Energy, the water sector and rapid urbanization in the “South”

Lessons from Asia, Africa and Latin America

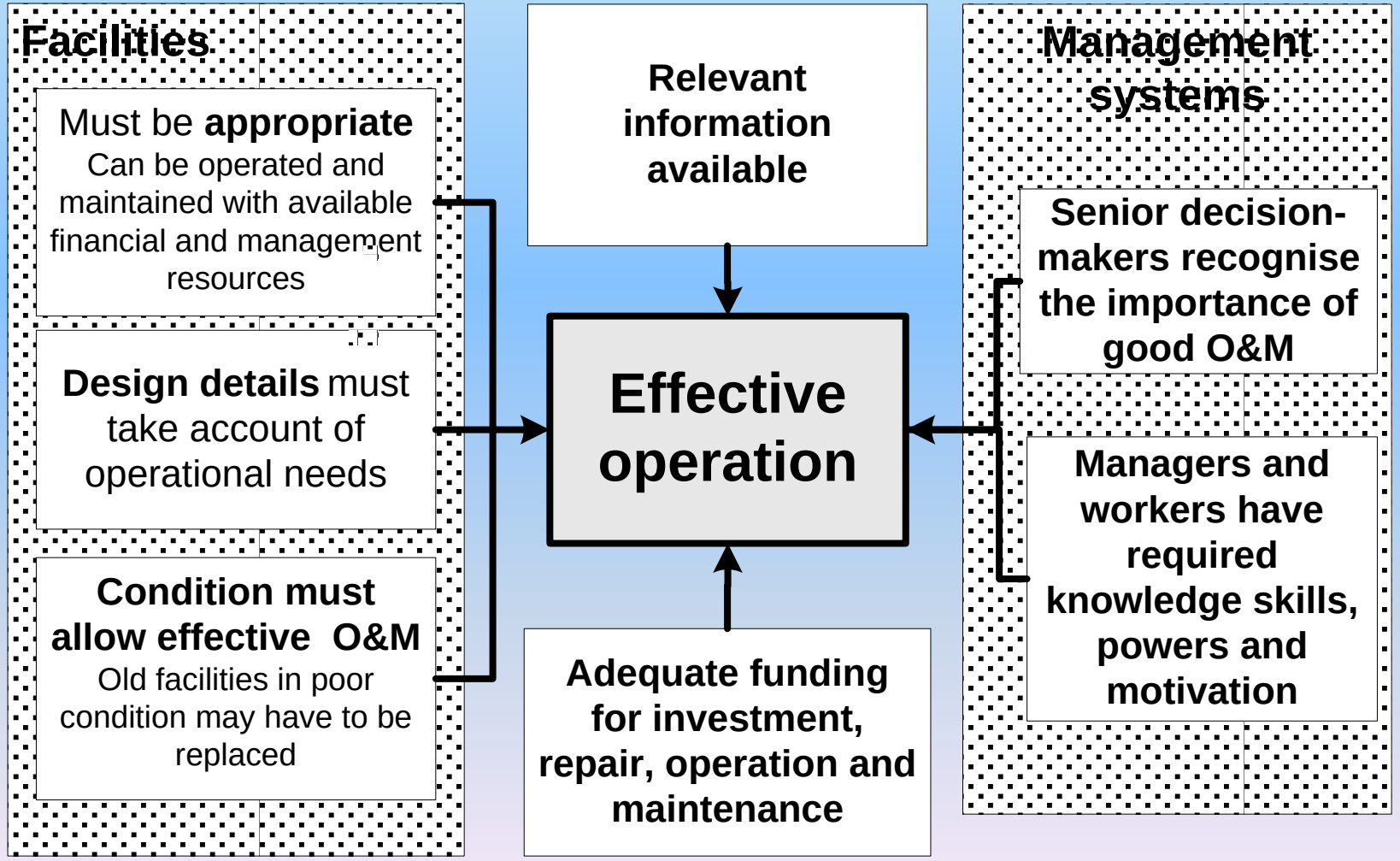
Structure of presentation

- Introduction – the context and overview of efficiency and energy-related issues
- Improving the efficiency of water supply systems
- Wastewater pumping – costs and challenges
- The energy requirements of wastewater treatment – choosing an appropriate technology
- Some thoughts on institutions

The context

- Rapid urbanization
- Limited service coverage by formal piped water supply systems
- Poor system performance – intermittent supply, low pressures, unreliable supply, poor quality water at taps
- Low proportion of wastewater treated – treatment facilities that do exist often produce poor results
- Institutional capacity limited – lack of an information-based planning culture

Conditions for effective operation



How conditions relate to energy

- FUNDING - Funding shortfalls largely due to high electricity bills (High proportion of expenditure)
- FACILITIES - Unreliable electricity supply affects operation
- Poor planning, inappropriate technology, lack of maintenance result in higher than necessary energy costs
- INFORMATION - Lack of information makes rational decision-making difficult
- MANAGEMENT SYSTEMS – Weak management results in lack of commitment to addressing problems

Water supply

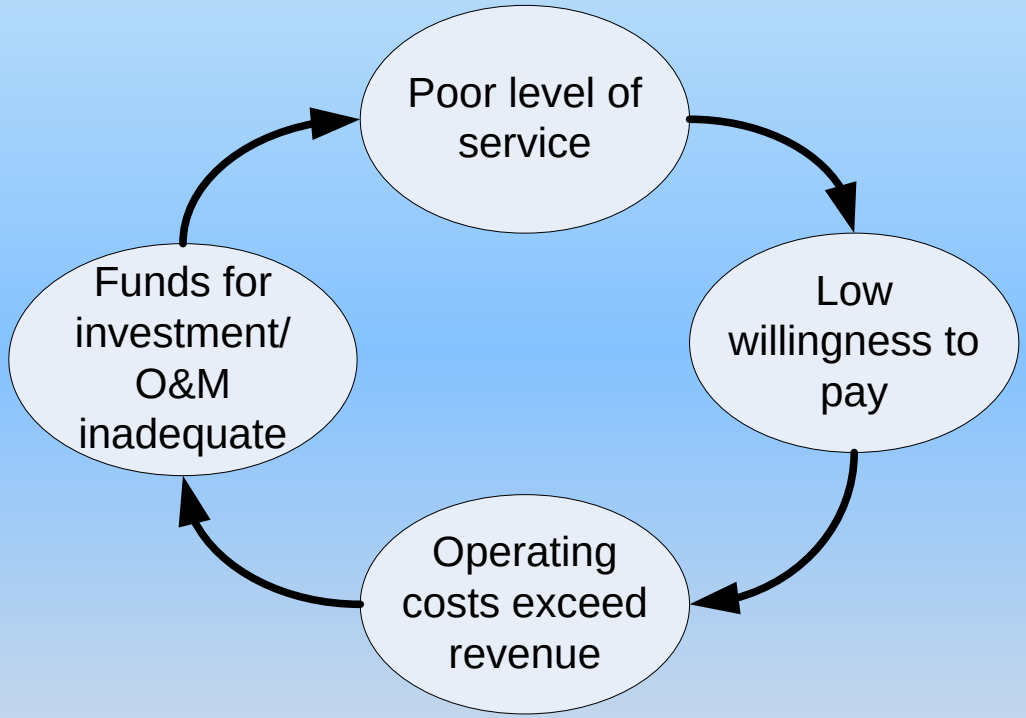
Focus on improving finances by reducing pumping costs

Current situation

Vicious circle of poor performance and low income.

Increasing production capacity unlikely to solve problems

Need to reduce costs, improve performance



Power bills often high proportion of operating cost – Need for strong focus on more effective use of power

Low-cost actions to reduce energy bills

(Recommendations from studies in India and Pakistan)

- Provide capacitors on pumps to increase power factor
- Replacement/modification of inappropriately sized pumps and motors
- Ensure that contracts with energy suppliers are based on accurate assessment of demand
- Decommission tubewells that are contributing little or no water to the system
- Ensure that elevated reservoirs are used rather than by-passed (Thus reducing variations in pumped flows)
- Regular pump/motor maintenance

Changing the source – an option?

- Water table is dropping beneath most cities
- Would switch from groundwater to surface water reduce energy costs?
- Approach adopted for Dhaka, Bangladesh
- But some cities are remote from surface water sources – examples from India include Bengalaru (Bengalaru) and Mahbubnagar.
- Focus for such cities should first be on reducing unaccounted-for water?

Reducing leakage and wastage

Bigger potential gains but more difficult

- Estimated water losses often exceed 50% .
- Reducing losses will clearly reduce pumping costs but how can this be achieved?
- Obvious challenge is lack of information – most systems in South Asia have no metering, bulk or household, no information on system pressures and poor distribution system records.

Some leakage is obvious

Ndola – Zambia Leak from transmission main – obvious but difficult to repair

Bhopal – India Leaking distribution main. Easy to survey then fix?

But how to deal with ‘diffuse’ leakage from house connections and wastage at the consumer’s premises?

Findings from some field investigations

Jaranwala, Pakistan

Town with population around 150,000, supplied mainly from tubewells drawing seepage water from below canal

Pressure and flow measurements (using portable ultrasonic meters) found:

- Low pressures, particularly in older parts of the system
- Some tubewell pumps delivering high flow at low pressure.

Relevant findings from other locations

- In many cases, rapid drop in pressure from source to consumer.
- Many households/institutions store water in tanks but few tanks have float valve to prevent overflow when full.
- Computer simulation using EPANET with reservoirs assumed at nodes reproduced conditions observed in field


Overflow from tank on Government building, Patna, India

Conclusion - wastage is occurring from open connections

Options for reducing losses

Reducing pressure not possible where pressures already very low.

Possible actions to reduce wastage:

- Require/provide float valves on tanks
- Meter connections

Use zoning and district metering to gain better understanding of water flows and where losses are occurring

All these actions require strengthened institutions – easy to say but more difficult to achieve!

Wastewater management

Options for reducing pumping and wastewater treatment costs

Sanitation and wastewater disposal background

- Formal sewerage coverage often limited
- But many cities have extensive informal sewerage coverage (Examples on right)
- Small percentage of wastewater treated
- Sewers often surcharged - pumping station wet wells operated with high water level to reduce pumping costs/ suction head

Inadequate sewage pumping stations

Larkana, Pakistan – single pump, high suction lift, poorly aligned. Needs frequent repair

Sialkot, Pakistan. Wet well - dry well arrangement failed. Replaced by pump with high suction lift

Inefficient practices

Karnal – Haryana, India
Pumping station operating during storm.
Pumping into drain but overflowing back into pumping station just to the right of the picture

Clearly there is scope for improvement!

Treatment options

‘CONVENTIONAL TREATMENT’

Activated sludge and its variants (SBRs etc.)

Trickling filters

Aerated lagoons

‘EXTENSIVE’ TREATMENT

Waste stabilization ponds and constructed wetlands

ANAEROBIC TREATMENT

Upward flow anaerobic sludge blanket (UASB)

Anaerobic waste stabilization ponds

‘NEW’ TECHNOLOGIES

Membrane filtration

Energy requirements of various technologies

- Waste stabilization ponds – Very low energy requirement but land requirements high – particularly where winters are cold.
- Trickling filters – Medium energy use (US figure given by ESMAP 0.177kWh/m3)
- Activated sludge – high energy use (US figure given by ESMAP 0.272 kWh/m3)
- Anaerobic technologies can produce energy- (Brazil study estimated 40% of energy requirement for the treatment plant)

Problems with 'conventional' technologies

Naivasha – Kenya
Wastewater lifted to screens and grit channels, then aerated lagoons and facultative/ maturation ponds

Pumps not used – so direct discharge to lagoon with no screening.
Aerators not operated - lagoon acting as anaerobic pond.

The Anaerobic treatment option

India - Ganga and Yamuna Action Plans

UASB followed by 'polishing pond'

Typical BOD removal: 50 – 60% through UASB with further 10% through polishing pond. Not sufficient to meet Indian discharge standards

Observations on Indian experience

UASB performance worse than theoretically expected:
Possible reasons:

- Low influent strength - BOD often less than 200mg/l
- Sludge build up in UASB reactor
- Polishing' pond has limited retention – not adequate to provide full secondary treatment

But:

Lower than expected performance not unique to UASBs – problem may be inadequate operational practices rather than the technology.

Other anaerobic options

- UASB followed by trickling filters – Quite common in Brazil and at least one example in Egypt
- Anaerobic ponds followed by trickling filters – used in Vietnam, proposed for Dhaka
- UASB could be used with mechanical aeration – on basis that anaerobic treatment removes more BOD than conventional primary sedimentation tanks
- But some issues – further work needed to improve systems (Scum removal in UASBs and escape of methane dissolved in UASB effluent).

Institutions
The biggest challenge?

How to increase focus on operations in general and energy conservation in particular?

Water supply scheme – Punjab, Pakistan

Newly built scheme. Facilities in good condition, possible to monitor bulk water supply and record of connections should be good on relatively new scheme

But: Small town, very limited management resources

How will facilities be maintained?

CPCB study of wastewater treatment in India

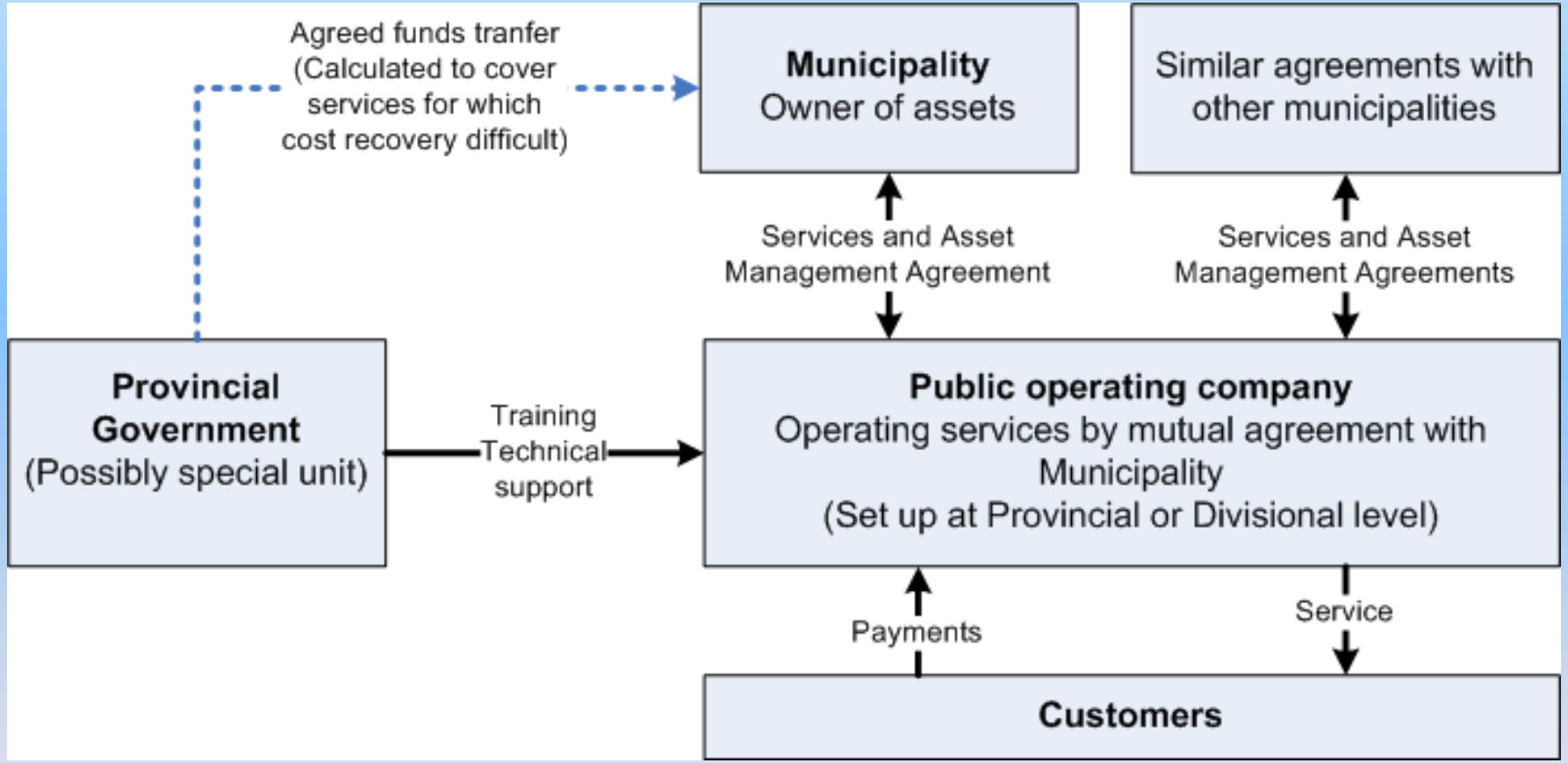
- Few treatment plants working well
- Performance not related to technology
- But it was related to location – some States performed better than others

Points to importance of institutions

Key institutional issues

- **Institutional culture** - in particular need for information-based decision making.
- **Training** – Engineers know how to build but have little knowledge of operational matters
- **Incentives** – There is more money/kudos in building than in operating
- **Powers** – Often very centralized but day to day decisions often taken informally by low-level operational staff.

Possible public operating company model



Points on public operating company model

- Public operating company only takes over services when both parties agree
- Strong emphasis on training and capacity-building – using local resources where possible
- Initial focus on taking over recently constructed/improved facilities – to ensure company can provide good services

Summary of key points

Checklist of actions to be taken

- Identify and implement low-cost actions that can bring immediate benefits
- Seek better information and act on it
- Reduce unaccounted for water – based on sound understanding of existing situation
- Explore anaerobic – aerobic systems for wastewater treatment

The challenge is to develop institutional context within which these actions can take place

This will often need institutional change

The End

Questions and comments welcome