Enabling Smart Water to make Indian Cities Sustainable and Carbon Neutral

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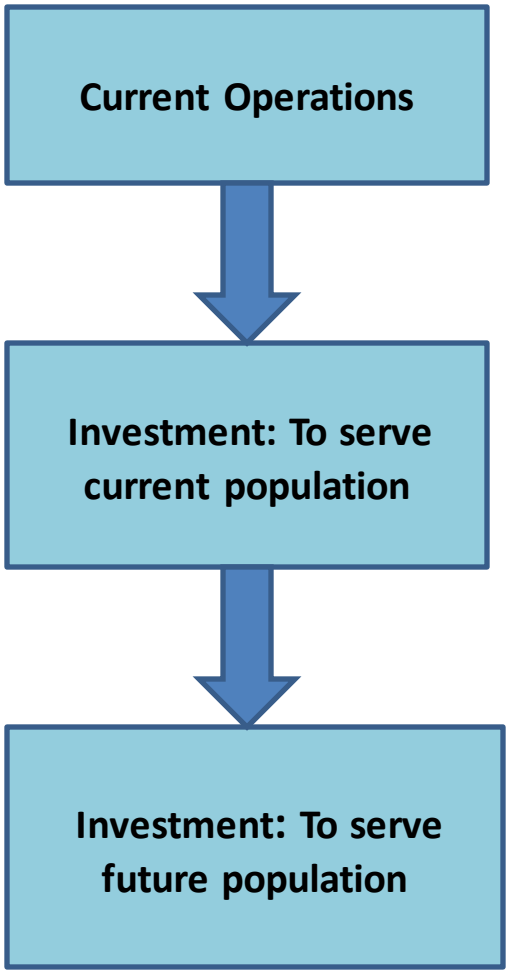
UNIQUE CHALLENGES IN URBAN WATER SECTOR



- Utilities don't exist or are weak
- Operating cost recovery is low
- Current service levels are poor, with water supply intermittent and often unknown
- Low commercial and staff efficiency

- Asset condition is poor and largely unknown
- Non revenue water (NRW) is unknown and often underestimated
- Capital expenditure to rehabilitate network is large and unknown
- Poor hydraulic design of networks

- Population growth is high but not clear
- Where population will live is unclear
- Capital expenditure planning is weak and financing sources uncertain
- Divided responsibility for city and periphery for distribution and bulk supply

MARKET CHARACTERISTICS

- Indian Metros are rated poorly with respect to hours of water supply per day among top 27 Asian cities.
  - Delhi : 4 hrs
  - Chennai : 4 hrs
  - Mumbai : 5 hrs
  - Kolkata : 10 hrs
- Barring some exceptions each city suffers from inadequate water supply, area coverage, unequal distribution and poor quality of water supply.
- Most Indian cities do not have sewerage system.
- Utility services run in to huge losses as full cost of water is not levied
- Alternative institutional arrangements – Water Utilities have not made any difference
- New measures have been taken to introduce PPP and SPV to raise funds
- Smart City program makes it mandatory for cities to have O&M recovery within 5 years
- New KPI being introduced through CPHEEO (Central Public health and Environment Engineering Organization Govt of India) to bring out revised manual incorporating the new technologies in water management, O&M and PPP structures including Smart initiatives

KEY OBJECTIVES

WATER MANAGEMENT

The city vision is to provide safe and reliable water supply by

- 100% coverage in terms of quantity and quality of water supply
- incorporating a broad range of water source options
- 24x7 water supply at consumer end and installation of smart meters
- Reuse of tertiary treated water for non potable usage for commercials and Parks

SEWERAGE MANAGEMENT

- 100% collection & Treatment sewerage as per MOUD guidelines
- Complete automation of sewerage pumping stations and STP

ICT FOR WATER MANAGEMENT

- Integrated Management information system

MAJOR GOVERNMENT INITIATIVES - AMRUT 2.0

Indian Government have committed to 40 Bn USD in the next 5 years .

- **Securing tap and sewer connections** :

  To bridge the estimated gap of 2.68 crore (27 Mn)urban households

  To provide 2.64 crore (27 Mn) sewer connections/septage in 500 Cities

- **Deploying Latest Technology:**

  To leverage latest global technologies in the field of water.

- Non –Revenue water loss of less than 20%
- Recycling used water for meeting 20% of city demand and 40% Cities Industrial demand
- Rejuvenation of water bodies
- Raising Municipal bonds and PPP contracts
- Outcome based funding
- Circular economy and water balance for each city
- Develop Coastline with small energy efficient desalination plants
- 500 Cities have been announced under this reform thus lends for application of digital solutions

The main drivers has been due to the commitment to meeting SDG goals by 2030 of Universal access to safe drinking water and sewerage , improving water quality and service standards .

REDUCING LOST REVENUES

Technical

- ✓ Poor network maintenance
- ✓ Wrong zoning
- ✓ High or irregular pressures
- ✓ Non-visible Leaks

Commercial

- ✓ Poor meter maintenance
- ✓ Inaccurate billing
- ✓ Inefficient meter readings
- ✓ Illegal, unknown or un-metered connections
- ✓ Inadequate debt management

Produce bulk water

Supply water to consumer

Invoice consumer

Collect revenue

NRW ANALYSIS

Authorised Consumption	Billed Authorised Consumption	Billed metered consumption	Paying	Consumption; large consumers
			Non-paying	Consumption; wastage; internal leakage; large consumers
		Billed unmetered consumption	Paying	Consumption; wastage; internal leakage; large consumers
			Non-paying	Consumption; wastage; internal leakage; large consumers
	Unbilled Authorised Consumption	Unbilled metered consumption	Goverment, public taps, etc	
		Unbilled unmetered consumption	Goverment, public taps, etc	
			Fire fighting & testing	
Water Losses	Apparent Losses	Unauthorised consumption	Illegal connect	Consumption; wastage; internal leakage
			Unregistered connect	Consumption; wastage; internal leakage
		Customer metering inaccuracies	Meter problems	Meter inaccuracies
				Broken meters
				Slow meters
				Oversized Meters
			Meter reading problems	Incorrect readings
				Incomplete reading
				Unidentified connections
	Real Losses	Leakage on pipes	Bad zoning & high pressures	
			Badly corroded pipes	
			Visible bursts	
			Major non-visible leaks	
			Minor leaks	
		Leakage/overflows at tanks		
		Leakage on service connections		

Non Revenue Water

Global NRW Estimates

- 126 billion m^3/year
- 346 million m^3/day
- 77 liters per capita per day
- USD 39 billion per year

Source - R. Liemberger & A. Wyatt

Estimated Global Carbon Emission

- 187.2 million metric tons CO^2 / year
- 513 thousand metric tons CO^2 / day
- .6% of global CO^2 emissions

Global CO^2 emissions

- 1.9% from Aviation
- 1.7% from Shipping

Source : IWA/ WLG

How do we reduce leak emissions ?

- We already know how…….. By reducing Real Loss!
- When we reduce Real Loss, we are reducing the amount of energy and resources used in our water supply chain for water that is ultimately wasted.

Estimated Global Water Production

Basic Water Source - no pumping and minimum chemicals	Traditional Water Systems – combination of pumping / treatment / chemicals	Desalination Sea Water Reverse Osmosis (Average)	Desalination Sea Water Reverse Osmosis (high) and plants run by fuel oil
10%	60%	20%	10%

source IWA/WLG

CO_2 in **grams** per m^3 of water per water production source

Basic Water Source - no pumping and minimum chemicals	Traditional Water Systems – combination of pumping / treatment / chemicals	Desalination Sea Water Reverse Osmosis (Average)	Desalination Sea Water Reverse Osmosis (high) and plants run by fuel oil
30 g/m^3	298 g/m^3	3170 g/m^3	6700 g/m^3

Source : IWA /WLG

CO2 emissions savings

CO2 SAVINGS METRIC TONS / YEAR				
Basic Water Source	Traditional Water System	Desalinated Sea Water – Reverse Osmosis	Desalinated Sea Water – RO using Fuel Oil	TOTAL
264,600	15,770,160	55,918,800	59,094,000	131,047,560

This equates to .4% of global CO2 emissions
Source : IWA/ WLG

So…. what does this look like ?

CO2 OVERVIEW PER WATER SOURCE PER YEAR				
Basic Water Source	Traditional Water System	Desalinated Sea Water – Reverse Osmosis	Desalinated Sea Water – RO using Fuel Oil	TOTAL
264,600	15,770,160	55,918,800	59,094,000	tons per year
10%	60%	20%	10%	% water source
30 g/m^3	298 g/m^3	3170 g/m^3	6700 g/m^3	CO^2 g/m^3
0.21%	12.03%	42.67%	45.09%	% of CO^2

Source : IWA/ WLG

NRW IN SELECT INDIAN CITIES WHICH HAD REFORMS

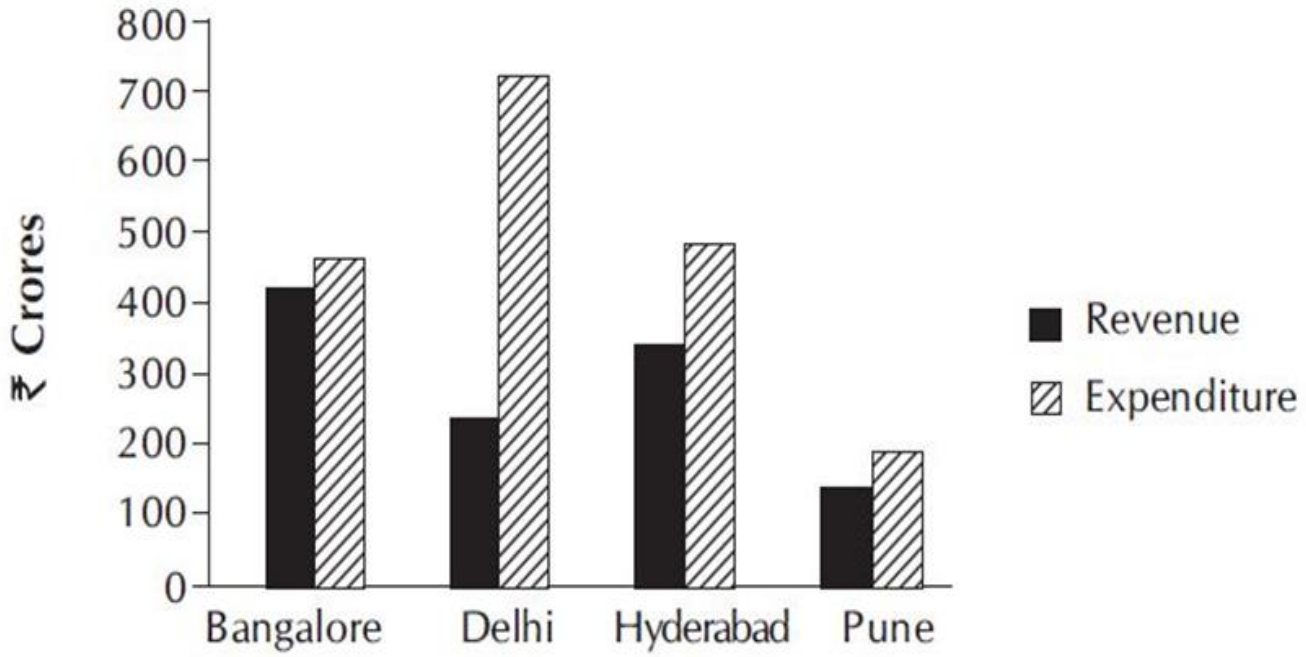
Table 3: NRW Estimates in Bangalore, Delhi, Hyderabad and Pune Based on IWA Standards

City	Bangalore	Delhi	Hyderabad	Pune
Total Input Volume (MLD)	930	3,677	1,503	1,123
Total Water Loss (MLD)	474.3	1,926.74	571.14	337
Unbilled Authorized	–	–	–	–
Consumption (MLD)	47.1	1311	156.5	104
Apparent Loss (MLD)	18.96	304.1	133.07	131.96
Real Loss (MLD)	408.24	311.6	281.57	101.04
Non-Revenue Water (%)	51	52.4	38	30
Unbilled Authorized Consumption (%)	10	68	28	31
Of Which Apparent Loss (%)	4	16	23	39
Of Which Real Loss (%)	86	16	49	30
Apparent Loss of L/Conn/Day	33.7	176.90	163.31	140.69
Real Loss of KL/Km/Day	86.87	32.45	80.44	40.84
Revenue Foregone Due to Unbilled Authorized Consumption (₹)*/Day	282,600	7,866,000	939,000	624,000
Revenue Foregone Due to Apparent Loss (₹)*/Day	113,760	1,824,600	798,420	791,760
Revenue Foregone Due to Real Loss (₹)*/Day	2,449,440	1,869,600	1,689,420	606,240
Daily Revenue Foregone (₹)	2,845,800	11,560,440	3,426,840	2,022,000
Annual Revenue Foregone (₹)	1,038,717,000	4,219,560,600	1,250,796,600	738,030,000

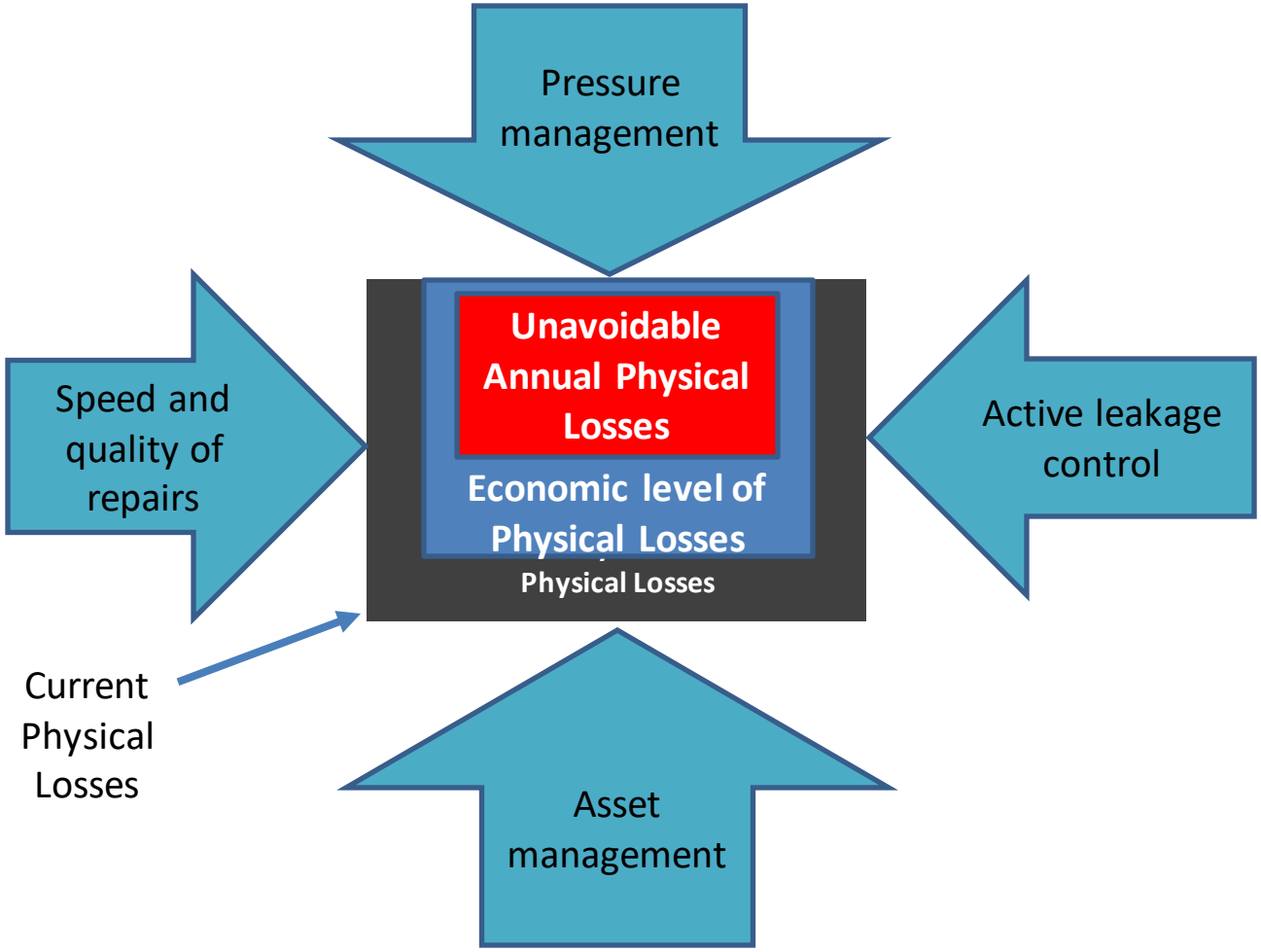
Note: * Water cost taken as (₹) 6/KL.

TYPICAL STATUS OF FINANCES OF UTILITIES

Figure 12: Revenue and Expenditure of Water Supply in BWSSB, DJB, HMWSSB and PMC



NRW Reduction Strategy – Physical Losses



Listening on each stop tap

- Must get too and from site
- Don't know if any leaks present in the region surveyed
- Low footprint if area is surveyed by foot

Lift and shift

- Movement of staff in vehicles doing lift and shift and follow up ALC activities
- Don't know if any leaks present in the region surveyed

Permanent installed equipment

- Once installed only go to alarms – reduced unnecessary vehicle usage

Satellite leakage

- Only go to AOI's – reduced unnecessary vehicle usage

Active leakage control factors affecting Carbon

Method of pipe installation	• Open cut • Bored / pipe bursting
Ground type	• Concrete / tarmac • Sand / grass
Material used	• Metallic - type • Non metallic
Life expectancy 30 - 60 years	
Service pipe	• Material • Renew or use existing

Asset Management factors affecting Carbon

Installation of PRV and servicing valves

Single time installation

Type of pressure control

Chose right type of installation for best results

Lowest cost on carbons once installed

Reduces losses without needing to visit site

Controlled remotely and serviced annually

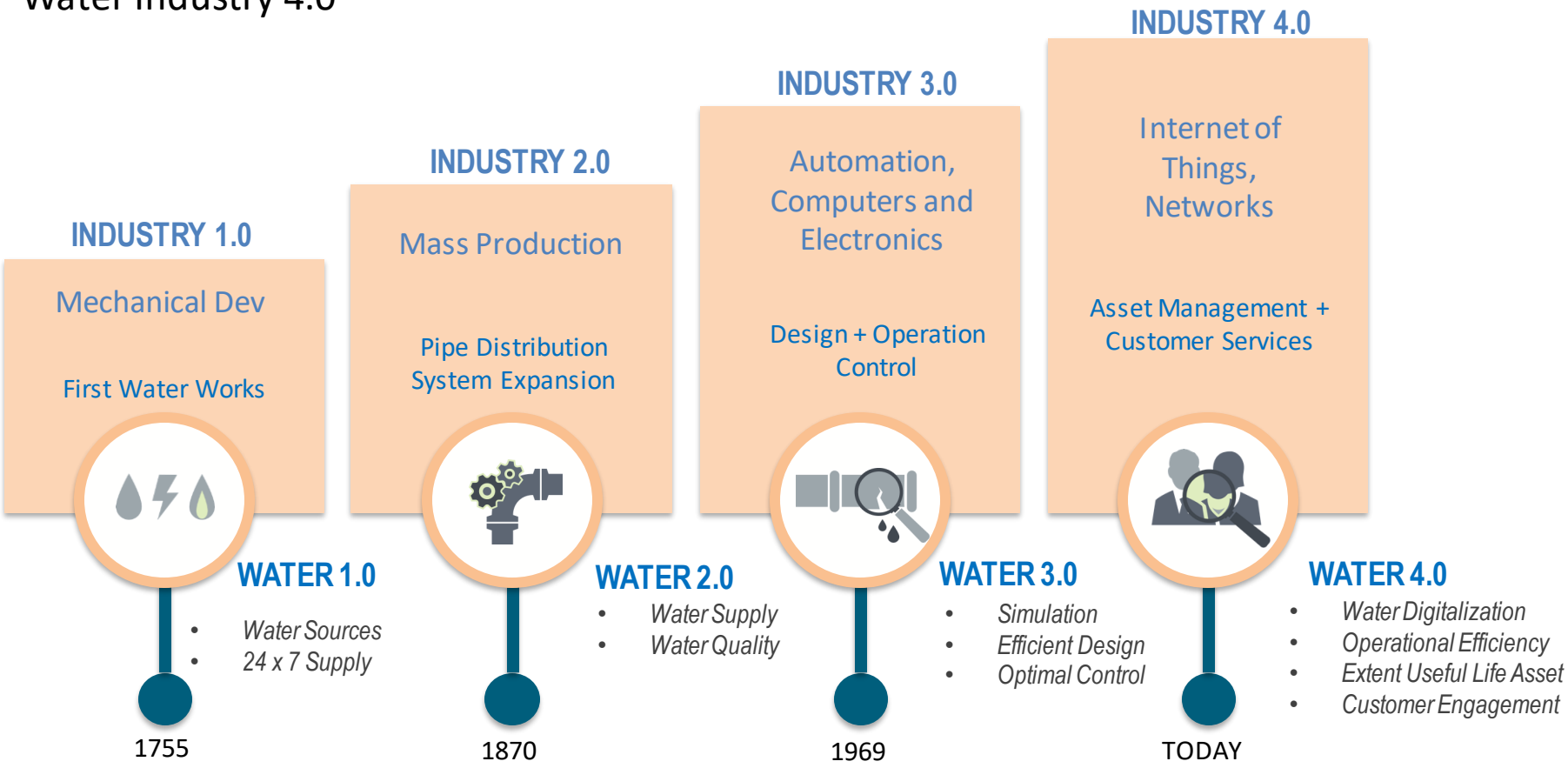
Pressure Management factors affecting Carbon

- Repair or replace
- Repair quality
- Quality of fittings used
- Run time of leak

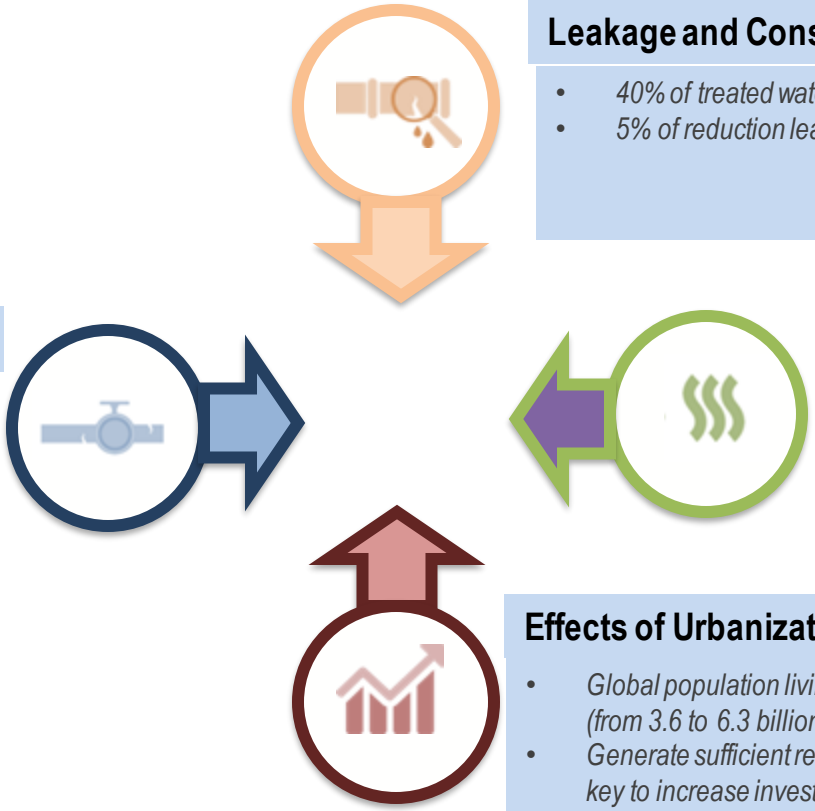
Speed and quality of repairs factors affecting Carbon

How water sector is transitioning

Water Industry 4.0



Market Drivers



Leakage and Conservation

- *40% of treated water to leaks*
- *5% of reduction leaks and a 10% reduction in pipe burst*

Aging Infrastructure

- *The age of infrastructure is a major issue in many older cities*
- *Pipe breakage and leaking are main factors leading to lost revenue*

Water Scarcity

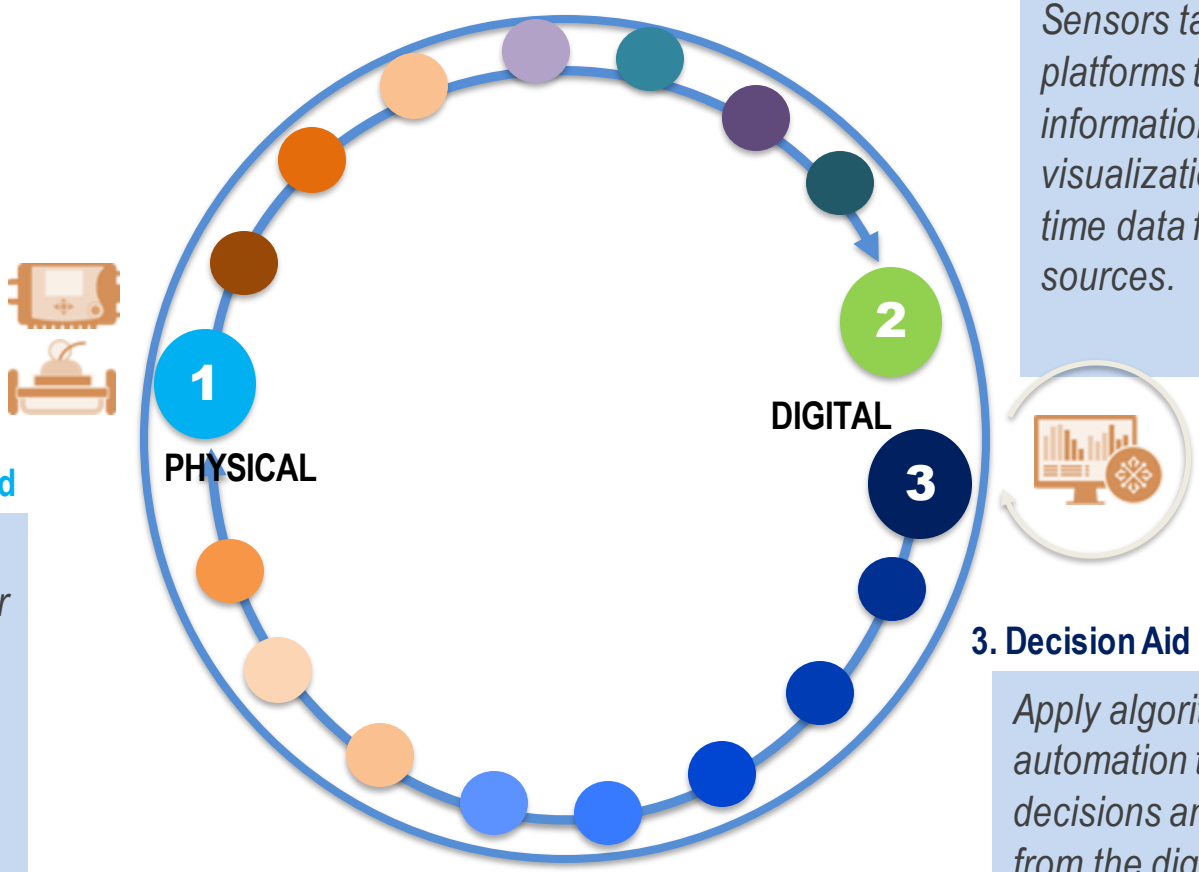
- *Water Stress Index*
- *US, India and Asia*
- *Growing Problem around the World*

Effects of Urbanization

- *Global population living in cities will increase to 70% (from 3.6 to 6.3 billion)*
- *Generate sufficient revenue from drinking water is key to increase investment in smart water programs*

What is a Smart Digital Water Distribution System?

Water Digital Solution



1. Establish a Digital Record

Capture information from the physical water network to create a digital record of the physical operation, water supply network, pipe assets and endpoints.

2. Analyze and Visualize

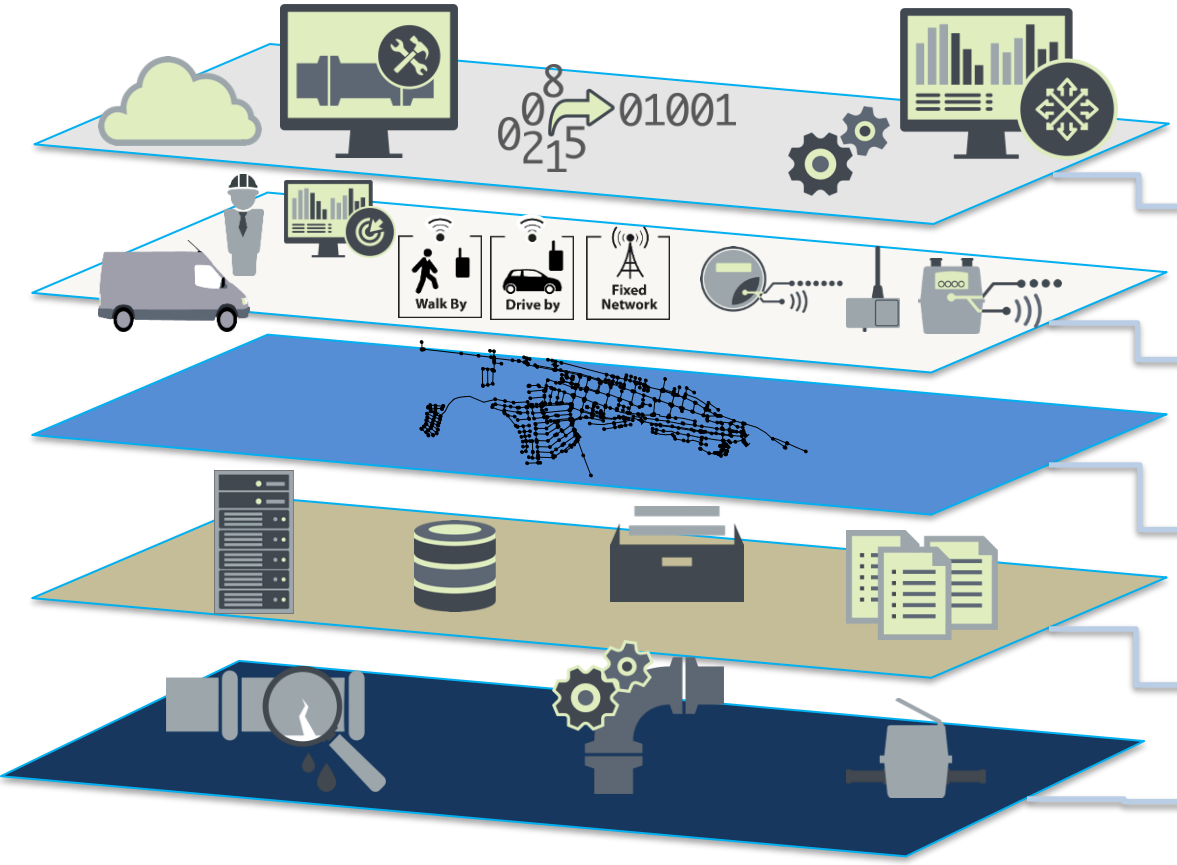
Devices and Hydraulic Sensors talk to cloud platforms to share information and visualizations of real-time data from multiple sources.

3. Decision Aid Support

Apply algorithms and automation to translate decisions and actions from the digital world to physical world

Smart solutions

- *Conceptual Fundamental for Proof of Concept*



Analytic Solutions for Decision
Data Analysis, IA, Machine Learning

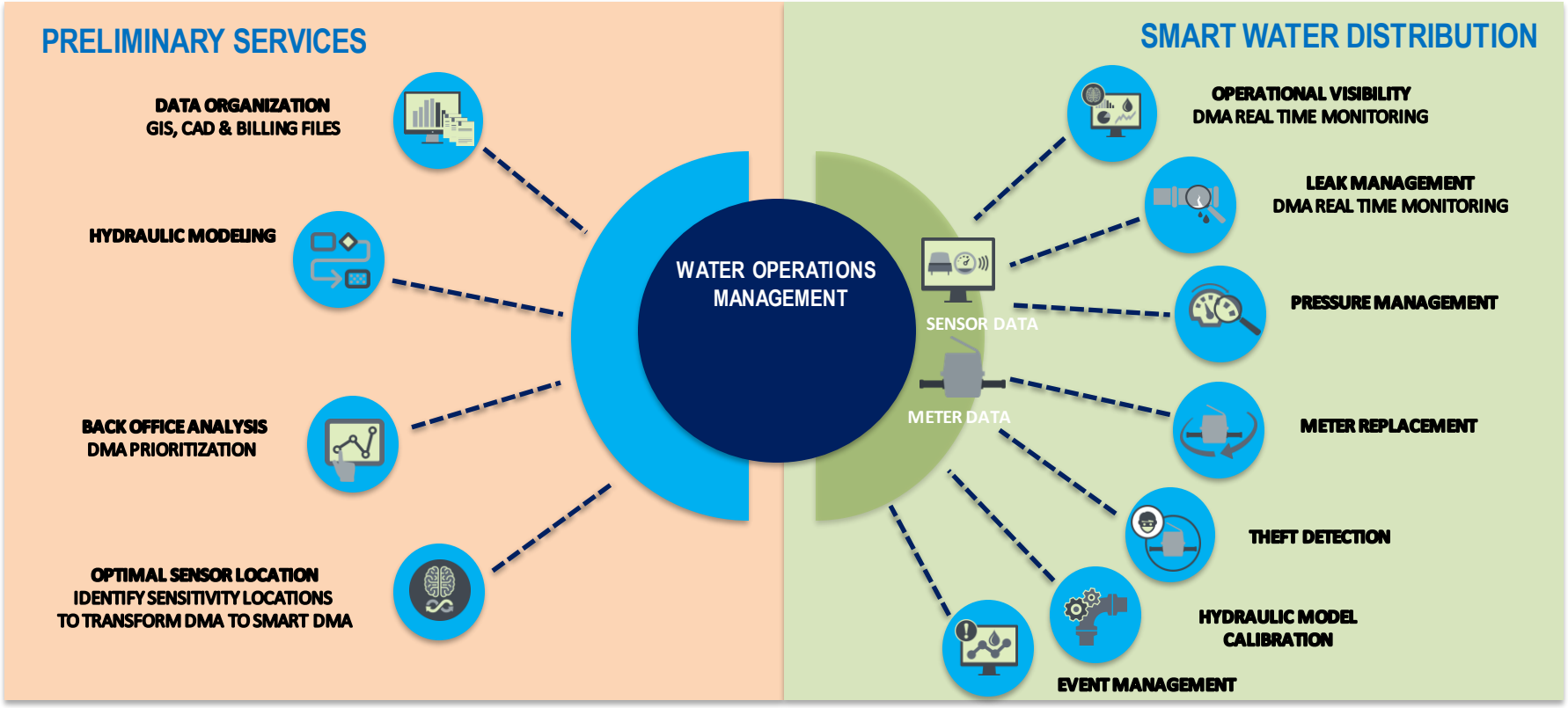
Data Collection, Visualization & Monitoring
Visualization, Monitoring

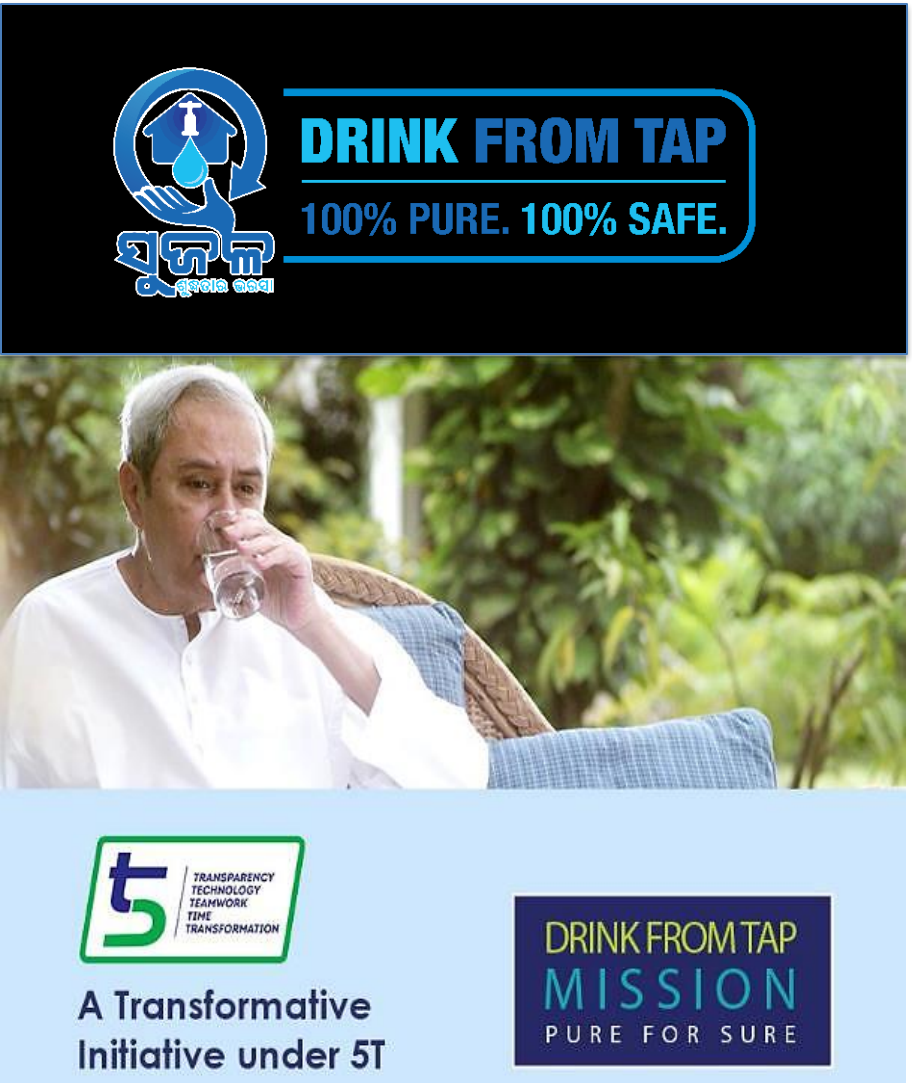
Digital Modelling
Models, Simulation

Utility/Customer Database
GIS, As Built, Billing, Commercial, Service Orders

Physical Layer
Grid, Network, Devices

WATER OPERATIONS MANAGEMENT OUTCOMES





IMPLEMENTATION

- DMA Concept Planning done
- Infrastructure Condition Assessment
- Gap Closing in the Network & other Infrastructure
- 100% Replacement of existing House Connections
- Water Metering (~33,000)
- SMART Water Management
- Increased Water Quality Surveillance

SERVICE LEVEL BENCHMARK FOR WATER SUPPLY IN PURI

Sl.	Performance indicator	Targeted Benchmark	Average values in India	PURI
1	Coverage of water supply connections*	100%	70%	**100%**
2	Per capita supply of water	135 LPCD	114 LPCD	**135 LPCD**
3	Extent of metering of water connections	100%	22%	**100%**
4	Extent of non-revenue water (NRW)	15%	31 %*	**15%**
5	Continuity of water supply	24 hours	2.7 hours	**24 hours**
6	Quality of water supplied	100%	95%	**100%**
7	Consumer Complaint redressal Efficiency	80%	89%	**97%**
8	Cost recovery in water supply services	100%	72%	**Under preparation**
9	Efficiency in collection of water supply-related charges	90%	60%	**100%**

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NON REVENUE WATER MANAGEMENT

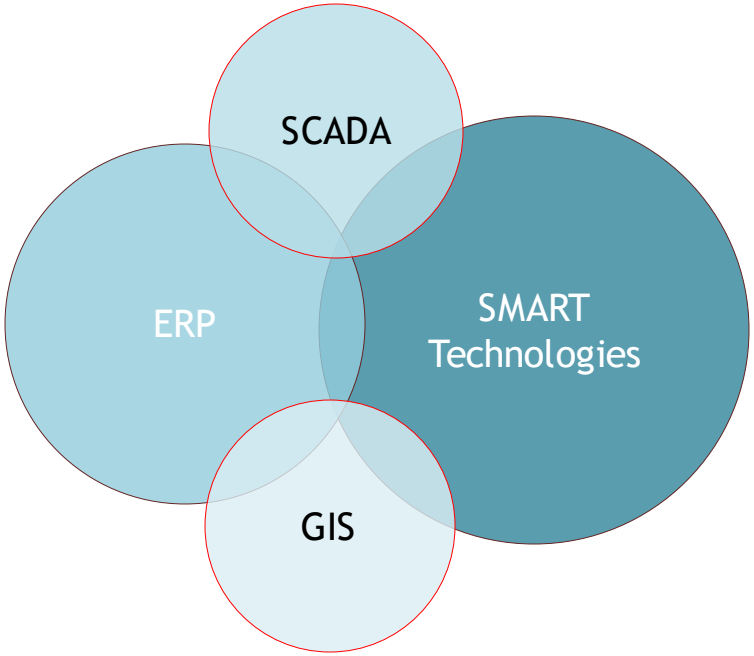
<table>
<tr><td rowspan="8">System Input Volume (Produced or Purchased Water)</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="6">Non Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage in Transmission and Distribution Mains</td></tr>
<tr><td>Storage Leaks and Overflows from Storage Tanks</td></tr>
<tr><td>Service Connection Leaks up to the Meter</td></tr>
</table>

The Non Revenue Water in PURI reduced from 47% to 15%

NRW CELL

FUTURE SCENARIO IN INDIA

- Addressing Utility Markets with solution-based technologies
  - Technical & Consulting Services like GIS, base line parameters study, NRW, Master Plans
  - Water Supply Information Management System
  - Pump house and pipeline SCADA, pump house energy optimization
  - Rehabilitation and performance-based in Smart Water implementations – DMAs, Bulk & Retail Metering, Leakage Detection asset management
  - Customer Information System
  - Management Contracts
  - Future Concession contracts with Indian JV partners



HOLISTIC APPROACH