technical expertise is required immediately:

- Desilting of the Tungabhadra dam which can enhance the carrying capacity
- Innovative ways of utilizing the West flowing rivers keeping in perspective the ecological sensitivities of the Western Ghats

The state government has indicated significant interest in such partnership proposals. Once a multi-stakeholder platform is established specific working groups can be created for some of these challenges.

Key Stakeholders:

- Government Representatives - WRD, UDD, DIC, Energy Department
- Industry Representatives – CII, FICCI, other private sector organizations
- Civil Society – NGOs, Academic Institutions etc.

4 Summary and Way Forward

Sustainable economic development is emerging as a central theme across the globe. The world is going to transition from the Millennium Development Goals to Sustainable Development Goals from 2015 to 2030. The 12th Five Year Plan for India also calls for faster, more Inclusive and sustainable growth. Climate change, which is at the forefront of concerns on sustainability, has received significant attention of policymakers. Climate Change, which has influence on change in patterns of monsoon and weather events such as droughts and floods, has an impact on the water sector. The State may face even tougher challenges in the governance of water sector, due to the above risks.

The Government should also examine measures other than primary source augmentation, particularly in areas already covered through water supply schemes. An Integrated Urban Water Management approach which focuses on water demand management and considers all water sources and solutions (rainwater harvesting, wastewater reuse, groundwater recharge, reduction of water losses) should be adopted. To the extent possible, the Government may try and restrict primary source augmentation measures only to extend coverage to rapidly expanding cities.

In the industrial sector, there is a need to adopt ever tightening water efficiency norms based on the latest available technology and ensuring that wastewater released is treated adequately before release into natural systems. While the Government is the principal actor in the urban sector, its role is more indirect in the industrial sector as the majority of the water consumption is by private sector players. The Government however, can take leadership role in reducing water consumption in industrial units owned by public sector entities such as power plants to set examples for the private sector to follow. There is also a need to plan for power sector in an integrated manner with water sector for which the planning framework needs to be evolved. A rationalized tariff structure would also provide additional signals to industries to be water efficient. In addition, there are local challenges for supporting industrial growth through enhanced water availability in select sub-basins of Karnataka which should be examined with necessary focus.

These direct actions by the Government must be complemented by creating an enabling framework of Governance to incentivize water conservation by all stakeholders through a range of instruments such as effective data collection systems and procedures, regular monitoring and oversight mechanisms to driver water use efficiency and effective use of economic regulation.

The transformation envisaged in this report would require support of several stakeholders and an in-built mechanism to generate and sustain momentum. The private sector has to play a critical role as a responsible water user, a driver of water use efficiency in the basin through “Beyond-the-fence” measures and a technology and service provider in the rapidly evolving water sector.

The report presents a broad analysis of water sector reform in urban and industrial sectors in Karnataka. In addition to the recommendations provided in the report, there are certain areas where there is a need to strengthen understanding which could facilitate the sector transformation process. The table below provides a roadmap for bridging this gap in understanding through more data and analysis.

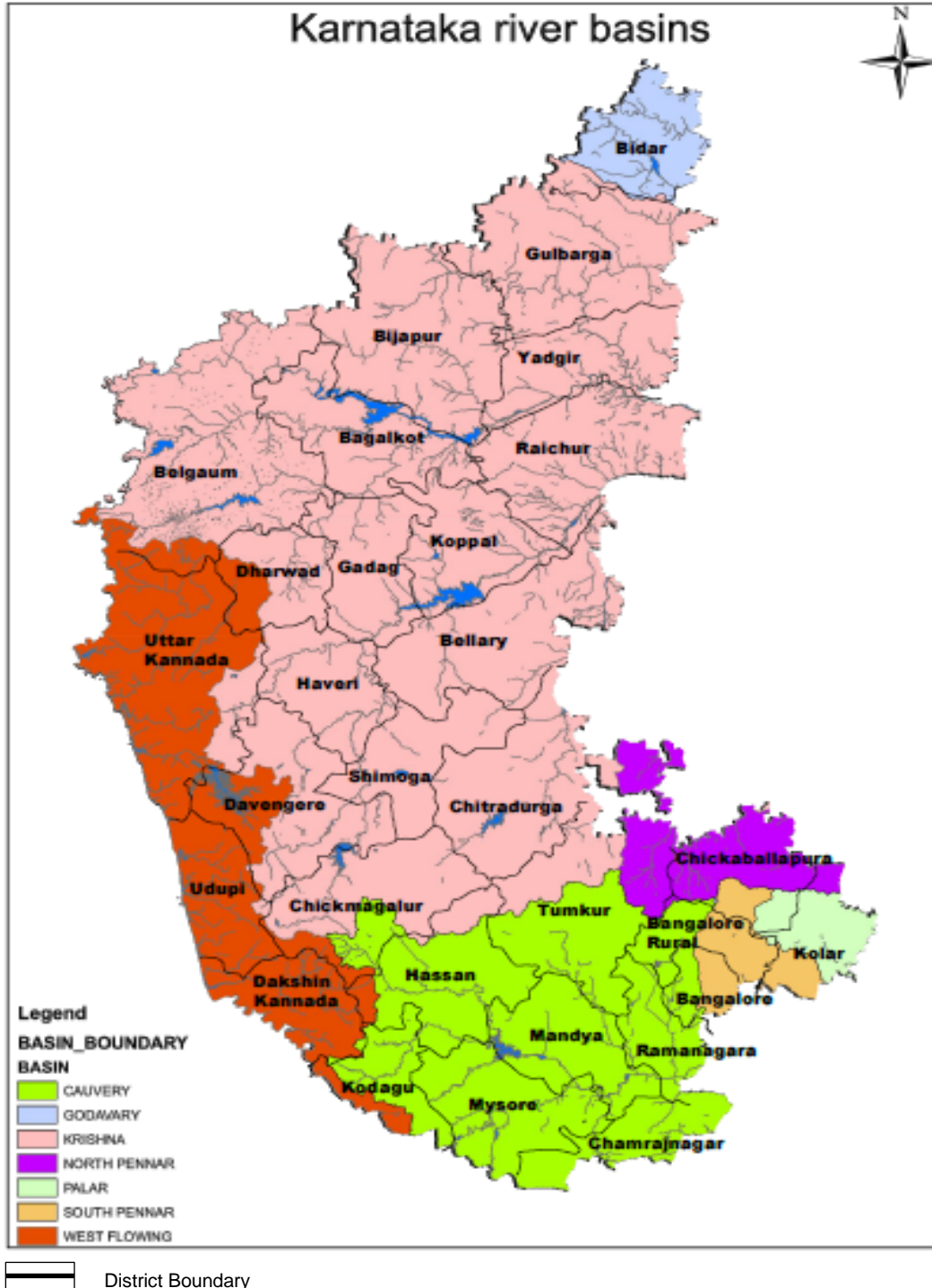
Sector	Roadmap for Further Analysis
Urban Sector	<ul style="list-style-type: none"> Use of Groundwater in Urban Areas– There is a need for a comprehensive understanding of ground water use (including private sourcing of ground water) in major cities of Karnataka. The analysis needs to take cognizance of availability of data at required micro-scale and increased frequency, recent legal and regulatory changes in groundwater governance of the State as well as long term trends in groundwater extraction which can threaten the

	<p>sustainability of existing patterns of urban growth.</p> <ul style="list-style-type: none"> • Tariff Reform in Urban sector – While it is recognized that Bangalore has one of the highest tariff structure for water services in the country, the study did not cover aspects of cost recovery and tariff structures in other cities. Sustainable high quality service delivery cannot be achieved without adequate tariffs that at the minimum aim to recover Operations and Maintenance cost. A study can be considered for understanding prevalent tariff and cost recovery scenario in select representative towns of Karnataka with a view to understanding the need for reform. This would facilitate long term investments in the sector which can contribute to improved service delivery and closure of the Demand-supply gap.
Industrial Sector	<ul style="list-style-type: none"> • Business Risk – There is a case for understanding the Business Risk perceptions of industry on account of water shortage. This would enable the government to plan appropriate measures to ensure that industrial investments in the State, which are essential for economic growth and job creation, do not suffer on account of availability of reliable and adequate water supplies. Perhaps a survey of select companies in all important industrial sectors with pre-determined frequency (one in a year or two years) could be planned to understand this critical aspect. • Industrial growth in Peri-urban areas – An overall study such as this tends to focus on high water consuming sectors such as energy and steel. However, Karnataka is rapidly emerging as a destination of choice for many services industries which are coming up in rapidly growing peri-urban areas of some of its larger cities. These sectors do not consume high quantities of water but water is still essential for their smooth functioning. Considering the State's reputation as the IT and BPO hub of the country, it may be important to study the water stress situation faced by these companies in peri-urban areas of the cities. The study should also aim to examine partnership opportunities with these important players for not only solving their own water issues but also for using their capital and management expertise in solving water woes of the cities through CSR initiatives.
Economic Analysis	<ul style="list-style-type: none"> • Fuller Economic Analysis: Each of the solutions presented to cover the gap has several additional economic benefits and risks. These include better health outcomes, higher productivity, indirect multiplier effects on economic growth etc. In addition to that the economic analysis could potentially cover other less frequently analyzed aspects such as environmental flows, impact on wetlands and endangered species, water quality challenges in both surface water and groundwater, groundwater exploitation etc. A much more comprehensive Hydro-economic Analysis could be carried out to fully understand some of these other aspects that have not been covered in this preliminary study. • Implications on State Finances: It is important to understand the total cost of water sector transformation by 2030 and correlate the funding requirements with availability of financial resources with the State. A more comprehensive analysis could also elaborate on various alternatives to generate financial resources from various sources such as banks, financial institutions, households, user industries and private sector (possibly through PPP arrangements). This would help the policy makers understand true impact of the cost of transformation on State's exchequer. The State could simultaneously develop a CGE model with rich water sector component along the lines of the TERM – H2O model maintained by Glyn Wittwer at Victoria

	University in Melbourne, Australia to assess the economic implications of water scarcity. Among other things, this approach would enable exploration of opportunities to modify policies considering impact on finances of the State.
Governance	<ul style="list-style-type: none"> • Water Budget: A comprehensive roadmap for water sector governance needs to start with a State water budget which would show the total water resources available from all sources, its present utilization and potential for further development. This would be a useful starting point from where a much more fuller planning exercise can be undertaken considering all sectors of the economy i.e. agriculture, industry, energy and domestic consumption as also for eco-system services. • Cross sectoral aspects – The report has tried to identify to the extent possible solutions within urban and industrial sectors which can contribute to closing the demand-supply gap by 2030. Of course it would not be possible to fully meet all additional demand through measures within the sectors only and therefore there is a need for higher water allocations. There are various solutions which can be considered which are cross sectoral in nature and which could not be therefore fully studied in this report because it doesn't cover agriculture sector <ul style="list-style-type: none"> ○ Reuse of municipal wastewater in agriculture ○ Higher water efficiency in agriculture sector supported through a multi-stakeholder partnership which can facilitate higher water allocations to urban and industrial sector to boost State's economic growth aspirations <p>2030 WRG has also facilitated a separate study for agriculture sector for Karnataka. There is a need to combine findings of both these studies to understand economic productivity of water in all three sectors of the economy together and identify most cost effective solutions across the three sectors to enable higher economic growth at the least cost to the State in the coming decade and a half.</p> <ul style="list-style-type: none"> • Governance Structure – The report highlights some of the lacunae in existing governance structure and suggests possible short and medium term reforms based on present thinking of some of the other States as well as central government. However, it may be useful to carry out an international benchmarking study for water sector governance which would enable generation of more innovative ideas for a much more evolved governance framework for water sector in the State.
Enablers of transformation	<ul style="list-style-type: none"> • Detailed Implementation Plan- The report identifies the major areas and strategic direction for water sector reform. However, implementation of each of the recommendation would require analysis of present situation, detailed business case for change, barriers and enablers of implementation as well as detailed implementation plan. Therefore it is suggested that based on prioritization agreed by all important stakeholders, a detailed work-plan is prepared for implementation of key recommendations.

As highlighted in the report, the success of most of the recommendations depends on involvement and oversight from multiple stakeholders. Therefore, as an immediate next step, the State may create a **multi-stakeholder platform** that brings all stakeholders together in a structured manner to prioritize recommendations, find technical and financial resources required for implementation, provide handholding support and ensure that the entire reform program enjoys broad based support from the start. Such a platform can be the key enabler that this transformation effort requires.

5 Annexure: River Basin Map

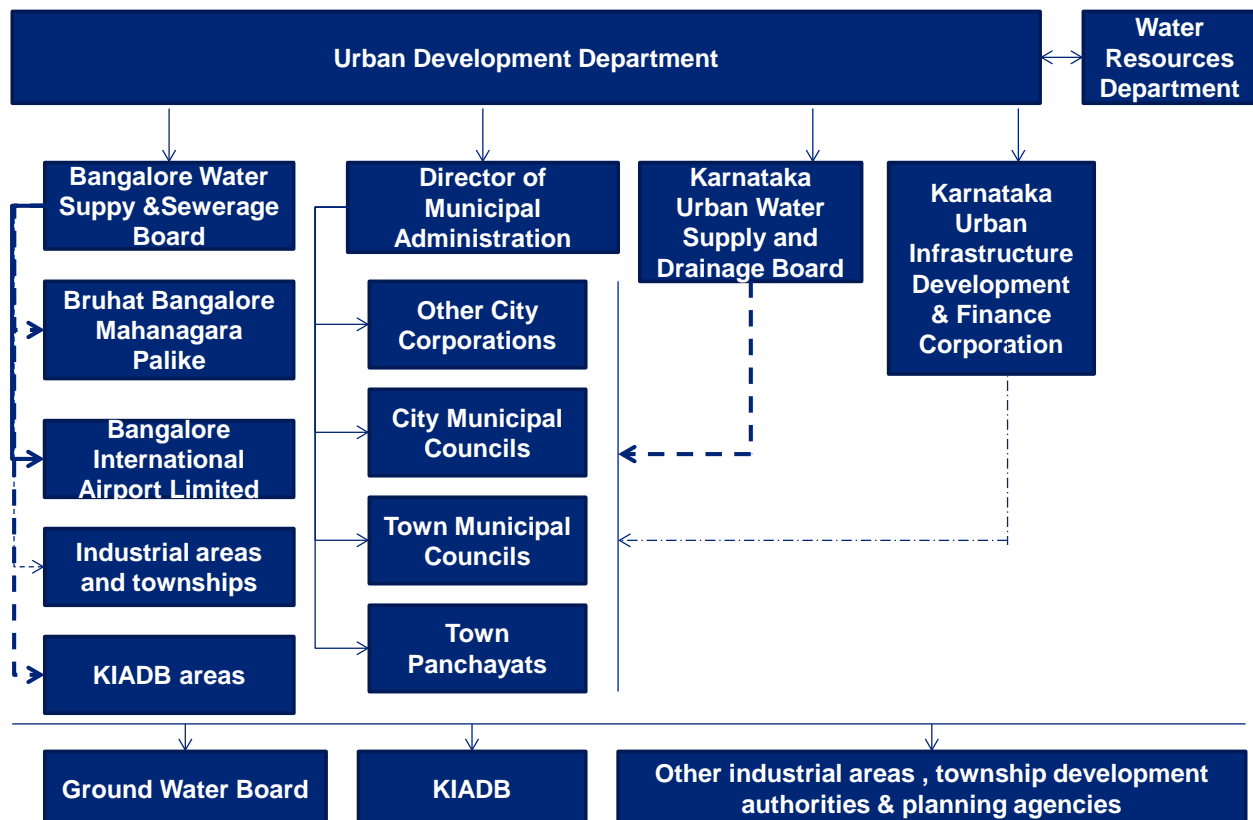


Source: Adapted from maps sourced from Government of Karnataka website; River basins have been superimposed on districts of the state

6 Annexure : Institutional Framework

I. Urban Water Supply and Sewerage

The urban water supply and sanitation sector in Karnataka is governed and monitored by the Urban Development Department (UDD) and supported by other agencies such as the Karnataka Urban Water Supply and Drainage Board (KUWSDB), the Bangalore Water Supply and Sewerage Board (BWSSB), Urban Local Bodies (ULBs), and the Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC). The following figure depicts the institutional structure.



The Government of Karnataka has established two centralised water utilities Bangalore Water Supply & Sewerage Board and Karnataka Urban Water Supply and Drainage Board to provide water supply, sewerage and sewage disposal services for the Bruhat Bengaluru Mahanagara Palike area and other urban areas in the state, respectively.

The following table indicates the roles of these institutions.

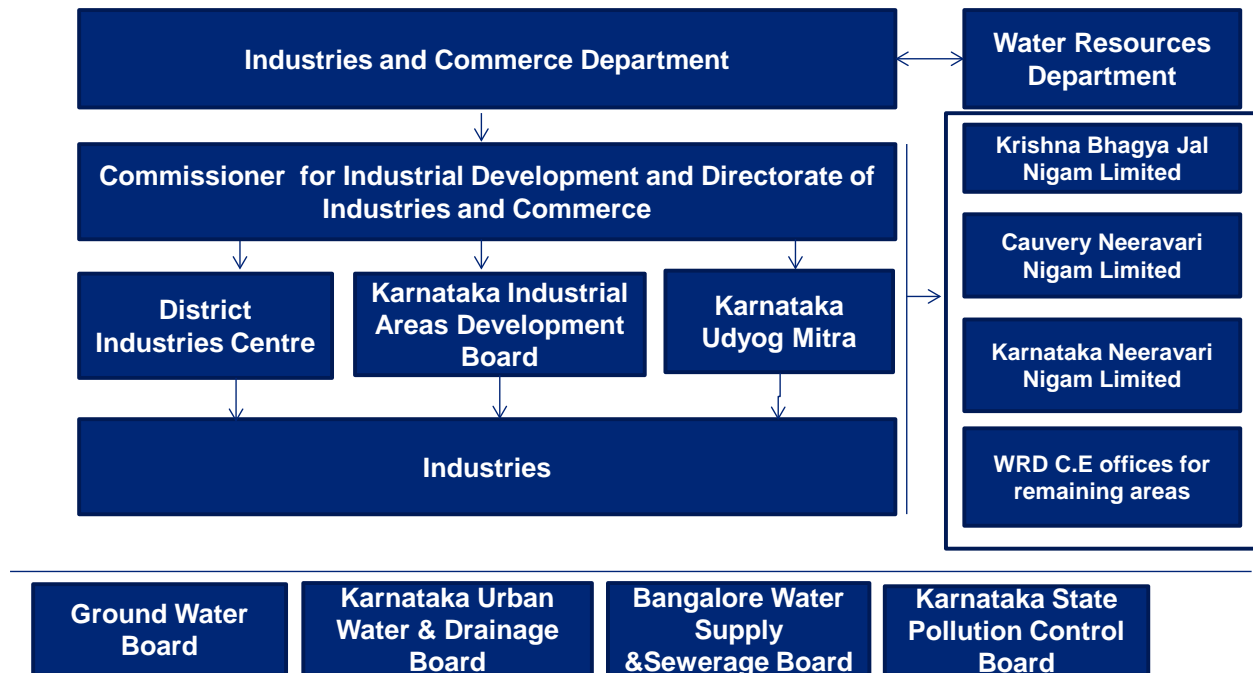
Institutional Structure

Agency	Role
Urban Development Department (UDD)	Responsible for sector policies, regulation, funding through budgetary support and external funding, sector coordination and monitoring.
Water Resources Department (WRD)	Responsible for provision of water for drinking water purposes for the state

Karnataka Urban Water Supply and Drainage Board (KUWSDB)	Designs and implements water supply and sewerage schemes in urban Karnataka, except Bangalore. The assets created by KUWSDB are transferred to the respective ULBs after execution of the schemes for operation and maintenance. KUWSDB also maintains a few schemes based on the requests from the ULBs. KUWSDB is responsible for such provision of services for City Corporations (other than Bangalore), City Municipal Corporations, Town Municipal Corporations and Town Panchayats.
Bangalore Water Supply & Sewerage Board (BWSSB)	Designs, implements, and maintains water supply and sewerage schemes in Bangalore area for domestic, commercial and industrial customers. Supplies water to a few industries in and around Bangalore which are either under Karnataka Industrial Areas Development Board areas or other industrial townships, residential townships and industrial areas within Bangalore. It also supplies water to Bangalore International Airport. Responsibility includes overseeing the Rainwater harvesting schemes. Operates and Maintains a few bore-wells in the city.
Urban Local Bodies (other than BBMP)	Takes over the water supply and sewerage schemes from KUWSDB and operates and maintains the same. Levies water connection fees, installs meters and collects water charges.
Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC)	Serves as a channel for funding by multi-lateral agencies.
Ground Water Board	Overseeing responsibility for groundwater in the state
Karnataka Industrial Areas Development Board (KIADB)	Areas developed by KIADB get their water supply and sewerage services from either BWSSB or KUWSDB depending on their location.
Other industrial areas, township development authorities and planning agencies	Areas developed by these agencies get their water supply and sewerage services from either BWSSB or KUWSDB depending on their location

II. Industrial Water Supply and Sewerage

The water supply and sanitation for industrial sector in Karnataka is governed by agencies depending on the size of industries. The following figure depicts the institutional structure.



Institutional Structure

Agency	Role
Department of Industries and Commerce (DIC)	Responsible for sector policies, regulation, funding through budgetary support and external funding, sector coordination and monitoring for industrial development in the state. Responsible for water sector arrangements for supply of raw water to industries by liaising with the Water Resources Department
Water Resources Department (WRD)	Responsible for provision of water for drinking water purposes for industries
Commissioner for Industrial Development and Directorate of Industries and Commerce	Implementation of schemes and policies of the state and union governments for the promotion of Industrial Development throughout the state; Liaising with the Water Resources Department for supply of water for industries.
District Industries Centre	Works under the Commissioner/Directorate of Industries and Commerce for district level operations; liaising with the Industries in their respective industries for water supply.
Industries	Some large industries draw water from surface water source (through I&C department and WRD interventions) or through groundwater directly from the river when they are located in a non-urban area/industrial area. Some industries which fall under the urban areas get their requirements from KUWSDB / BWSSB through Karnataka Industrial Areas Development Board/respective industries corporations. Some industries are dependent only on groundwater.

KBJNL/CNNL/KNNL /WRD CEs in other districts	These agencies under the Water Resource Department and sell water and recover revenues from industries, depending on the location of the industry.
Karnataka Urban Water Supply and Drainage Board	Supply of water supply to industries based on requests from Karnataka Industrial Areas Development Board, Department of Industries and Commerce (DIC), KUM in urban areas except Bangalore
Bangalore Water Supply & Sewerage Board	Supply of water supply to industries based on requests from Karnataka Industrial Areas Development Board, Department of Industries and Commerce (DIC), KUM in Bangalore area
Ground Water Board	Overseeing responsibility for groundwater in the state
Karnataka Industrial Areas Development Board	Areas developed by Karnataka Industrial Areas Development Board get their water supply and sewerage services from WRD, BWSSB or KUWSDB depending on their location.
Pollution Control Board	Collects cess from industries for water consumed and responsible for monitoring of waste water discharge and industrial pollution.

7 Annexure : Key Definitions

Consumptive use of water	Consumptive use of water is the actual consumption of water in domestic and industrial sectors. This is calculated at 2.5 percent of fresh water withdrawals from industry and about 80 percent of freshwater withdrawals from the domestic sector with remaining water available for further use as return flows
Allocation of water	Water allocated for –domestic, industrial and irrigation sectors by the River Water Tribunals.
Water use efficiency	Optimal utilization of existing water sources. Reduction of UFW considered in Urban Sector. Technological interventions such as increasing CoC, dry cooling, dry-dedusting etc. under industrial sector.
Primary surface water augmentation	Making available additional water through tapping surface water resources or by creating new water sources. Existing Govt. proposals such as additional allocation of water from existing sources, inter-basin transfer, diversion of water from existing reservoirs etc. were considered
Water Conservation	Solutions such as Rainwater Harvesting, remodeling Storm Water Drainage (SWD) for groundwater recharge, lake rejuvenation etc. have been categorized as water conservation solutions.
Hydro-cost Analysis	Depicted by a cost curve, the analysis showcases benefits in the form of water availability by water saving solutions. It represents the life-cycle cost per unit of water available through each solution.
Unaccounted For Water (UFW)	Water losses due to physical leakages in the distribution system such as pipeline joints, overflows in service reservoirs etc.; faulty metering, unmetered connections and unaccounted use of water like unauthorized connections.
Integrated Urban Water Management	Holistic mode of strategic planning aiming to develop flexible and efficient urban water systems by linking together planning, management and stakeholder participation across sectors and institutions.
Zero Liquid Discharge	Minimizing the volume of wastewater at source (especially in industries) that requires treatment and practice wastewater recycling and reuse it in an economically-feasible manner
Cycles of Concentration	In cooling towers of power plants, the number of times cooling water is re-circulated based on the ratio of the blow down (sump or re-circulating water) salt concentration to the salt concentration in the makeup water.
Super Critical and Ultra Super	Technology operating at higher temperatures and pressures to

Critical Technology	achieve higher efficiencies thereby reducing water consumption. Additional advantages include - reduced fuel costs due to improved plant efficiency & reduced GHG Emissions.
BAU scenario	Current scenario assuming no gains in quantum of water through implementation of water efficiency improvement, reduction of water losses or any other measures.
“Within the Fence” measures	Within the industrial premises measures involving technological interventions such as recycling of ash water, reuse of other wastewater, dry cooling etc.
“Beyond-the-fence” measures	Measures taken at a larger scale for a larger area and not by a single industrial unit.
Water Demand Management	Managing consumptive demand itself to postpone or avoid the need to develop new resources and reduce pressure on the existing resources. Concentrates on managing demand for water by controlling leakage and maximising its efficient use

8 Annexure: Solution Set Assumptions

Measure	Industry Sector	Description	Key assumptions
Industrial Demand Measures			
Coke Oven: Coke Dry Quenching (CDQ)	Steel	<p>Alternative to wet quenching- coke cooled using an inert gas instead of water.</p> <p>Several advantages- allow recovery of thermal energy which can be used for the production of steam and electricity. Also improves quality of coke & reduction of coke consumption in the blast furnace.</p>	<ul style="list-style-type: none"> Existing penetration 25 percent (presence only in JSW Bellary) Water savings around 0.5-1.0 m³/tonne of gross coke Approx. INR 1764 Million for a 3.2 MTPA capacity plant Energy savings- up to 40 percent lesser energy consumption.
Dry De-dusting of Blast Furnace Gas	Steel	<p>Alternative to water scrubbing to remove Blast Furnace Gas (BFG) – dry methods such as electrostatic precipitator or a bag filter employed to clean the BFG.</p> <p>Advantages include minimized wastewater generation & freshwater consumption and energy savings.</p>	<ul style="list-style-type: none"> 80percent penetration by 2030 Water savings: 25percent reduction in water consumption Investment costs 70percent higher compared to wet-type de-dusting equipment cost Approx. INR 1080 Million for 1.5 MTPA Plant Power generation (by TRT systems) may increase by 30percent compared to wet-type de-dusting
Wastewater reuse in industrial processes (excluding RWH)	Steel	<p>Reuse wastewater generated during the steel production process. Includes</p> <p>reuse of blow down water from various steel making processes, recovery & reuse of backwash water & water from sludge , Condensate recovery and reuse etc.</p>	<ul style="list-style-type: none"> Already undertaken by larger plants. 100 percent penetration by 2030 Water savings: 40percent reduction in freshwater consumption
Dry beneficiation	Steel	<p>Beneficiation is done to remove impurities (like alumina & silica) from iron ore - higher iron content in the ore increases productivity &</p>	<ul style="list-style-type: none"> Limited current usage. 50 percent penetration by 2030 High water savings

		<p>decreases coke rate.</p> <p>Dry Beneficiation technique is an alternative to iron ore washing from wet processes to dry methods.</p>	
Increasing Cycles of Concentration (CoC)	Power	<p>To compensate evaporation loss and blow down losses in cooling towers make up water is provided. Water circulation in the closed loop leads to increase in the concentration of dissolved solids (CoC) over a period of time leading to more water consumption.</p> <p>Increasing COC (3 to 5) results in reduced blow down quantity & thereby significant saving of water.</p>	<ul style="list-style-type: none"> Existing penetration 20 percent. Assumed 100 percent penetration by 2030 Water savings: 40 percent reduction in water consumption
Dry cooling	Power	<p>Alternative to water-cooling system by using air cooled condensers to cool the steam exiting a turbine in TPP.</p> <p>Trade-offs - higher costs and lower efficiencies in terms of more usage of fuel per unit of electricity.</p>	<ul style="list-style-type: none"> Water savings : 80 percent reduction in overall water consumption 100percent penetration in newer TPPs by 2030 Capital costs- 12percent higher compared to water cooled systems Higher energy cost due to low efficiency
Recycling of Ash Water	Power	<p>About 50 percent of water is consumed in wet ash handling TPPs to remove bottom ash and fly ash in the form of ash slurry. Decanted water after ash gets settled can be recycled and re-used for ash handling purpose.</p>	<ul style="list-style-type: none"> Water savings : 70 percent reduction in overall water consumption Capital Cost relatively lower than other technological solutions (Incremental CAPEX~INR 15Crore/TMC) 100percent penetration in existing as well as newer TPPs by 2030
Wastewater reuse	Power	<p>Reuse of blow down water & other processes waste water generated during power production in TPP.</p>	<ul style="list-style-type: none"> Water savings: 40percent reduction in freshwater consumption 100percent penetration by 2030
Rainwater Harvesting	For all industries	<p>Collection, storage and reuse of rainwater that runs off from roof tops, paved areas, etc. in industry campuses in sumps, tanks or lined</p>	<ul style="list-style-type: none"> 30 percent of industrial area (rooftop & paved) assumed to tap rain water in industrial campuses

		ponds.	<ul style="list-style-type: none"> ▪ Avg. rainfall of 800 mm in Karnataka ▪ Minimal energy use and O&M cost
Municipal Waste Water for Industrial Re-use(post tertiary treatment)	For all industries	Tertiary Treatment of municipal waste water through stronger and more advanced treatment systems such as membranes filtration, dechlorination, reverse osmosis etc.	<ul style="list-style-type: none"> ▪ Total waste water generated in urban areas in state (80 percent of total water consumed~56 TMC) ▪ Possible tertiary treatment of waste water for Industrial reuse assumed @ 10percent ▪ CAPEX calculated from Case studies : INR 100-150 crore/TMC
Zero Liquid Discharge	For all industries	<p>ZLD is a 'no effluent or discharge' system. Employs advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater effluent produced.</p> <p>Advantages include saving on the cost and consumption of raw water.</p>	<ul style="list-style-type: none"> ▪ Cost based on average of other ZLD in industries examples ▪ Cost assumed for systems including both MBR (Membrane Bio-Reactor) & RO (Reverse Osmosis)

Measure	Sector	Description	Key assumptions
Urban Demand Measures			
Unaccounted for Water (UFW) Reduction	Water-use Efficiency	Involves reducing water losses due to physical leakages in the distribution system such as pipeline joints, overflows in service reservoirs etc.; faulty metering, unmetered connections and unaccounted use of water like unauthorized connections.	<ul style="list-style-type: none"> ▪ Assumed for Core BBMP Area, new areas under BBMP, all Municipal Corporations & Municipal Councils-51 ULBs excluding Bangalore & other smaller cities through 24 X 7 projects. ▪ Total Water savings - 12 TMC ▪ Capital Cost of approx. INR 7300 Crore
Reuse of Wastewater(secondary treatment)	Secondary Surface Water Augmentation	Treatment & re-use of water-water generated in urban areas for various purposes-industrial supply, commercial use etc.	<ul style="list-style-type: none"> ▪ Assumed for Bangalore, 51 ULBs-Municipal Corporations & Municipal Councils & remaining ULBs ▪ Total Water savings - 11 TMC ▪ Capital Cost of approx. INR 2700

			Crore
Rainwater Harvesting (Rooftop RWH in domestic & commercial buildings)	Secondary Surface Water Augmentation	Collection of rainwater on roof-top for domestic use. Comprises of a roof catchment Area, a storage tank and gutters to transport the water from the roof to the storage tank.	<ul style="list-style-type: none"> Assumed for Bangalore, 51 ULBs- Municipal Corporations & Municipal Councils & remaining ULBs Average rainfall for the state-1000 mm Possible rooftop rainfall capture for Bangalore city - 10percent & other cities <2percent Total water savings - 7 TMC Total capital cost of approx. INR 1800 crore Average rooftop area 2400 sq. ft. Capital cost of RWH per rooftop – INR 20,000
Rejuvenation of lakes	Secondary Surface Water Augmentation	Restore lakes to collect flood water during rains through storm water drains and gradually recharge ground water by percolation.	<ul style="list-style-type: none"> Assumed only for Bangalore UA Water availability - 4 TMC Capital Cost of the project approx. INR 6250 Crore
Remodelling Storm water Drains	Secondary Surface Water Augmentation	Re-designing, re-laying and improvement in the drainage system. Re-modelling of storm water drains to ensure rain water is conveyed to the lakes.	<ul style="list-style-type: none"> Assumed only for Bangalore UA Water availability - 9 TMC Capital Cost of the project approx. INR 10,000 Crore
Additional water from Cauvery Stage V	Primary Surface Water Augmentation	Total 12.88 TMC of water (6.44 TMC for short term + 6.44 for long term) out of the 17.64 TMC of unallocated water awarded by the Cauvery Water Disputes Tribunal	<ul style="list-style-type: none"> Assumed only for Bangalore UA Water availability from the source in both phases -8 TMC Capital Cost of the project approx. INR 4900 Crore Expected implementation time frame-Phase I : 2014-18 Phase II : 2017-21

Inter-Basin Transfer	Primary Surface Water Augmentation	Diversion of 10 TMC of water from Konganahole & Kakkathuhole streams in the Western Ghats to Cauvery Basin. Allocation of 6.44 TMC out of this for Bangalore city.	<ul style="list-style-type: none"> Assumed only for Bangalore UA Water availability -6 TMC Capital Cost of the project approx. INR 4100 Crore Expected implementation time frame- 2014-21
Additional water from Ettinahole Reservoir	Primary Surface Water Augmentation	Diversion of 24 TMC of water from Ettinahole & other tributaries of Netravathi river for the districts of Kolar, Bangalore Rural, Chickballapur & Tumkur. Allocation of 10 TMC to Bangalore City.	<ul style="list-style-type: none"> Water availability - 24 TMC Capital Cost of the project ~ approx. INR 12,200 Crore
Additional water from Linganamakki Reservoir	Primary Surface Water Augmentation	Diversion of water from the existing hydro-power reservoir Linganamakki across the west flowing river Sharavathi to cater to Bangalore drinking water supply needs.	<ul style="list-style-type: none"> Assumed for Bangalore UA Water availability - 10 TMC Capital Cost of the project ~ approx. INR 12,500 Crore
Transfer of water from Hemavathi reservoir to Arkavathi catchment	Primary Surface Water Augmentation	Transfer of 5TMC of water from Hemavathi Reservoir to Hessaraghatta/T.G Halli Reservoirs for Bangalore city through the existing irrigation canal only during non-irrigation season.	<ul style="list-style-type: none"> Assumed for Bangalore UA Water availability - 5 TMC Capital Cost of the project ~ approx. INR 1840 Crore Dependent on water availability in Hemavathi and allocation from Linganamakki & Ettinahole projects
Desalination	Primary Surface Water Augmentation	Treating sea-water through various processes such as reverse osmosis etc. for domestic use	<ul style="list-style-type: none"> Water availability shown - 10 TMC. Could be extended as per requirements. Capital Cost of approx. INR 410 Crore/TMC

9 Annexure: Deep Dive - Bangalore City

1. Background

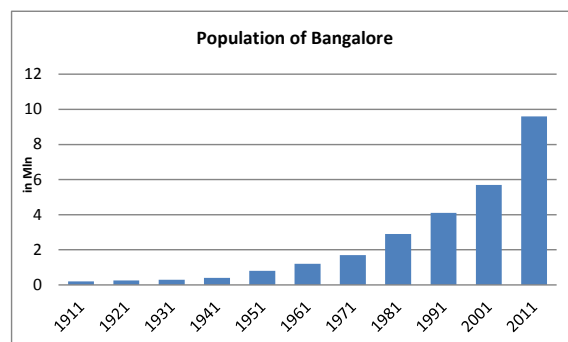
This annexure presents provides a “deep dive” study of Greater Bangalore (hereinafter referred to as Bangalore) city. The objective of the deep dive is to examine the city’s water demand and supply position in addition to the analysis of the urban sector. The topics covered include:

- Demand for water in Bangalore city until 2030
- Current supply levels and the resulting demand supply gap
- Alternatives for meeting the supply requirements through a combination of efficiency measures and additional supply sources
- Policy Interventions required in order to meet the gap in a sustainable manner

2. Population growth trends of Bangalore city

The city of Bangalore has been growing rapidly for the past few decades and is now the third most populous city in India. About 15 percent of the population of Karnataka lives in Bangalore. Along with the natural increase in population and migration, the growth of population can also be attributed to the increase in geographic area of Bangalore in the year 2007, when there was a change in jurisdiction of the city’s limits from 225 sq.km to 800 sq.km.

The city has witnessed high population growth since 1971 due to increased activity in the manufacturing and IT sectors. The population of the city as per the year 2011 census is 9.6 million. At an annual growth rate of 4.23 percent, **the population is expected to reach 21.15 million by 2030**. There are multiple departments and agencies providing civic services and urban infrastructure services like water supply and sewerage, urban transport and waste management. While Bruhat Bengaluru Mahanagara Palike (BBMP) is responsible for all municipal services, the water supply and sewerage service provision rests with Bangalore Water Supply and Sewerage Board (BWSSB) which designs, plans, finances and executes schemes for provision of drinking water to the city and also to certain industries within its jurisdiction.



3. Sources of water for Bangalore city

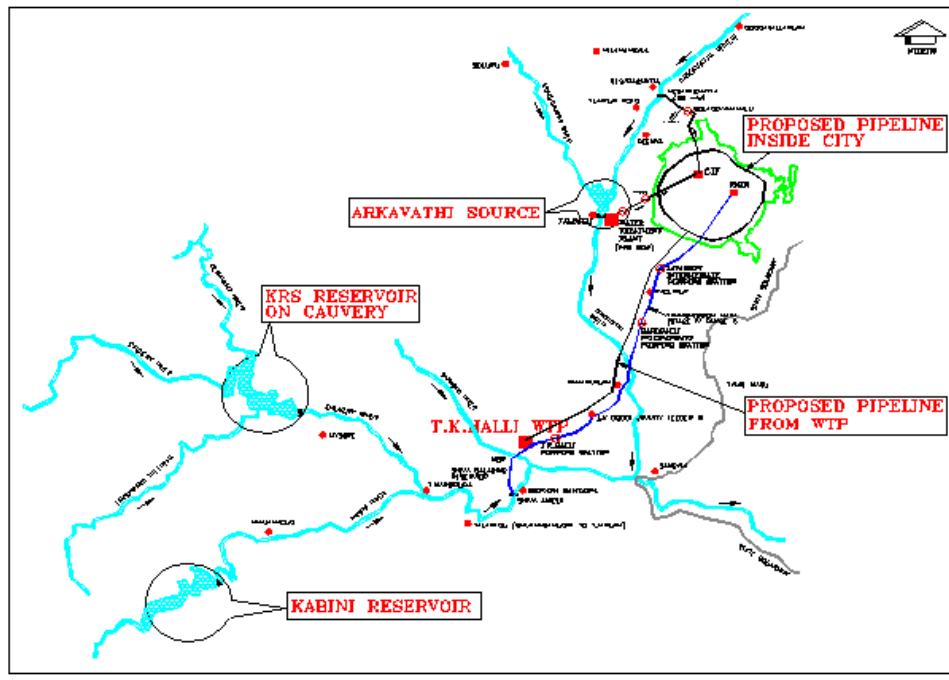
Surface water sources

The city drinking water supply needs were met earlier through several lakes, dug wells and temple tanks until a water supply scheme with piped network from the Arkavathi river was commissioned to supply 170 MLD. As the city grew, the increased demand for water could not be met through this source and hence the Cauvery Water Supply Scheme was commissioned in 1974. The water under the scheme is drawn from over 100 km from the river Cauvery and supplied to the city. With



Cauvery river source

augmentation of the scheme in four stages, the scheme is designed to supply 1410 MLD (18 TMC) of water. The dependability of the Arkavathi scheme is low due to quantity and quality issues, and only about 50 MLD is drawn when water is available during monsoon. Hence, presently Cauvery is the only reliable source of surface water to the city supplied by Bangalore Water Supply & Sewerage Board. The following figure shows the source of water supply to Bangalore city.



Source: Bangalore Water Supply & Sewerage Board

There are limitations to draw Cauvery water as it is linked to the overall allocation decided by the Cauvery Water Disputes Tribunal, which allocates water between the states of Karnataka, Tamil Nadu, Kerala and Pondicherry.

Ground water sources

In addition to Cauvery water, the Bangalore Water Supply & Sewerage Board also supplies about 500 MLD of ground water through 6869 bore-wells that it maintains in the city. Although there is no published data available on the total amount of water drawn through bore-wells in the city, it is estimated that there are about 4 lakh bore-wells in the city, most of which are not regulated. Due to rapid expansion of the city and a growing population, groundwater sources are being extracted at unsustainable levels. High levels of extraction have led to lowering of the ground water level to up to 1000 feet in the city.

In order to control the indiscriminate exploitation of groundwater in the city, the Government of Karnataka has passed the Karnataka Ground Water (regulation and control of development and management) Act, 2011. Bangalore Water Supply & Sewerage Board has the supervisory and controlling powers for bore-wells in the city.

4. Water demand and supply gap

The present norm for water supply is 150 LPCD for domestic use for Bangalore. Water demand is calculated based on the existing norms and providing for additional water losses for the population as per 2011 census. The demand projections for 2030 are provided in the table below:

Year	Population in Mln	Drinking water norm In LPCD	Physical losses In percent*	Water Demand		
				LPCD	MLD	TMC
2011	9.6	150	20.4	188	1813	23.37
2030	21.15	150	20.4	188	3986	51.38

* - Physical Losses assumed at 40percent of NRW

At a growth rate of 4 percent of the population, Bangalore will require about 51.38 TMC of water to meet the requirements of 21 million people in 2030. The current supply is only 1460 MLD (18 TMC), which is met from the following sources:

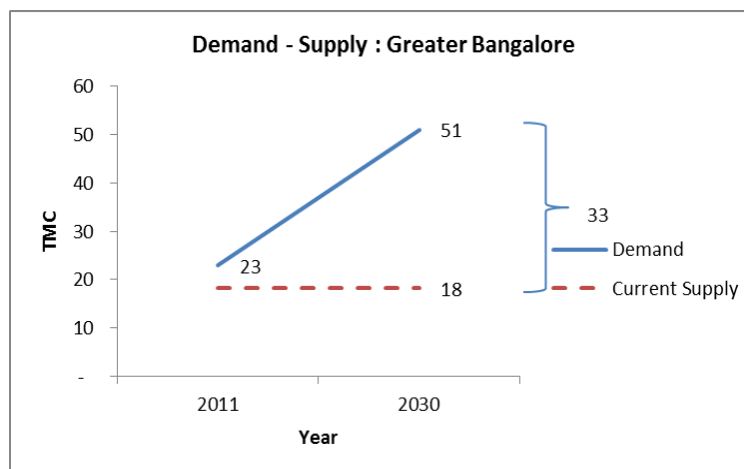
Scheme	Capacity	Supply (2011)	Current supply	Supply available for future
	(MLD)			
Arkavathy (TG Halli)	149	50	50	50
Cauvery Stage I	135	135	135	135
Cauvery Stage II	135	135	135	135
Cauvery Stage III	270	270	270	270
Cauvery Stage IV Phase I	270	270	270	270
Augmentation done	100	100	100	100
Cauvery Stage IV Phase II	500	-	325	500
Total (rounded off)	1460	960	1285	1460

Source: BWSSB

Based on projections, the **demand supply gap for water works out to around 33 TMC, in the year 2030**. The city is expected to witness a population growth of over 10 million by 2030 and the **largest demand supply gap** for water amongst all cities in Karnataka is expected to be in Bangalore.

Addressing the deficit of water will be far more difficult in the future and will require several interventions from stakeholders. Several initiatives have been initiated by the state government in order to address these challenges.

While the respective state government bodies / agencies / parastatals have initiated some measures, the need is to have a larger framework to address the demand supply gap from all alternatives. The following section details the measures for bridging the gap.



5. Bridging the demand supply gap

The measures for reducing the gap in demand supply of water supply can be through a combination of:

1. Optimizing the demand; and
2. Augmenting the supply

The following short and medium term measures have a potential of meeting the demand supply gap of 33 TMC for Bangalore city.

Demand optimization measures	Benefits	Initiatives attempted / underway	Critical Success Factors	Case examples	Water availability in TMC
Reuse and recycle of waste water	Use of wastewater after treatment in domestic buildings through laying of dual pipelines in large apartment complexes, schools and colleges in the city and industries which are in the peripheral Bangalore.	Bangalore Water Supply & Sewerage Board is in talks with several industries for use of treated water. Three projects under various stages of implementation with joint effort of Bangalore Water Supply & Sewerage Board & Karnataka Industrial Areas Development Board.	<ul style="list-style-type: none"> • Prioritize creation of additional sewerage network and treatment plants. • Planning for wastewater network and location of treatment plants to be done keeping reuse potential in mind. • Consider pilot projects with dual-piping schemes in large apartment complexes in developing localities. 	Bangalore International Airport Limited (BIAL) is being supplied 1 MLD of treated water from Bangalore Water Supply & Sewerage Board for gardening, cleaning and other non-potable purposes	6
Supply augmentation measures	Benefits	Initiatives attempted / underway	Critical Success Factors	Case examples	Water availability in TMC
Unaccounted For Water reduction	Current levels of UFW in the city are at 48percent. Reduction in these levels to 16percent will enable savings in water supply and the additional water can be made use for supply to other areas.	UFW reduction project funded by Japan International Cooperation Agency (JICA) is being piloted in Bangalore. The initiative however needs to be scaled up to the remaining parts of the city.	<ul style="list-style-type: none"> • Challenges in terms of funding the extension of PPP model for the remaining areas of Bangalore must be addressed. • Design of network to newer areas must be planned considering the ease of leak detection and repair. • Use of SCADA (supervisory control and data acquisition) systems for greater operational control. 	Swaziland Water Services Corporation initiated an integrated approach to UFW wherein through IT interventions, the physical and consumer data were captured and monitored effectively. The potential of saving in water production was 17.2percent and increase in volume of water billed by 25percent.	Core Bangalore – 4 New areas - 4

Rain Harvesting on rooftops of buildings	Water on of	Rainwater harvesting can be effectively used to recharge groundwater or store water for consumption during lean periods in summer. This can aid in addressing the issue of the gross over-exploitation of groundwater in Bangalore city to some extent.	Legislative interventions by the state government for construction of RWH structures during the time of building approvals have proved helpful to some extent.	<ul style="list-style-type: none"> • Conduct Micro studies to identify areas where groundwater situation is particularly serious. • Higher focus for rainwater harvesting in these areas through more stringent requirements and enforcement (possibly mandate RWH for all structure irrespective of rooftop size) • Consider fiscal incentives in terms of capital subsidy for collective action 	Tamil Nadu has stringent legislations with enforcement clauses which have required the citizens of Chennai to construct RWH structures in their premises. The Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) initiative of the RWH as a program with continuous monitoring has enabled sufficient recharge of the groundwater.	3
Lake rejuvenation		<p>Lakes act as a major source of groundwater recharge.</p> <p>Lakes can also be used for storing storm-water and used subsequently for domestic use post adequate treatment.</p>	Constitution of the Lake Development Authority has enabled revival of 11 lakes in the city. In addition, with the jurisdiction of all lakes in the city, the authority can liaise with other authorities like Bruhat Bengaluru Mahanagara Palike (BBMP), Bangalore Development Authority (BDA) to develop plans for restoration.	<ul style="list-style-type: none"> • Intuitional and Financial strengthening of Lake Development Authority to be created by support of state government • State government to assess funding requirements for rejuvenation and seek CSR funding from important corporates in the city. • Lake Development Authority to increase participation from NGOs and other civil societies to assist in this regard • PPP projects for lake rejuvenation considering the tourism potential may be considered by the state 	Rejuvenation of Kaikondrahalli lake is an example where citizens participation has been witnessed in both rejuvenation and maintenance	4

			government.		
Cauvery source – additional allocation	Additional supply to Bangalore from the unallocated 17.64 TMC of water from Cauvery water has been proposed. Of this, approval for 8 TMC for Bangalore has been accorded, which will improve the water supply situation.	Details of the scheme are being contemplated by BWSSB	<ul style="list-style-type: none"> • Tie-up necessary funds and execute the project • To the extent possible restrict water supply for expansion of services into newer areas. 	Not applicable	8
Inter basin transfer-Diversion of Konganahole and Kakkattuhole streams to Cauvery	Additional supply to Bangalore from two streams of the west flowing rivers	Scheme prepared by WRD	<ul style="list-style-type: none"> • Handling resident objections during construction of scheme • Approvals from the Government of Kerala as the river flows in Kerala before entering the sea 	Not applicable	6
Total					35

In addition to the above, the following measures can be adopted in parallel:

Other demand management measures	Activities	Initiatives attempted / underway	Critical success factors	Case examples
Tariff revisions	Tariff is an important instrument to bring about change in consumer behavior towards water savings. Water tariff in Bangalore is amongst the highest in the country due to the high pumping costs involved as Bangalore is located at an elevation. The cost of water supplied to Bangalore is Rs. 38 per Kilo Litre which includes the O&M costs and capital cost recovery but despite a high tariff, the rates do not cover the entire	Bangalore Water Supply & Sewerage Board has made several representations for increase of tariff. Due to lack of political support it has not been possible to escalate tariffs.	<ul style="list-style-type: none"> • Exercise of matching revenue with cost to be taken up; rationale of charging high costs to be communicated through awareness programmes • Buy in strategy from all stakeholders for tariff revision • Provide subsidy for lifeline level of consumption to obtain 	Nelspruit transitional National Council (now Mbombela municipality) in South Africa operates its water supply system through a concession. It has a tariff structure that protects the urban poor by allowing free water upto 6 KL of consumption per month and thereafter allows a steep increase as the slab increases. The higher

	<p>costs of supply. Tariff revisions are also not regular (the last tariff revision was in 2005). Lack of escalations in tariff for over 9 years stabilizes the rates in the minds of the consumers and does not dis-incentivize them for reducing the wasteful use of water.</p> <p>Consider a system of yearly increase in tariffs based on an index comprising of energy and staff costs so that tariff increase correlate closely with expenditure increases.</p>		political support of tariff revisions	slab effectively targets the affluent society which consumes more water for car washing and gardening. The slab structure itself prevents people from wastage of water.
Remodeling of storm water drains	The storm water drains are in a neglected state in Bangalore. Sewerage water mixes up with the storm water and the same is conveyed to the water bodies. Remodeling the storm water drainage network as an integrated system can prove beneficial to improving the water availability in the water bodies and groundwater recharge.	-	<ul style="list-style-type: none"> • Preparation of a master plan for storm water redesigning for the whole city • Tie-up of funds for the redesign • Take-up pilot projects as suggested in the report prepared by Expert Committee for Bangalore Water Supply & Sewerage Board. 	
Diversion of Sharavathi river from Linganamakki reservoir	The Linganamakki reservoir supplies hydro power to the state. Abundant water being available, diversion of 10 TMC every decade for 3 decades from 2021 will help in meeting the future water demand supply gap.	-	<ul style="list-style-type: none"> • Creation of a multi-stakeholder platform with Energy department, WRD and UDD as important stakeholders to decide whether Linganamakki reservoir can be used to support Bangalore cities drinking water requirements. 	

Other long term supply augmentation measures	Activities	Initiatives attempted / underway	Critical success factors
Diversion of Sharavathi river from Linganamakki reservoir	The Linganamakki reservoir supplies hydro power to the state. Abundant water being available, diversion of 10 TMC every decade for 3 decades from 2021 will help in meeting the future water demand supply gap.	-	<ul style="list-style-type: none"> • Preparation of the scheme and project reports • Approvals from the respective authorities • Land acquisition is expected to be a hurdle, so appropriate Rehabilitation & Resettlement packages should be prepared • Funding tie-ups
Diversion from Hemavathi reservoir to Arkavathy catchment	During non-irrigation period, the water can be diverted to fill the Arkavathy catchment to supply drinking water to Bangalore	Proposal prepared by Minor Irrigation Department	<ul style="list-style-type: none"> • Necessary approvals for the scheme • Funding tie-ups

10 Annexure: Deep Dive – Power Sector

1. Background

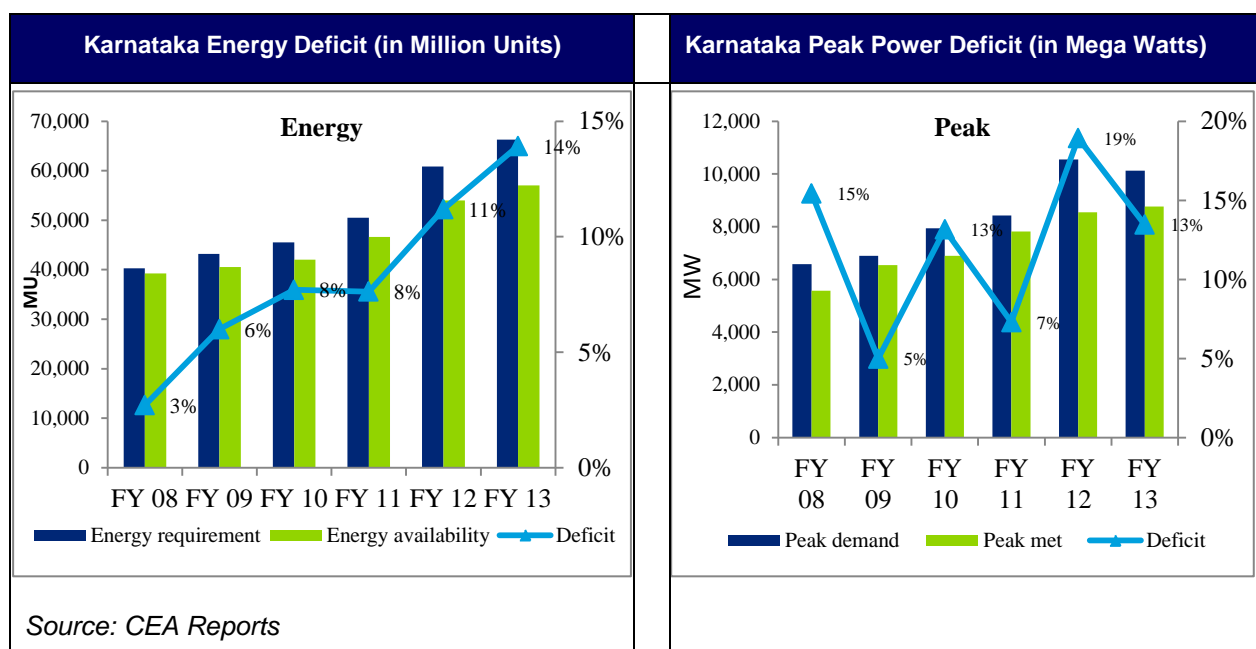
This section presents a deep dive study of the power sector in Karnataka. This section examines the water consumption requirements as it relates to growth rates in the state's power sector. The following topics are covered:

1. Overview of the power sector in Karnataka
2. Water demand and supply gap in 2030
3. Optimising water consumption through efficiency measures in power plants
4. Key policy decisions

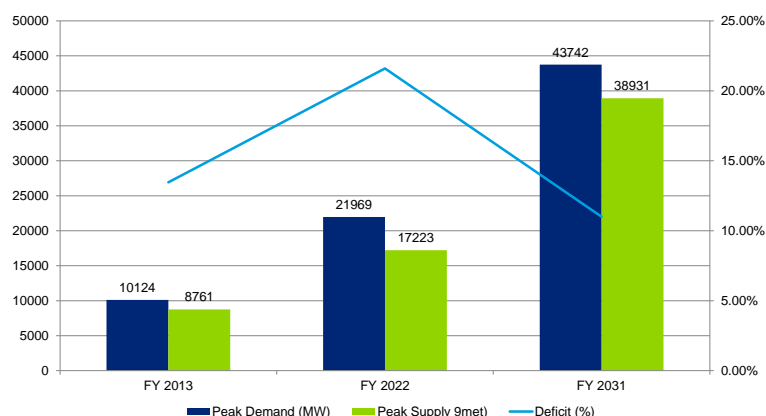
2. Overview of the Power scenario in Karnataka

Karnataka meets its energy requirements through a combination of sources - thermal (coal and gas fired), hydro, nuclear, solar and renewables. Thermal power constitutes the highest share in the energy mix of the state. The state has a contracted capacity of 12,565 MW. The state has its own generating companies like Karnataka Power Corporation Limited (KPCL) that are mandated to contract 100% of their power output to the state. In addition, the state also has a share of power allotted from the Central Generating Stations (CGS) owned by companies such as the National Thermal Power Corporation (NTPC), the National Hydroelectric Power Corporation (NHPC), Neyveli Lignite Corporation (NLC) or the Nuclear Power Corporation of India Limited (NPCIL), as well as from other private companies including the Udupi Power Corporation Limited (UPCL).

Karnataka has become a power deficit state in the recent past due to the inability to increase its power generation to meet the growing demand. From FY 08 to FY 13, the average energy deficit has been gradually increasing as a result of shortages in coal supply and unfavourable climatic conditions, which result in reduced water availability for power plants. The peak deficit has been fluctuating because of instances of intermittent breakdown of primary power plants.



Based on the past trends, it is estimated that the peak power demand in FY 2031 will be 43,742 MW. In order to meet the future demand, the state has several plans for increasing the capacity of plants, across several sub-sectors (thermal, nuclear, hydro and renewables). If these additional capacity plans were to be implemented, another 10,387 MW will be made available by 2022. The projected peak supply is calculated by taking a weighted average of Karnataka's share in the new capacity additions across fuels in that particular year. The overall supply of peak demand by 2030 is expected to reach 38,931 MW (from all fuels) based on Business As Usual Scenario.



The above projections reveal that by FY 2021-22 Karnataka is likely to become an energy-surplus state on average – but still fail to meet the peak demand completely. This indicates that in the from FY 22 to FY 30, to try to meet the peak demand, there is a possibility that gas based plants would be accorded priority over coal fired plants. In addition, a relatively greater proportion of renewable energy capacity may be added in order to meet environmental goals, regulatory mandates and lower cost of renewable energy sources.

3. Water consumption in Thermal Power Plants

Thermal power plants consume more water than other power plants due to the large amount of water required for cooling purposes. This is evident from the fact that about 30 percent of the water in a coal fired thermal power plant is used in the cooling towers. These towers use a significant volume of water to dissipate the heat of the hot water received from the condensers. In addition to this, a large amount of water (about 40 percent of the freshwater intake) is consumed in converting ash residue generated during the combustion process to slurry for disposal. Apart from these two water consuming processes, water is used for other purposes such as in the DM (demineralization) plant, for drinking water needs, firefighting purposes, coal handling etc.

A typical breakup for water usage in a Thermal Power Plant is given below:

Water Usage

Cooling Tower: water used in the cooling towers & make-up water to compensate loss due to evaporation.

Ash Handling: converting ash into slurry for disposal.

Demineralised Water (DM water): used in the boilers for generating steam

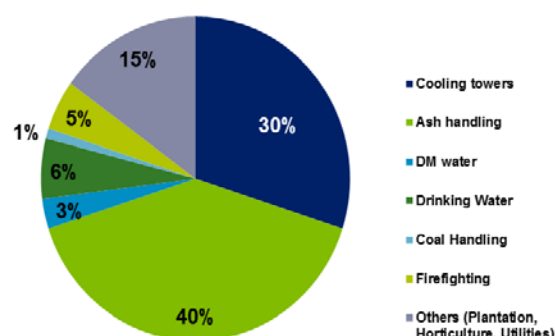
Coal Dust Suppression

Firefighting measures

Drinking water – for plant and township

Other Uses: water for plantation and other greening activities, toilets and other utilities

Typical Water Usage in a Thermal Power Plant



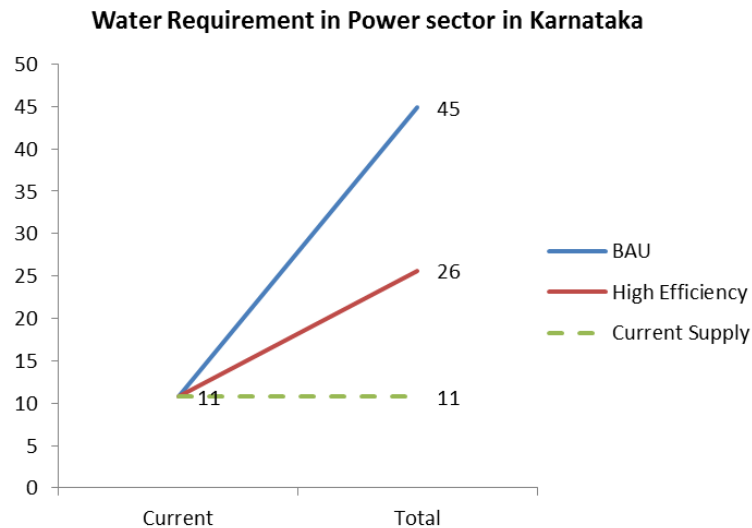
(Source: Water Use and Efficiency in Thermal Power Plants, HSBC)

4. Projected Water Demand in Thermal Power Plants

As mentioned above the peak power demand is estimated as 43,742 MW, and the overall supply from all fuels is expected to reach 38,931 MW based on Business As Usual Scenario by 2030. At present, more than 40% of the total supply is contributed by the thermal power plants. The current installed capacity of these thermal plants in Karnataka state is around 5380 MW. An installed capacity of 25,601 MW is expected by 2030.

Water demand for the thermal power plant is calculated based on the specific water consumption. Currently, it varies between 6.0 to 8.0 m³/MW/hr depending on various parameters such as size, age and the type of the plant (either coal based or gas based), type of water circulation (once through system or cooling tower based), dry ash handling system or wet ash handling system, provision for waste water recycling, etc. If we use the specific water consumption of the state's largest thermal power plant (7m³/MW/hr) and apply it to the total power demand projection in 2030, the overall water demand is estimated to be 45 TMC. The current water consumption is 11 TMC.

The specific water consumption levels can be reduced if the thermal power plants are able to initiate efficiency measures. A combination of measures is possible to be implemented, which has the potential to reduce the specific water consumption to 3m³/MW/hr.



Source: Deloitte Estimates

Water saving measures in power plants like introduction of advanced technology, reuse of water and leakage management can reduce the water demand to 26 TMC in the state. A detailed list of efficiency measures are discussed in the next section.

5. Optimizing water consumption through efficiency measures in power plants

Based on different technologies and processes that have been implemented by power plants the world over, it is possible to reduce the consumption of water to a significant extent. A few of the important measures are discussed below:

The following technological and water conservation measures have a potential to bring down the water demand for the thermal power plants in the state.

Demand optimization measures	Benefits	Initiatives attempted / underway	Critical Success Factors
Dry Cooling System	The process avoids water usage for cooling purpose thereby leading to considerable freshwater savings. For draft creation, there are two types of air cooled condenser available - mechanical and natural draft air cooled condenser. Both the methods result in water savings.	Retrofitting water cooled systems to air cooled systems has been extensively carried out in China	<ul style="list-style-type: none"> Government's intervention in policy decision for the State's TPPs regarding adoption of technology. Easier to implement as majority of the power providers are public sector entities. Enforcing mandatory water audits and drawing up a water balance for all Plants Close monitoring and plugging leakages to minimize water overflow in the cooling towers
Increased Cycles of Concentration (CoC)	The Cycles of Concentration (CoC) is the ratio of dissolved solids in the circulating water to the make-up water. Decreased CoC leads to larger consumption of water in the plants. CoC can be increased by various interventions, including use of stabilizing chemicals and disinfectants etc. enabling large freshwater saving needed as make-up.	-	<ul style="list-style-type: none"> No complex technology involved, hence "implementability" is higher, provided Government creates an enabling framework for adoption of the same in the TPPs. Enforcing mandatory water audits and a strict monitoring system
Ash Water Recycling	Ash generated during combustion is required to be converted into slurry by using water for disposal. Recapturing and recycling this water facilitates water savings in addition to lesser waste water generation	-	<ul style="list-style-type: none"> Government intervention required in prioritizing objectives for water resource management in the plants in terms of reducing freshwater consumption as well as pollution of water sources Construction of ash water ponds for treating wastewater used in ash handling plant Enforcing mandatory water audits and drawing up a water balance for all Plants

Recycling of other Waste Water	Waste water generated can be reused in the TPPs by adopting simple technologies. This includes measures such as reusing cooling tower blow down water , use of Pressure Sand Filters (PSF) and softeners for back wash water recovery, recycle of clarifiers sludge and recovery of water through thickener, rainwater harvesting etc.	A few power plants have already implemented some of the softer measures like reducing the non-process water and use of alternate sources of water like recycled water.	<ul style="list-style-type: none"> • The measures have relatively lower CAPEX, hence have higher “implementability”. Government can encourage adoption by undertaking related policy decisions through effective use of economic signals such as providing incentives or disincentives etc. • Implementing a series of water conservation measures identified through the audit • Higher focus for rainwater harvesting through a RWH mandate for industries and more stringent enforcement strategies
Adoption of Ultra Super Critical Technology	USC Technology operates at higher temperatures and pressures to achieve higher efficiencies thereby reducing water consumption. Additional advantages include - reduced fuel costs due to improved plant efficiency & reduced GHG Emissions.	Recommended by the Planning Commission in the 12th Five Year Plan. However, not adopted in any power plant till date.	<ul style="list-style-type: none"> • Government’s support in undertaking research and few pilots in the state for optimal choice of technology (sub-critical / super critical and ultra super critical) based on Indian conditions.
Sea-Water Cooled System	Rather than being setup inland, TPPs could be encouraged to be setup near the coast so that they only consume sea water for cooling purpose by constructing a Desalination plant to supply water for steam generation and other purposes.	Lanco’s plant in Udupi uses desalinated water for the processes.	<ul style="list-style-type: none"> • Presence of other critical raw materials such as coal. • Government support in availability of land and other adequate infrastructure • Creation of a multi-stakeholder platform comprising of officials from WRD, Energy Departments, DIC as well as representatives of Industry, academia and community to work through the challenges.
Dry Ash Handling System	Dry ash evacuation techniques for discharging ash instead of mixing it with water to make slurry for disposal could be developed. Another advantage of this method is that the ash can be utilized	-	<ul style="list-style-type: none"> • Government’s support in undertaking research regarding implementation of the required technologies • Locational analysis of Cement and Brick manufacturing industries with respect to TPPs

	downstream in Cement and Brick manufacturing industries.		
Other measures			
Water Audit	Institutionalising Water Audits within power plants indicate ample scope for improvement in water-use efficiency and water savings	NTPC has attempted water audit for their Vindhyachal Super Thermal Power Station (VSTPS) in Singrauli district of Madhya Pradesh.	Mechanism for institutionalizing water audit

6. Key policy decisions

The primary focus of this deep dive is on technical interventions for water efficiency in thermal power plants. However, there are several policy decisions in the energy sector that have wide-reaching implications for water and urban sector and vice-versa. For example, to ensure energy security the Government has the following decisions to make:

- How much power to generate in the state vis-à-vis how much to import?
- What would be the energy mix? Specifically how much power is to be generated through hydropower and how much to generate through thermal power?
- What would be the location for thermal power plants? Can thermal power plants be set-up near the coast to utilize imported coal and sea water?
- What would be the optimal choice of technology (sub-critical / super critical and ultra super critical) for coal-based thermal power plants?
- What would be the cooling technologies in thermal power plants (dry cooling / wet cooling)?

Many of these questions represent various types of trade-off between different uses and users. For example:

- Importing power from other states may obviate the need to provide for water, land and other infrastructure for the Power plants in the state, but it may leave the state vulnerable to supply and pricing shocks.
- While hydro-power generation may not be a “consumptive” use of water, it does alter the usability of water. For example, the Linganamakki reservoir has been created for hydropower generation. The water from the reservoir can be used for alternative purposes such as domestic consumption. In fact, the report prepared by the committee constituted for Bangalore water security in 2050 argues that hydropower generation from the reservoir be reduced to supply water to the city of Bangalore as there are alternatives for generation of power – but there are no substitutes for making available additional water for domestic consumption.
- While locating thermal power plants near the coast to use seawater for cooling may solve water challenges, it may create new challenges. For example, can imported coal be cost competitive? Can adequate land be made available in the region? Is there availability of adequate evacuation infrastructure? Can the power plant be constructed in an eco-sensitive zone?
- Adoption of super critical technology has been found to be efficient and effective from all perspectives and is recommended by the Planning Commission in the 12th Five Year Plan. Adoption of Ultra Super Critical Technology needs to be proven more in Indian conditions before large scale implementation can be suggested.
- A study conducted by Central Electrical Authority on dry cooling systems found that installation of dry cooling systems can potentially reduce the consumptive water requirement of a 2X500 MW power plant by about 80 percent. But it also reduces the unit output by about 7 percent and reduces the thermal efficiency from 38 percent to 35.5 percent. As per the Tariff Model based on Central Electricity Regulatory Commission (CERC) Regulations for 2009-14, this has the implication of raising the power tariffs by about 8 to 9 percent.

There are no straightforward solutions, and decision making requires careful analysis of all options considering the overall interests of the state. In the present circumstances, such careful deliberation requires inter-departmental co-ordination or public – private – community co-operation and is quite challenging. 2030 WRG has helped set-up such forums in various countries recently.

It is suggested that a multi-stakeholder platform comprising of officials from WRD, DIC, UDD departments as well as representatives of industry, academia and the broader community be created to work through such complex challenges.

11 Annexure: Deep Dive – Steel Sector

1. Background

The objective of this deep dive for is to examine the water consumption requirements in line with the growth in steel production in the state. The topics here include:

- Overview of the steel sector in the state
- Water consumption in steel plants
- Projected water demand-supply gap
- Measures for optimising consumption of water through efficiency measures

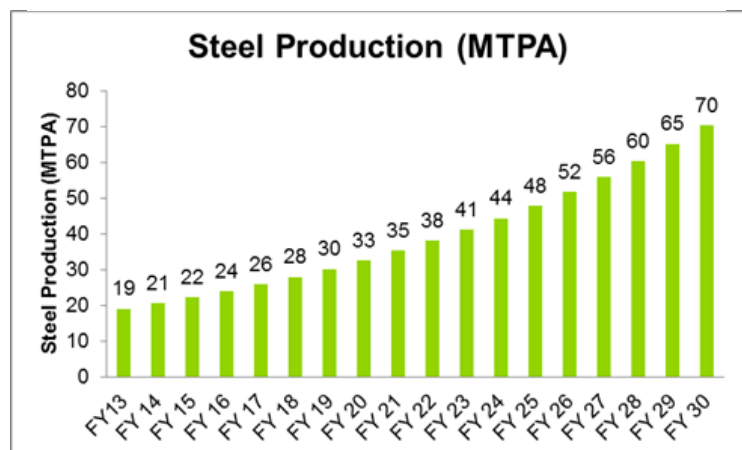
2. Overview of Steel Sector

Karnataka is the third largest producer of steel in the country and contributes 30 percent of national steel output, with 18.4 MT produced annually.¹² The state has the second largest iron ore reserves in India constituting about 16.5 percent of the country's total reserves. The state is known for its high grade iron ore primarily comprising of four mineralogical types of iron ore resources: magnetite, hematite, titaniferous magnetite and goethite and limonite.

Bellary, Chitradurga, Tumkur and Koppal are the districts with predominant mining activities in the state. The region produces one fifth of India's production at around 40MT of iron ore of which 70 percent is in the form of fines and 30 percent are lumps. The state has been exporting about 25 MT of ore each year, with one-third of the total iron ore shipment going to countries like Japan and Korea. The sector also supplies raw material to small and medium-sized sponge iron units in Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu.¹³

The steel industry in the state comprises big industries such as JSW Steel, BMM Ispat, Mukand, Sunflag Steel, Tata Metaliks, Kalyani Steels and Kirloskar Ferrous – and produces 15 MT steel annually out of the annual production of 18.4 MT. **These plants are also the major water consuming steel plants in the state.** The remaining 3.4 MT steel is produced by the smaller plants in the Bellary-Hospet-Sandur Region. Due to availability of iron ore, proximity to the coal belt and availability of large areas of uncultivated land, Bellary-Hospet-Sandur Region will remain a hub for the iron and steel industry.

Figure 8: Projected Steel Production of Karnataka by 2030



¹² Foundry Informatics Centre, Government of India

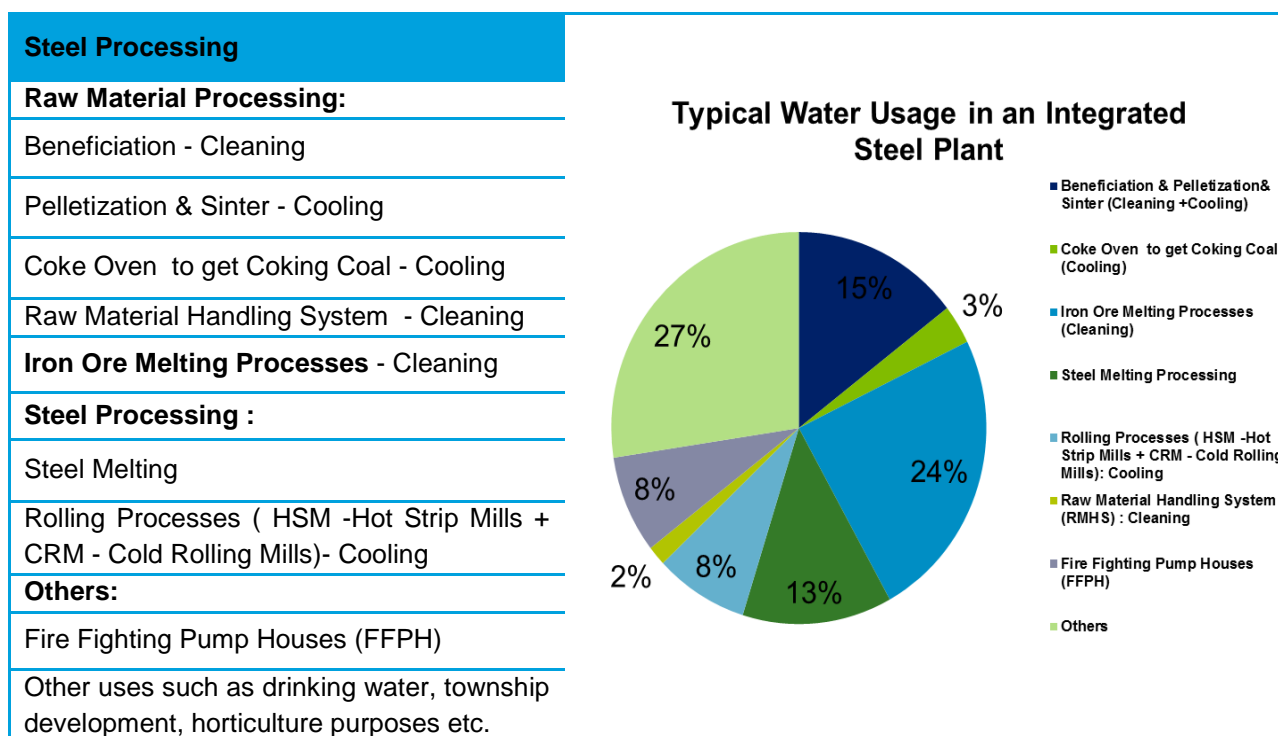
¹³ Karnataka Udyog Mitra

Steel production is expected to grow to 70 MTPA by 2030 based on the crude steel production in the state and the national compounded annual growth rate (CAGR) growth rate of 8 percent (calculated from 2005-06 to 2011-12).

3. Water Usage in Steel Industry

In a typical steel plant, water is consumed for steel processing, power production and for domestic purposes. About 40 percent of the water is consumed by the captive power plants while the remaining is used in steel producing processes including coke quenching, reactor cooling at the Blast Furnace, Electric Arc Furnace and in hot and cold rolling mills. In addition water is also used for cleaning off-gas in Coke Ovens, Blast Furnaces and Basic Oxygen Furnaces. Water is also used for descaling at hot rolling and as part of chemical treatments, such as solvent in acidic pickling, matrix for generation of emulsions for rolling, cleaning, degreasing or rinsing steel sheet surface, etc.

The breakup for water usage in steel processing in an integrated steel plant (in steel production sequence) is given below:



(Source: JSW, Bellary)

4. Water Demand-Supply Gap

Based on the water consumption norms for the steel industry, the water demand will be 10 TMC for projected steel demand of 70 MTPA in 2030. This excludes the water requirement of the captive power plants in the integrated Iron and Steel Plants in the state.

The table below shows the existing and projected water consumption (2030) of the steel industry at current and proposed consumption levels.

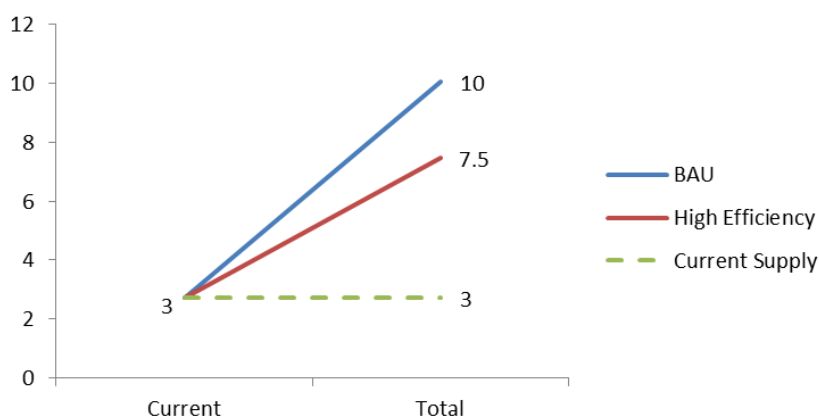
Existing and Projected Water Demand for Steel Sector in Karnataka by 2030¹⁴

*Water Consumption (in m3 /tonne of finished steel) – Existing Plants: 4

Estimated Steel Production in 2030 (in MT)	Water consumption (m3) - Current Norms*	Water consumption (m3) - Proposed Norms#	Water consumption (TMC) - Current Norms*	Water consumption (TMC) - Proposed Norms#
19,000,000 MT (FY2013)	76,000,000	57,000,000	2.7	2.0
51,300,343 MT	205,201,372	152,000,000	7.3	5.4
70,300,343 MT (FY2030)	281,201,372	410,402,744	10.0	7.5

#Water Consumption (in m3 /tonne of finished steel) assuming water efficient due to technological advancements- Current Plants: 2 Existing Plants: 3

By 2030, annual water demand for the steel sector in Karnataka will be 10 TMC. The current water consumption of Steel Plants (excluding Captive Power Plants) is 3 TMC.

Water requirement for Steel sector in Karnataka

(Source: Deloitte Estimates)

The demand of 10 TMC considers the proposed capacity additions in the future. Despite the mining restrictions, existing players and new players are considering capacity additions in the state.

Industries can reduce the water demand if certain technological changes and efficiency measures are adopted. While these are discussed in detail in the next section, it is estimated that these efforts can potentially reduce the water demand from 10 TMC to 7.5 TMC by 2030.

5. Optimizing water consumption through efficiency measures in power plants

Focused efforts on getting Integrated Steel Plants to adopt technological solutions to use water efficiently would significantly reduce water demand. In this context, several technological solutions that can result in savings of water in the steel sector have been identified. Some of the specific technological interventions that can result in water savings are discussed in the table below (see the following page):

¹⁴ Excludes the water demand for Captive Power Plants in big Integrated Iron & Steel plants

The following short and medium term measures have a potential of water savings.

Efficiency measures	Benefits	Initiatives attempted / underway	Critical Success Factors	Water saving potential in TMC (Source: Deloitte Analysis)
Coke Dry Quenching	Coke required for melting and reducing iron ore in Blast Furnace is produced by heating coking coal in Coke ovens and thereafter quenching it with water. This results in loss of significant quantity of water apart from waste water generation. Dry quenching involves using an inert gas instead of water to quench red hot coke. This saves water, reduces water pollution and provides opportunity for waste heat recovery which can then be used for the production of steam and electricity.	Has been partly adopted by JSW in their 10MTPA capacity Steel Plant in Bellary	Units that extract groundwater do not have to pay any freshwater charge. This has resulted in very low incentives for installation of water efficient technologies. Combined with little external monitoring of water consumption, there is very limited pressure on industries to adopt water efficient technologies.	Retrofitting in Existing Plants - 0.05 In New Plants - 0.19
Blast-furnace Dry De-dusting	Blast furnace (BF) gas is a gaseous by-product which is generated while producing hot metal (liquid iron) in a blast furnace. Traditionally this BF gas is cleaned in through wet processes resulting in extensive polluted water & slurry. Dry type de-dusting technology avoids water scrubbing and employs an electrostatic precipitator or a bag filter to clean the BFG thereby minimizing wastewater generation and freshwater	No major initiatives have been taken so far.	Same as above	In Existing Plants – 0.33 In new Plants – 0.89

	consumption.			
Reuse of water in industrial processes	This involves reusing wastewater generated during the steel production process. This includes reuse of blow down water from various steel making processes, recovery & reuse of backwash water and water from sludge, condensate recovery etc.	Due to relatively smaller capital cost and Pollution Control Board's waste water discharge limits, measures are being implemented in both large and medium scale steel plants.	Same as above	In Existing Plants - 0.20 In New Plants - 0.77
Dry Beneficiation	Beneficiation is the process of removing impurities from the iron ore to increase the iron content in the ore that would result in better productivity. Dry Beneficiation technique is an alternative to iron ore washing from wet processes to dry methods resulting in lower water consumption and waste water generation.	No major initiatives have been taken so far.	Same as above	In New Plants- 0.13
Total				2.6

The table below provides an overview on the penetration of the above mentioned technologies in the steel plants in the State today; expected penetration in the existing as well as future establishments and the amount of water that can be saved by adopting the same. As observed about 2.6 TMC of water can be saved by adopting the above-mentioned technologies. This can potentially bring down the 2030 water demand from 10 TMC to 7.4 TMC for the Steel sector by 2030.

In addition to reducing the demand through water efficiency measures identified above there are several other options which can reduce the freshwater consumption of steel plants. Some of the implementable approaches in the sector examined include:

Other demand management measures	Activities	Initiatives attempted / underway	Critical success factors
Reuse of water in Steel Plants by adopting Zero	All water consumed by the plant could be recycled and put to secondary use. This reduces the overall intake from the source of	JSW Steel is implementing measures to move towards Zero Liquid Discharge. While in some months in a year, it already has zero	Since units that use surface water have to draw water from sources which are quite distant, cost of water is very high. This has resulted in

Liquid Discharge systems	water and also eliminates the outflow of potentially contaminated water into the system.	discharge, but is planning to improve its systems to attain this through the year. JSW operates very close to national benchmarks for steel industry.	relatively high incentive for installing water efficient systems in plants.
Municipal Waste-water Reuse in Steel Plants	Tertiary Treated Wastewater from the city/urban areas within manageable distances from Steel Plants can be supplied to these industries.	A similar initiative has already been undertaken by Bellary Municipal Corporation. The Corporation has received requests from steel companies for treated wastewater to the extent of 22 MLD. Permissions have been granted to two industries (Janki Steels– 15 MLD, Hothur Steels- 2.5 MLD).	The government requires industries to lay a pipeline at its own cost to bring the treated wastewater to their premises. Many a times this cost becomes prohibitively expensive for reuse of treated water. It would therefore be advisable for government to choose location of STPs in a manner which reduces costs for further reuse of water.
Rainwater harvesting and Artificial Ground water recharge	Rainwater harvesting and artificial ground water recharge are therefore important measures for ensuring that industrial activity does not contribute to over-exploitation of groundwater resources in the region.	Apart from two large integrated steel plants (JSW and BMM Ispat) all other steel units primarily rely on ground water. A few of such industries have attempted this.	
Water audit	Presently, none of the steel plants in this region have conducted independent external water audits.	Recently Karnataka Pollution Control Board has started some efforts for collecting data from industrial units in an electronic form. Data pertaining to freshwater consumption of industries is collected by government agencies (WRD and KPCB) based on self-reporting basis. Data is not available in a consolidated manner at the state level which can be analysed and compared for identifying water efficiency of different industries.	Data availability is key for success of this initiative.

12 Annexure: Deep Dive – Bellary Region

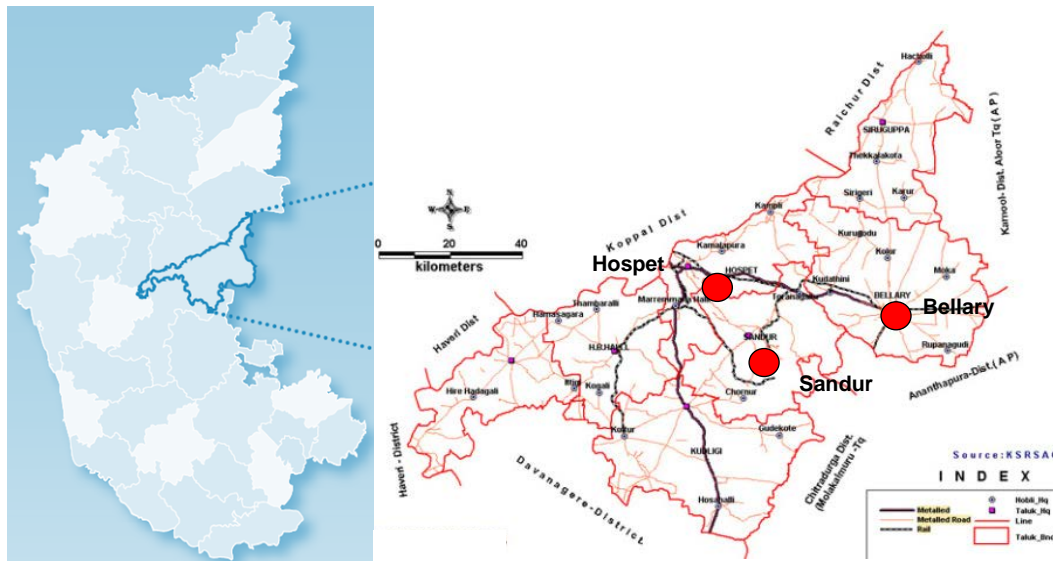
1. Background

The objective of the deep dive for Bellary region is to examine the impact of the industrialisation and urbanisation on the region's water resources and provide some solutions to meet the challenges. The coverage of this annexure includes:

- Demand for water in the region from the urban and industrial perspective until 2030
- Current sources of supply measures/ plans for meeting additional demand
- Alternatives for meeting the supply requirements through a combination of efficiency measures and additional supply sources
- Policy Interventions required in order to meet the gap in a sustainable manner

2. Introduction

Situated on the eastern side of the State, Bellary District is spread across 7 Talukas- Bellary, Siruguppa, Hospet, Kudligi, Sandur, Hadagali and Hagaribommanahalli. With Bellary city as the headquarter and the only Corporation, the district has one City Municipal Council, two Town Municipalities, six Town Panchayats as other urban areas. The figure below shows the main urban areas of Bellary district along with the district headquarter.



Source : District NRDMS Centre, Bellary

The district is rich in mineral resources both metallic and non-metallic and supports a strong industrial base for steel, cement, rice mills, readymade garments and textiles, which contribute significantly to Bellary's growing economy.

3. Population Growth Trends of Bellary region

The Bellary (Municipal Corporation) and Hospet (City Municipal Council) are the two important urban areas in the region. The city of Bellary has been growing rapidly for the past few decades and is now the second fastest growing city in the state. Apart from being the district headquarter, the city lies within the steel belt of the region.

The population of the city as per 2011 census is approximately 0.40 million. At an annual growth rate of 2.66 percent, the population is expected to increase to 0.67 million by 2030. It is projected that the population of town of Hospet at a similar growth rate will increase from 0.20 million to 0.34 million by 2030.

4. Industrial Profile of Bellary region

As mentioned above, Bellary has a strong industrial base comprising of steel, cement, rice mills, readymade garments, textiles, cotton based industries and oil extraction units – all due to availability of important minerals and other raw materials. As per the Department of Industries and Commerce, there are 70 Large and Medium Industrial Units with a total investment of INR 36,579 crores in the district at present. These include industry giants from all sectors such as JSW Ltd., JSW Cements, MSPL, Bellary Thermal Power Corporation, Sirugappa Sugars and Chemicals, Mukund Steels, Kalyani Steels etc. There are also 70-75 steel based industrial units in the Bellary-Hospet-Sandur Region, and these account for more than 80 percent of the steel plants and more than 90 percent of the total steel production in the state.

Despite the current mining restrictions by Supreme Court, large capacity additions in the iron and steel sector have been planned by Arcelor-Mittal, NMDC, Bhushan Steel, Brahmani Steels and other steel giants. In addition, six Industrial Areas with and 4 Industrial Estates spanning over more than 600 acres are being proposed in the Hospet and Bellary area¹⁵.

5. Sources of water for the region

Surface water sources

Drinking water supply needs for all the urban areas are met through the Tungabhadra River either through its distributaries or canals. The city of Bellary gets its water supply from the two canals from the Tungbha Bhadra Dam- HLC & LLC Canals (High Level & Low Level Canals). The Low Level Canal started supplying water to Bellary city in 1964. In 1992 it was augmented with water from Low Level Canal from the dam. At present the water supply system is maintained by KUWSDB till the bulk point; water distribution thereon is undertaken by the Municipal Corporation.

In case of industries, only JSW Steel and BMM Ispat are the predominant users of surface water in the region. JSW Steel receives its allocated water supply of 1.24 TMC & 2 TMC for plant operation and township from Tungbha Bhadra dam and Almatti dam respectively. All other industries in the region primarily depend on ground water for their operations.

Ground water sources

As mentioned above, all industries in the region including remaining steel based units except JSW & BMM Ispat, apparel, cement, agro –food processing units etc. utilize groundwater for their operations. The Pollution Control Board estimates about 33 MLD (~ 0.4 TMC) of water is being extracted from sub-surface for industrial purposes.

Due to quality issues, groundwater is not utilised for drinking purposes at present.

¹⁵ Advantage Karnataka-Global Investors Meet 2012

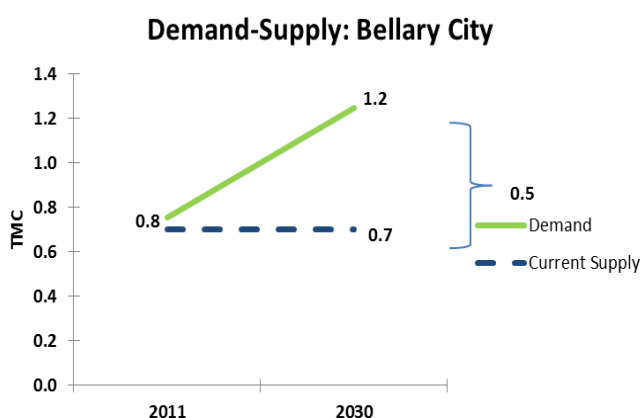
6. Water demand and supply gap

The present norm for water supply is 135 LPCD for domestic use for Bellary. Water demand is calculated based on the existing norms and providing for additional water losses for the population as per 2011 census. The demand projections for 2030 are provided in the table below:

Year	Population in Mln	Drinking water norm in LPCD	Physical losses in percent*	Water Demand		
				LPCD	MLD	TMC
2011	0.41	135	5	142	58	0.75
2030	0.67	135	5	142	96	1.24

* - Physical Losses assumed at 5percent of the NRW

At a growth rate of about 3 percent of the population, Bellary will require about 96 MLD (~1.2 TMC) of water to meet the requirements of 0.6 million people in 2030. Of this the current supply is only 54 MLD (~0.8 TMC) met from both surface water-Tungabhadra HLC & LLC Canal & borewell sources. Based on the projections, the **demand supply gap works out to 42 MLD (~0.5 TMC) in the year 2030.**



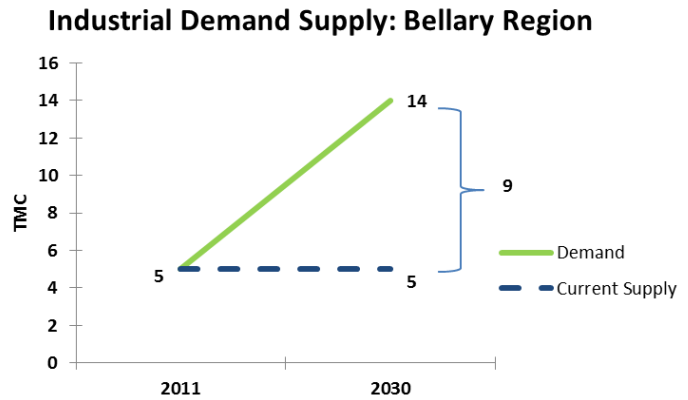
Source: Deloitte Analysis

In case of industries, the existing water demand for the large and medium scale industries in the region is around 5 TMC¹⁶. With the growth in industries in the region and large capacity additions in the iron and steel sector – which is the biggest consumer of water along with the upcoming industrial areas – the demand for industrial water will also grow in the future. An additional requirement of 10-12 TMC¹⁷ of water is expected with the establishment of the large steel plants.

¹⁶ Karnataka Udyog Mitra

¹⁷ District Industries Centre (DIC), Bellary

At a CAGR of about 6 percent for the medium and large scale industries, it is projected that Bellary will require about 14 TMC of water to meet the requirements of industries in 2030. Based on the projections, **the demand supply gap works out to around 9 TMC in the year 2030.**



Source: Deloitte Analysis

With a steadily growing population and industrial growth – in addition to expected capacity additions in the iron and steel sector in the region – addressing the deficit of water and ensuring supply security will be far more acute in the future. In this context, several interventions to address and link urban water supply issues with the industrial water demands needs to be undertaken. The following section details the measures for bridging the gap.

7. Bridging the demand supply gap

In the Bellary region, the presence of large industries with large water requirements has necessitated the industries to internalize water savings as a routine exercise. Hence plants have dedicated departments to focus on water and wastewater management. They have also developed plans for investments in technologies that can reduce water consumption, lower the need for top up water and reduce discharge of wastewater. While some large companies have adopted such measures, it is important that the push for demand management spreads to all the industries and industrial clusters in the region. The industry – urban interface for water is preeminent due to source constraints arising out of growing water demand and for the future.

Some key measures are discussed below:

The following short and medium term measures have a potential of meeting the demand for water in Bellary region.

Demand optimization measures	Benefits	Initiatives attempted / underway	Critical Success Factors
Compulsory Water Audit for industries	Water audit identifies areas where water can be saved in an industry with associated cost benefit analysis. This helps industries prioritize their water conservation efforts.	JSW Steel conducts internal water balance in its plant in Bellary. Active involvement of the state government in encouraging industries to take up external audits is yet to be seen.	<ul style="list-style-type: none"> Creation of a water efficiency Bureau which can require industries to conduct water audits and follow up based on recommendations given in the audit is important. There is a need to transform the culture of industries from viewing water as a utility to viewing water as an economic resource. Water audits can be the instrument through which the state government can have a meaningful dialogue with industries to bring about this change in mindset.
Use of treated municipal waste water use by industries	Through the Karnataka Urban Water Supply and Drainage Board, the Bellary City Corporation has set up 2 Sewerage Treatment plants and after treatment, 70 percent of the treated water is available for industries. As industries search for water sources that can supply water across the year, there is an increased demand amongst the industries in Bellary to use this as a key water source for their operations.	Industries in Bellary have already approached the city corporation to provide the treated water to them. Currently, from the 30 MLD STP (Sewage Treatment Plant), about 22 MLD has already been committed to industries.	<ul style="list-style-type: none"> While treated sewerage water commitments are already available, the financial and operational modalities of setting up pipelines to draw the water from the STP have not yet been finalized. As the cost of the pipeline from the STP to the plant is expected to be significant, there could be reluctance from the medium sized industries to build their own pipeline. A mechanism for construction of pipelines for shared use could be devised. This could be done through a public private partnership where a group of industries can support laying of pipeline on a cost sharing basis.
Construction of Common Effluent Treatment Plants by industry associations/clusters	Industrial clusters in Bellary with large water requirements especially for water intensive	Karnataka State Pollution Control Board has initiated some measures towards	<ul style="list-style-type: none"> As the demand for raw water is expected to decrease by 80percent per unit, this model could be attempted in high water consuming industrial units that operate as a cluster like gin washing (Bellary has about 50 gin

	industries like gin washing clusters, can opt for constructing a Common Effluent Treatment Plant with the intervention of the municipality/Pollution Control Board or other state level agencies. About 80percent of the water in the cluster can be recycled at the CETPs.	Common Effluent Treatment Plants (CETPs) through subsidies available from Government of India scheme.	washing units consuming about 50 KLD of water each). <ul style="list-style-type: none"> It may be difficult for industries to take effective collective action and therefore pro-active leadership of state government through Karnataka State Pollution Control Board and District Industries Centre utilizing various subsidy schemes available would be important for success of these types of initiatives.
Creation of raw water pondages as storage structures for storing water for use during summer	Pondages act as storage structures to store rain water and serve the industry during summer when the raw water availability becomes scarce as flow in river Krishna becomes inadequate to support industries. Creation of such pondages require large parcels of land to store water which can sustain the need for at-least a few weeks in a year. Presently creation of pondages is a responsibility of the individual unit. This is a sub-optimal arrangement due to high overheads required in terms of resources and management attention required from all industries. Creation of common storage	Due to proximity constraints (as plants are not located close to each other in Bellary), the possibility of such common pondages have not been initiated. However, individually companies like JSW have identified 600 acres of land for the purpose of creation of pondage for their water consumption.	<ul style="list-style-type: none"> Land availability is a critical issue for creation of large storage structures. This will require state government interventions wherein government land can be used for this purpose and the private sector constructing the same. This largely being contemplated as an industry-led initiative, formal representations to the government on the necessity of such common storage structures is required. This could be taken up by the industrial associations through the District Industries Commissionerate (DIC) in Bellary region for seeking necessary involvement and participation of the state government As this involves a number of private sector players and the government, an appropriate PPP structure with well-defined roles and responsibilities and revenue streams could be devised. A framework for sharing of the construction cost and the cost of pipelines needs to be developed. An option includes government sharing the land for the storage structures and the private sector developing the pipeline network. Another option involves developing a SPV for

	infrastructure could be cost efficient for all units.		the project with equal representations from the government and the private sector.
Rain water harvesting	Industries in Bellary region rely heavily on groundwater and 40percent of the industries' water requirements are met through groundwater. Recharge structures can be very beneficial due to this heavy dependency on ground water.	Individually, a few large plants have constructed recharge pits where rain water is collected and channelized to reach the guard pond. This water is treated and used for the processes.	<ul style="list-style-type: none"> All units that use groundwater should be mandated to create rainwater harvesting structures within the premises. Industries that use groundwater heavily and cannot replenish it with Rainwater harvesting within premises should be encouraged to take up watershed development activities as CSR measure to ensure neutral water balance in the region.
Desilting of Tunga Bhadra reservoir in partnership with private sector.	Tunga Bhadra reservoir is an important surface water source available for industries in Bellary region. The reservoir has lost the storage capacity to the extent of 34 TMC due to deposition of silt over the years. Desilting of Tunga Bhadra reservoir is beneficial as it can free up storage capacity that can be utilized by industries (assuming industries played an important role in desilting activities)	-	<ul style="list-style-type: none"> At present there are several challenges in desilting TB dam such as high cost, appropriate technology, location for depositing removed silt etc. Government is serious in seeking a solution for desilting the dam and it is looking for partnership with technology providers with proven expertise and industries for a joint effort. A dedicated working group with international expertise may be useful in identifying the best techno-commercial approach for the challenge.
Wastewater reuse and Zero Liquid Discharge systems	Implementation of projects to reuse wastewater and achieve zero liquid discharge cannot only reduce freshwater intake but also reduce water pollution to a large extent.	JSW has taken concerted efforts to make their plant a Zero Liquid Discharge one through a combination of projects involving setting up a bioreactor facility for	<ul style="list-style-type: none"> Since Zero liquid discharge measures are relatively expensive there is limited appetite in industries to implement such measures unless they face very high cost of water. Therefore a careful combination of incentives and

		processing 3 MLD of water and advanced treatment plants.	disincentives (subsidies or mandatory installation requirements) could be adopted considering the financial capacity of the typical units and harmful effect on the environment of the wastewater in each sector.
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13 Annexure: List of Stakeholders

Overall Water sector stakeholders	Water Resources Department (WRD)	Mr. D.Satya Murthy, Ex-Principal Secretary Mr. Gurupadaswamy B G, Secretary Mr. Gurumurthy S Hegde Joint Secretary Mr. I.D. Daman, Officer on Special Duty
	Karnataka Neeravari Nigam Limited (KNNL)	Mr. R.Rudraiah, Managing Director, Mr. M G ShivaKumar, Superintending Engineer
	Krishna Bhagya Jala Nigam Ltd (KBJNL)	Mr. Kapil Mohan, Managing Director
	Cauvery Neeravari Nigam Limited (CNNL)	Mr. K. Jaiprakash, Managing Director
	Water Resources Development Organisation (WRDO)	Mr. Sreenivas, Superintending Engineer
Urban Sector stakeholders	Urban Development Department	Mr. D.Satya Murthy, Additional Chief Secretary Mr. T.K Anil Kumar ,Secretary
	Karnataka Urban Water Supply and Drainage Board	Mr. Rajeev Chawla ,Managing Director Mr. B M Nagesh , Deputy Chief Engineer
	Bangalore Water Supply and Sewerage Board	Mr. M S Ravishankar, Chairman Mr. Rudramurthy S.P, Chief Engineer Mr. Narayana, Chief Engineer Mr. S.M Ramakrishna, Additional Chief Engineer Mr. V. Mahesh, Additional Chief Engineer Dr. P N Ravindra, Executive Engineer
	Karnataka Urban Infrastructure Development Corporation	Mr. Darpan Jain , Managing Director Mr. Ashok Jain, General Manager Mr. C.S. Pratinidhi, Advisor – Water projects Ms. P.Jayamala, Deputy General Manager Mr. Sharif, Executive Director (NKUISP)
	Directorate of Municipal Administration	Mr. S.R Garwad Joint Director Development
	Sector Experts	Mr. G.S Paramashivaiah, Retd. Superintendent Engineer and Irrigation Expert Mr. Shiv Kumar, Rainwater Harvesting Expert, Indian Institute of Science. Mr. Narayana Iyengar, Member, Thyagaraja Expert Committee
Industrial Sector stakeholders	Industries and Commerce Department	Mr. M N Vidyashankar Ex-Principal Secretary Mr. M. Maheswar Rao, Commissioner & Director

		Ms. Swaroopa T.K , Joint Director Mr. Syed Isfaq Ahmed, Joint Director (Industrial Development)
	Karnataka Udyog Mitra (KUM)	Mr. B. Mahesh, Joint Director
	Karnataka Industrial Areas Development Board (KIADB)	Mr. Ashok R. Manami, General Manager Mr. M. Rama, Development Officer & Executive Engineer
	Karnataka State Industrial Infrastructure Development Corporation(KSIIDC)	Mr. N.R.N. Simha, Deputy General Manager
	Technical Consultancy Services Organization of Karnataka (TECSOK)	Mr. M. Mokashi, Chief Adviser & CEO Mr. M S Raghavendra, Adviser
	District Industries Center , Bellary	Joint Director/Deputy Director
	Steel Companies	JSW Steel Limited, Vijayanagar, Bellary Janaki Steels
	Karnataka Power Corporation Limited	Chief Engineer
	Karnataka State Pollution Control Board	Mr. Vaman Acharya, Chairman Other Nodal Officers
	Pollution Control Board, Bellary	Regional Officer, Bellary
	Department of Geology and Mines	Ms. Sannabormma Subramani, Joint Director
	Sector Experts	Mr. Hari Hedge, CII & Water Task Force, Wipro Mr. Anand Krishnamurthy, GE Water and Process Technologies



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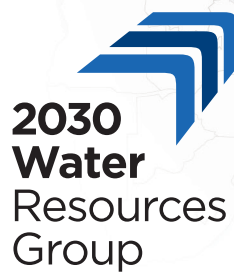
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Karnataka, India



2121 Pennsylvania Avenue, NW
Washington, D.C., 20433 USA

www.2030wrg.org

For further information, please contact
2030wrg@ifc.org