Energy and resource efficiency in Urban Water Management:
Challenges & potential for enabling paradigm shift

Dr Suresh Kumar Rohilla
Programme Director – Water Management, CSE

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CSE CCBP NURM Regional Workshop at
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Structure of the Presentation

• Summary assessment of water (and sewage) management in India based on latest CSE publication – Excreta Matters (2012)

• CSE recommended - current reform agenda

• Challenges & Potential for Paradigm Change – mainstreaming energy and resource efficiency.
CSE’s Recent Publication

Volume 1 - dwells on how urban India is soaking up water, polluting rivers and drowning in its own waste (296 pages).

Volume 2 - contains a very detailed survey of 71 cities, and presents an assimilation of the survey's results (496 pages).

http://cseindia.org/content/excreta-matters-0
Buy online at http://csestore.cse.org.in
The water-sewage connection

The conventional way:

Bring water **into** the city – storage, diversion, pipe, pump, treat – **from further and further away**.

Flush and carry the waste **out** of the city – pipe, pump, divert, treat – **further and further away**.
How is urban water supply need calculated in India?

<table>
<thead>
<tr>
<th>Classification of towns/cities</th>
<th>Recommended maximum water supply levels (lpcd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towns provided with piped water supply but without sewerage system</td>
<td>70</td>
</tr>
<tr>
<td>Cities provided with piped water supply where sewerage system is exists</td>
<td>135</td>
</tr>
<tr>
<td>Metropolitan and Mega cities provided with piped water supply where sewerage systems existing</td>
<td>150</td>
</tr>
</tbody>
</table>

Per capita supply is high and completely arbitrary

CPHEEO Norm
Official Water Demand, Supply, leakage loss and supply after leakage loss

<table>
<thead>
<tr>
<th>Category</th>
<th>Official per capita demand</th>
<th>Official per capita supply</th>
<th>Official per capita supply after leakage loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million plus cities</td>
<td>210</td>
<td>190</td>
<td>125 (34%)</td>
</tr>
<tr>
<td>Class I</td>
<td>160</td>
<td>150</td>
<td>115 (23%)</td>
</tr>
<tr>
<td>Class II &amp; III</td>
<td>140</td>
<td>130</td>
<td>110 (15%)</td>
</tr>
</tbody>
</table>

Per capita water (lpcd)
### THE WATER DIVIDE IN URBAN INDIA

<table>
<thead>
<tr>
<th>Category</th>
<th>Metro (MLD)</th>
<th>Class I (MLD)</th>
<th>Total (MLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>15,749</td>
<td>136</td>
<td>979</td>
</tr>
<tr>
<td>Class I</td>
<td>2,639</td>
<td>136</td>
<td>19,367</td>
</tr>
<tr>
<td>Total</td>
<td>18,388</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mention:**
MLD: Million litres daily

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### 71-CITY SURVEY: WATER THAT ACTUALLY TRICKLES DOWN TO SLUMS

<table>
<thead>
<tr>
<th>Category</th>
<th>Population living in slum (%)</th>
<th>Supply in slum (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Class I</td>
<td>18</td>
<td>5</td>
</tr>
</tbody>
</table>

Cities Craving to Supply More

71 Indian Cities Survey by CSE reveals:

<table>
<thead>
<tr>
<th></th>
<th>Supply 2005 (MLD)</th>
<th>Demand 2011 (MLD)</th>
<th>Augmentation needed (MLD)</th>
<th>% Augmentation in 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>16,591</td>
<td>21,805</td>
<td>5,214</td>
<td>31</td>
</tr>
<tr>
<td>Class I</td>
<td>2,775</td>
<td>3,605</td>
<td>829</td>
<td>30</td>
</tr>
<tr>
<td>Class II&amp;III</td>
<td>123</td>
<td>230</td>
<td>107</td>
<td>87</td>
</tr>
</tbody>
</table>

In 2005, 32% more water was required to meet 2011 water needs.

MLD: Million litres daily
Source: Anon 2011, 71-City Water-Excreta Survey, 2005-06, Centre for Science and Environment, New Delhi
## Water / Sewage Management - Costs

<table>
<thead>
<tr>
<th>Sector</th>
<th>Per capita cost (Rs)</th>
<th>Per capita O&amp;M (Rs)</th>
<th>Total capital expenditure needed (Rs crore)(^1)</th>
<th>Relative share of sector (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply</td>
<td>5,099</td>
<td>501</td>
<td>3,20,908</td>
<td>10.4</td>
</tr>
<tr>
<td>Sewage</td>
<td>4,704</td>
<td>286</td>
<td>2,42,688</td>
<td>7.8</td>
</tr>
<tr>
<td>Solid waste management</td>
<td>391</td>
<td>155</td>
<td>48,582</td>
<td>1.6</td>
</tr>
<tr>
<td>Urban roads</td>
<td>22,974</td>
<td>397</td>
<td>17,28,941</td>
<td>55.8</td>
</tr>
<tr>
<td>Stormwater drains</td>
<td>3,526</td>
<td>53</td>
<td>1,91,031</td>
<td>6.2</td>
</tr>
<tr>
<td>Transport</td>
<td>5,380</td>
<td>371</td>
<td>4,49,426</td>
<td>14.5</td>
</tr>
<tr>
<td>Traffic support infrastructure</td>
<td>945</td>
<td>34</td>
<td>97,985</td>
<td>3.2</td>
</tr>
<tr>
<td>Street lighting</td>
<td>366</td>
<td>8</td>
<td>18,580</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43,386</strong></td>
<td><strong>1,806</strong></td>
<td><strong>30,98,141</strong></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) At 2009-2010 prices; O&M: Operation and maintenance

Source: Anon 2011, Report on Indian Urban Infrastructure and Services, the high powered expert committee for estimating the investment requirements for urban infrastructure services; JNNURM, Ministry of Urban Development, GOI, Delhi
**IT REALLY TAKES A LOT OF MONEY TO SUPPLY WATER AND TAKE CARE OF SEWAGE**

<table>
<thead>
<tr>
<th>Description</th>
<th>Rs crore per MLD</th>
<th>Rs crore per km</th>
<th>Rs per connection</th>
<th>Per capita (Rs)$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average cost of comprehensive water supply schemes (JNNURM)$^2$</td>
<td>3.00</td>
<td></td>
<td></td>
<td>4,500</td>
</tr>
<tr>
<td>Augmentation of water supply schemes</td>
<td>2.00</td>
<td></td>
<td></td>
<td>3,000</td>
</tr>
<tr>
<td>Rehabilitation of water supply distribution scheme (laying pipelines)$^3$</td>
<td></td>
<td>0.74-1.00</td>
<td>20,000-30,000</td>
<td></td>
</tr>
<tr>
<td>Water treatment plants (cost depends on technology and quality of intake water)</td>
<td>0.22-1.00$^4$</td>
<td></td>
<td></td>
<td>330</td>
</tr>
<tr>
<td>Average cost of comprehensive sewage project, including collection network and treatment plant</td>
<td>3.33-6.00$^5$</td>
<td></td>
<td></td>
<td>4,000</td>
</tr>
<tr>
<td>Building underground sewage systems</td>
<td></td>
<td>0.74-1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage treatment plant</td>
<td>0.30-1.00</td>
<td></td>
<td></td>
<td>360-800</td>
</tr>
<tr>
<td>Sewage network – pumping stations and mains</td>
<td></td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MLD: Million litres daily

$^1$ Water supply estimated at 150/LPCD and sewage generation at 120/LPCD

$^2$ Based on 36 schemes funded by the Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

$^3$ Depends on location and size of mains: smaller diameter lines cost Rs 0.50 crore/km. Most DPRs estimate costs at Rs 0.74 crore/km

$^4$ Agra will spend this amount because the intake water is extremely polluted

$^5$ Ganga programme
Energy can make up 25-40% of the total operating cost of WWT facility.
### Cost Components

**71-CITY SURVEY: WATER SUPPLY REQUIRES EXHAUSTIVE SPENDING ON ENERGY (TOP 22 CITIES)**

<table>
<thead>
<tr>
<th>City</th>
<th>Energy expense</th>
<th>%</th>
<th>Rs lakh/MLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jodhpur</td>
<td>54</td>
<td>77</td>
<td>24.40</td>
</tr>
<tr>
<td>Vadodara</td>
<td>41</td>
<td>74</td>
<td>15.30</td>
</tr>
<tr>
<td>Pune</td>
<td>22.5</td>
<td>73</td>
<td>2.8</td>
</tr>
<tr>
<td>Aurangabad</td>
<td>20</td>
<td>67</td>
<td>9.8</td>
</tr>
<tr>
<td>Nagpur</td>
<td>20</td>
<td>63</td>
<td>4.3</td>
</tr>
<tr>
<td>Bhopal</td>
<td>21</td>
<td>60</td>
<td>7.9</td>
</tr>
<tr>
<td>Indore</td>
<td>49</td>
<td>60</td>
<td>24</td>
</tr>
<tr>
<td>Mussoorie</td>
<td>3</td>
<td>60</td>
<td>37</td>
</tr>
<tr>
<td>Bengaluru</td>
<td>251</td>
<td>60</td>
<td>28</td>
</tr>
<tr>
<td>Baramati</td>
<td>0.22</td>
<td>57</td>
<td>1.8</td>
</tr>
<tr>
<td>Ranchi</td>
<td>12</td>
<td>57</td>
<td>10.3</td>
</tr>
<tr>
<td>Bhubaneswar</td>
<td>14</td>
<td>56</td>
<td>6.9</td>
</tr>
<tr>
<td>Dehradun</td>
<td>6</td>
<td>54</td>
<td>5.2</td>
</tr>
<tr>
<td>Jaipur</td>
<td>42</td>
<td>54</td>
<td>12</td>
</tr>
<tr>
<td>Alwar</td>
<td>5</td>
<td>47</td>
<td>15.8</td>
</tr>
<tr>
<td>Bhilwara</td>
<td>0.91</td>
<td>45</td>
<td>4.8</td>
</tr>
<tr>
<td>Faridabad</td>
<td>8.55</td>
<td>44</td>
<td>3.7</td>
</tr>
<tr>
<td>Aizawl</td>
<td>9</td>
<td>44</td>
<td>86</td>
</tr>
<tr>
<td>Jammu</td>
<td>13.79</td>
<td>40</td>
<td>6.3</td>
</tr>
<tr>
<td>Jabalpur</td>
<td>5.5</td>
<td>38</td>
<td>3.5</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>80</td>
<td>37</td>
<td>8.6</td>
</tr>
</tbody>
</table>

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*Note: % denotes the percentage of total energy expense.*

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*Image: CSE*
The current paradigm – water supply

More water supplied = More waste water generated = more costs for treatment = Unsustainable
Water, not supplied

• Planners obsessed with water, not supply

- Water sourced from further and further away, leads to increasing cost of supply
- Leads to high distribution losses and less water to supply at end of pipeline
- Less water means more costly water

Cities not able to recover costs of supply, have no money to invest in sewage
Water = Wastewater

Cities plan for water, forget waste

• 80% water leaves homes as sewage

• More water = more waste

• Cities have no accounts for sewage

• Cities have no clue how they will convey waste of all, treat it, clean rivers

• Cities only dream of becoming New York or London
Sewage: more sums

**TWO METROS: DISPROPORTIONATE TREATMENT**

- Total wastewater generation: 3,255 MLD
- Total treatment capacity: 11,788 MLD

- Delhi, 800 MLD (10%)
- Mumbai, 671 MLD (7%)
- Other metro cities, 3,580 MLD (30%)
- Metro cities, 8,040 MLD (68%)

- Delhi, 2,330 MLD (20%)
- Mumbai, 2,130 MLD (18%)
- Metro cities: 15,644 MLD (41%)
- Other metro cities: 173 MLD (4%)

MLD: Million litres daily

Source: Anon 2009, *Status of Water Supply, Wastewater Generation and Treatment in Class-1 cities and Class-II towns of India*, Central Pollution Control Board, Ministry of Environment and Forests, Delhi

- 30% of total sewage can be treated
- But Delhi and Mumbai alone have **40 per cent** of sewage treatment capacity in the country
Cost Estimates of Select Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Cost /mld (at 2008 prices) in Rs. lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Stabilization Ponds</td>
<td>25</td>
</tr>
<tr>
<td>UASB + Post treatment</td>
<td>55</td>
</tr>
<tr>
<td>Activated Sludge Process, C-Tech, FAB</td>
<td>87</td>
</tr>
</tbody>
</table>

- Cost of Interception & Diversion works (main trunk sewers, SPS excl. house connections, branch and lateral sewers) and cost of land acquisition is around Rs. 3-4 crore per mld

- Estimated Class I & II Sewage Generation in year 2020 = 45000 mld

- Cost would increase to the extent of Rs. 45,000 crore to Rs. 1,32,000 crore.
Planning for **hardware**

**Cities plan for treatment not ‘sewage’**

- Treatment plants are not simple answers

- Can build plants to treat, but there is no waste being conveyed for treatment

- Most cities do not have underground sewerage. But engineers sell pipe-dreams of **catching up with infrastructure**

- Politicians buy pipe-dreams

- We lose rivers. Generations of **lost rivers**
<table>
<thead>
<tr>
<th>% of area covered</th>
<th>Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>Cuttack, Guwahati, Jabalpur, Jammu, Ranchi, Thane, Aizawl, Bathinda, Bhilwara, Siliguri, Srikakulam</td>
</tr>
<tr>
<td>10-30</td>
<td>Agra, Alwar, Aurangabad, Indore, Mathura, Meerut, Puducherry, Thiruvananthapuram, Dehradun, Dewas, Hubli-Dharwad, Jhansi, Kozhikode, Lucknow, Solapur, Tumkur, Udaipur, Ujjain, Dhanbad</td>
</tr>
<tr>
<td>30-50</td>
<td>Allahabad, Bengaluru, Bhopal, Delhi, Lucknow, Patna, Srinagar, Amritsar, Bhubaneswar, Jodhpur, Mumbai</td>
</tr>
<tr>
<td>50-70</td>
<td>Faridabad², Hyderabad, Jaipur¹, Kanpur, Kolkata, Nagpur, Gwalior, Mussoorie, Nainital, Rajkot, Vadodara, Yamunanagar</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>Chennai, Pune, Surat, Gurgaon²</td>
</tr>
</tbody>
</table>

¹Claims 80% coverage in CSE survey, 65% in City Development Plan for JNNURM; ²Faridabad and Gurgaon: only old-city within municipal limit included

Source: Anon 2011, 71-City Water-Excreta Survey, 2005-06, Centre for Science and Environment, New Delhi

- Cities do not have drains
- New growth cities are growing without drains
- Backlog and front-log impossible to fix
- As cities fix one drain, another goes under
For example - Bengaluru: sewage not reaching

- 3610 km of sewage pipes
- **14 sewage treatment plants = 781 mld**
- Generates 800-1000 mld of sewage
- **But treats only 300 mld**
- Rest does not reach
- Now plans to build 4000 km more
- **Builds, grows and more lines need repair**
- Catch-up that does not catch-up
Partial treatment = pollution

“Cities do not control pollution” and Cost of building system is high

- City can build sewerage system for few not all
- Spends on building pipes, repair and energy costs of pumping to treatment plant of this waste of some few
- Spends to treat waste of some few
- Treated waste of few gets mixed with untreated waste of majority
- The result is pollution
For example: Delhi

Has 20 drains
Has 17 STP

Capacity exists
But River Yamuna dead

Why?
Delhi keeps building to ‘catch up’

Can’t
Sewage reaches river

River has no water only sewage
For example: Chennai

Funds spent
Sewage system coverage high
Large number of pumping stations

Why still polluted?
Pumps and pumps
Takes to outskirts of city
Dumps it back into canals and rivers
These flow through city

Engineers say 'all is well'
Waste is intercepted
Only stormwater flows

But not true
Sewage flows, Treated sewage flows
What is happening in Guwahati?

**GRAPH: THE PUBLIC AND PRIVATE OF COVERAGE**

Guwahati is a city of private borewells

- Household tap: 26%
- Community taps: 9%
- Handpumps: 1%
- Private borewells: 64%

Source: Based on data received from Assam Urban Water Supply and Sewerage Board (AUWSSB), Guwahati, 2005-06

### THE CITY
- Municipal area (Guwahati Municipal Corporation): 216 sq km
- Total area (Guwahati Metropolitan Authority): 264 sq km
- Population (2005): 1.1 million
- Population (2011), as projected in 2005-06: 1.3 million

### THE WATER

#### Demand
- Total water demand as per city agency (AUWSSB): 163 MLD
- Per capita demand as per AUWSSB: 148 LPCD
- Total water demand as per CPHEEO @ 150 LPCD: 165 MLD

#### Sources and supply
- Water sources: Brahmaputra, groundwater
- Water sourced from surface sources: 68%
- Water sourced from ground sources: 32%
- Total water supplied: 103 MLD
- Per capita supply: 94 LPCD
- Leakage loss: 20%
- Actual supply (after deducting leakage losses): 82.4 MLD
- Per capita supply (after deducting leakage losses): 75 LPCD
- Population served by the water supply system: 30%
- Per capita supply in the served area: 283 LPCD
- Demand-supply gap (after leakage losses): 81 MLD

#### Treatment
- Number of WTPs: 12
- Total treatment capacity: 137 MLD
- Actual treatment: 103 MLD

#### Future demand and supply
- Demand (2011), as projected in 2005-06: 193 MLD
- Augmentation needed to meet 2011 water demand: 90 MLD
- Required increase in supply (in per cent): 87%
**THE WATER-WASTE PORTRAIT**
The capital of Assam has no sewage treatment plant, and a multiplicity of water agencies – a recipe for water and sanitation chaos.

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### THE SEWAGE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation</strong></td>
<td></td>
</tr>
<tr>
<td>Sewage generated as per CPCB</td>
<td>275 MLD</td>
</tr>
<tr>
<td>Sewage generated as per city agency</td>
<td>98 MLD*</td>
</tr>
<tr>
<td><strong>Collection</strong></td>
<td></td>
</tr>
<tr>
<td>Length of sewerage network</td>
<td>NA**</td>
</tr>
<tr>
<td>Population covered by sewerage network</td>
<td>NA</td>
</tr>
<tr>
<td>Area covered by closed sewerage network</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
</tr>
<tr>
<td>Number of STPs</td>
<td>Nil</td>
</tr>
<tr>
<td>Total treatment capacity</td>
<td>Nil</td>
</tr>
<tr>
<td>Actual sewage treated</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>Disposal</strong></td>
<td></td>
</tr>
<tr>
<td>Disposal</td>
<td>Brahmaputra</td>
</tr>
</tbody>
</table>

**Source:** Anon 2011, *71 City Water Excreta Survey, 2005-06*, Centre for Science and Environment, New Delhi

**Notes:** *Since most of the population depends on its own water supply sources, the actual quantity of sewage generated would obviously be much higher. **The city does not have a sewer system. The sewage from the septic tanks flows into the open drains and goes to the river*
GUWAHATI’S ECONOMICS OF MULTIPlicity
Confusion reigns supreme, as there is no single balance sheet

Guwahati has about 6,000 metered connections – which account for around 20 per cent of the household connections. As multiple agencies are involved in the supply of drinking water in the city, confusion reigns: no combined report exists on the total annual budget. A break-up of agencies and their available balance sheets illustrates the situation (see Table: On record).

<table>
<thead>
<tr>
<th>Agency</th>
<th>Water supplied (MLD)</th>
<th>Total cost of generation</th>
<th>Production cost (Rs per kilolitre)</th>
<th>Components of cost</th>
<th>Revenue collected (Rs crore per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUWSSB</td>
<td>9</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>2.05</td>
</tr>
<tr>
<td>GMC</td>
<td>90</td>
<td>Rs 7.14 crore on O&amp;M</td>
<td>Rs 5.58</td>
<td>Energy (42% of O&amp;M), salary and establishments (30%)</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Based on data received from Assam Urban Water Supply and Sewerage Board (AUWSSB), Guwahati, & Guwahati Municipal Corporation (GMC). 2005-06
Sewage treatment in Guwahati

GRAPH: SANITATION – WHO HAS WHAT
*The septic tank is the majority’s way out*

- 0.12%
- 18.27%
- 81.61%

- Sepic tanks
- Open defecation
- Others

Source: Anon 2006, *City Development Plan, Guwahati, JNNURM, New Delhi*
NEW DRAINAGE DREAMS?
Or future nightmares? ‘Surface beautification’ is the key

In 2006, the Assam government proposed a whopping Rs 1,000 crore for reviving the drainage-cum-sewerage system of its capital city. It has also decided to give a facelift to the city’s grand river-front. Ironically, when the lack of proper sewage management has led to pollution of waterbodies, all that the authorities can think of is a river ‘beautification’ project. The drainage part would cost Rs 800 crore, while river-front work is expected to cost another Rs 200 crore.\(^1\)

Nothing much is said or is known about treatment or disposal of voluminous sewage flow in the city.
Urban water paradigm – cause & effect

**Supply**
- Water is imported – pipes, tankers, trains
  - Costs for government
    - Cannot meet the demand
      - Indiscriminate groundwater mining within and outside the city

**Treatment**
- Raw water quality is very poor
  - Costs of treatment for government
    - Cannot meet the demand
      - High health impacts among poor
      - Growth of bottled water industry

**Sewerage**
- Supplied water turned into polluted water
  - Costs of collection and treatment for government
    - Cannot meet the demand
      - Polluted rivers and lakes. Further reduction of water supply
Water financials, a dilemma

- Water price is a public issue (no volatility, even fixed)

- Chemicals & additives will increase

- Asset management need regular investments

Source: Schneider Electric
Cannot play catch up game

Cannot flush – and forget

Have to find new approaches:

affordable and sustainable
Rework water-energy nexus in UWM; rework economics

- Need to fix urban water use. Cannot be wasteful any more.
- Reduce energy to cut costs; Need to charge to reduce wastage
- Local recycle and reuse waste water
- **Closing the loop!**
Reform agenda

1. Prioritize public investment differently
2. Plan to cut costs of water supply
3. Invest in local & decentralised water systems
4. Reduce water demand
5. Spend on sewage not on water
6. Cut costs on sewage systems
7. Plan to recycle and reuse every drop
Paradigm Shift in Enabling Environment

Mainstreaming requires paradigm shift at all four levels – in terms of development in practice:

Policy → Plan → Programme & Project

In DPRs for JnNURM Phase II:

We need objectives, indicators and standards that can be measured and monitored and that meet challenges of ‘energy efficiency aimed at carbon neutral city’.
Saving Water and Energy

- Municipalities and Water Utilities
- At Home / Buildings
- In Industry
Way ahead

- Create *informed public opinion*

- **Demand side** management

- **Capacity building & training** the real users and implementers

- **Legislation** followed by strict implementation
THANK YOU

Email: srohil@hotmail.com