Wastewater: From Waste to Resource

The Case of Nagpur, India

Treating Wastewater for Reuse in Thermal Power Generation

Context

Water stress has become a problem in most Indian cities, as rapid population growth increases simultaneously water demand by households, industries, and power plants. Utilities need to meet this growing demand while ensuring fair tariffs for users and promoting a sustainable use of water resources.

As federal and state governments look for innovative alternatives to freshwater, the reuse of treated wastewater is gaining attention and being promoted at the federal and state levels. In addition to the environmental, health, and social benefits of treating wastewater; treated wastewater can become a reliable water source for industrial users, freeing up freshwater resources for households and helping address water scarcity in big cities.

The government of India has taken steps to promote wastewater reuse, starting with the regulation of industrial water consumption and the setting and enforcement of mandatory water reuse targets for industries. The national target is to treat and reuse 50 percent of total wastewater by 2022 (PwC 2016). Some cities have set their own, more ambitious targets, and states such as Gujarat (Government of Gujarat, 2018) and Maharashtra (IndianExpress, 2017) have implemented new policies to promote wastewater reuse. Moreover, the government of India has adopted policies, established strong mechanisms of regulation, and provided funding for various programs, such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), to enable municipal authorities to enter into public-private partnership (PPP) arrangements to attract private funding. As a result, municipalities across the country have started to implement wastewater reuse projects. Most of these initiatives are led by utilities, through partnerships with the private sector, and with the central government covering part of the capital costs. The success of these projects reveals that wastewater reuse activities can be viable if properly structured and supported by enabling policies and institutions.

WORLD BANK GROUP

This note focuses on the case of Nagpur. Nagpur is the largest city in central India. It has considerable political and geographical importance but limited sources of freshwater. Demand for water increased substantially over the decade before the project due to population growth and economic development. Large amounts of freshwater were used to generate electricity in thermal power plants owned and operated by the Maharashtra Generation Company Ltd. (MahaGenCo)[1]. To meet increasing electricity demand, in 2008 MahaGenCo decided to increase its power capacity, a move that required additional water supply for its operations. Before the project described below, wastewater treatment capacity in Nagpur was low. The city generated around 425 million litres a day of wastewater. However, the Nagpur Municipal Corporation (NMC) had only one wastewater treatment plant, with a capacity of just 100 million litres a day (ICLEI 2010). Given the water scarcity in the region and the heavy water demand for the upcoming power plant, MahaGenCo decided to partner with NMC to explore the use of wastewater from Nagpur for its operations.

CHALLENGE

Water scarcity

Low wastewater treatment capacity

Increased water demand for the power sector

OBJECTIVE OF THE REUSE PROJECT

Diversify water supply sources by incorporating alternative sources (treated wastewater) and invest in sanitation and wastewater infrastructure for the city.

Solution: The Build-Operate-Transfer End-User Public-Private Partnership Model

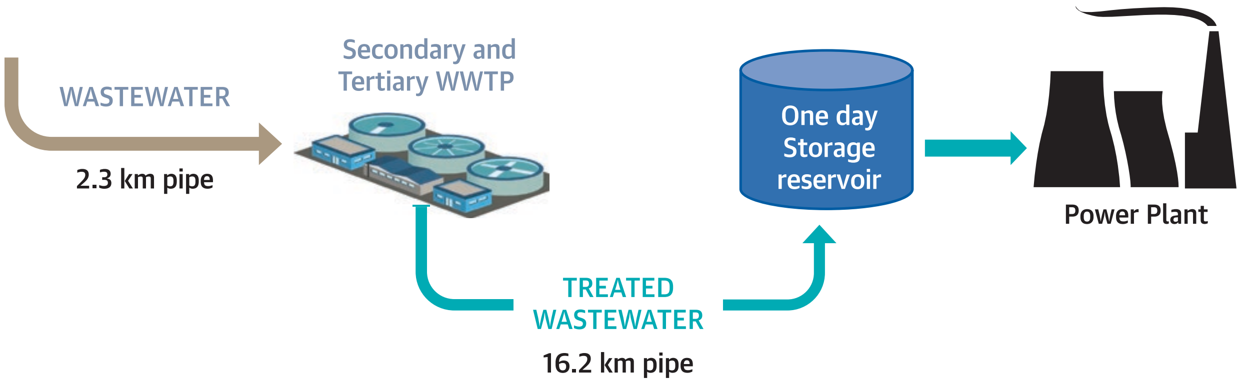
The water reuse project, which came into operation in 2015, reuses municipal treated wastewater from Nagpur for cooling purposes in the new power plant (the Koradi Thermal Power Plant) built and operated by MahaGenCo. MahaGenCo and NMC signed a Memorandum of Understanding in 2008 "Construction and Operating Agreement of Treatment and Transmission Facilities for Reclaimed Water Usage". The partnership took the form of a build-operate-transfer (BOT) end-user contract with a 30-year concession, with the option for extension. NMC agreed to provide the raw wastewater, and MahaGeCo agreed to be in charge of the transportation and treatment needed to be able to reuse the wastewater effluent from the NMC sewerage system. The contract was developed to ensure a regular source of water to the power plant (the raw wastewater) while providing NMC with a constant stream of revenue from MahaGenCo (in the form of raw wastewater fees). The city would also reap the environmental, health and social benefits from the extra wastewater treatment.

The investment project included a raw wastewater intake facility with a pumping station of 130 million liters per day, a 2.3-kilometer pipeline to the wastewater treatment facility, a wastewater treatment plant with secondary and tertiary treatment to meet MahaGenCo's water quality requirements, a 16.2-kilometer pipeline from the wastewater treatment plant to the power plant, and a one-day reservoir of treated wastewater at the Koradi Thermal Power Plant for back-up (figure 1).

The fact that MahaGenCo was the only end-user of wastewater ensured strong project ownership and management, which were facilitated by regular communication and coordination with the municipal authority. There was no bidding process, because the MahaGenCo directly approached NMC and selection was done on a sole-source (nomination) basis (FICCI Water Mission and 2030 WRG 2016). The collaboration between NMC and MahaGenCo ensured that the synergies of wastewater treatment and reuse were fully exploited through the contractual arrangement.

An important aspect of this project is that MahaGenCo did not undertake the transport and treatment of the wastewater but instead selected an engineering, procurement, and construction (EPC) contractor and an operations and maintenance (O&M) operator through a single-stage competitive tender (FICCI Water Mission and 2030 WRG 2016).

FIGURE 1. **Diagram of the Nagpur wastewater reuse project**



Source: adapted from Sharma, 2013.
Note: WWTP = wastewater treatment plant

Financial and Contractual Agreements

The capital cost of the project was about INR 195 crore (US$28 million), excluding the cost of land, which NMC agreed to provide. NMC also agreed to cover part of the capital cost with a grant of INR 90 crore from JNNURM. MahaGenCo agreed to finance the rest and to assume cost overruns (FICCI Water Mission and 2030 WRG 2016). MahaGenCo committed to build, operate, and maintain the wastewater treatment plant and pay NMC a fixed amount of INR 15 crore (US$ 2.25 million) a year for the raw wastewater (110 million liters a day). For flows that exceeded the contracted amount, MahaGenCo agreed to pay NMC INR 2.03 per cubic meter of raw wastewater.

The benefits of the deal to MahaGenCo are the cost savings of using wastewater rather than freshwater to meet its water requirements. The treatment and provision of water through this arrangement cost Mahagenco about INR 3.4 (US$0.05) per cubic meter (Sharma, 2013). Its costs would have been significantly higher if it had sourced fresh water from another municipal or irrigation project (about INR 9.6 (US$0.13) per cubic meter for recent projects) (World Bank 2016).

For NMC, given that its investment was a grant from the JNNURM program, the royalties from the sale of wastewater to MahaGenCo represent an extra revenue stream of nearly INR 400 crore (US$ 60 million) over the concession period (ITAC, 2019). This income represents twice the amount of depreciation of the asset and allows NMC to cover the operating and maintenance cost of the existing wastewater treatment plant in Bandewhadi and the cost of some rehabilitation works.

Benefits of the Wastewater Treatment Project in Nagpur, India

Economic	Environmental and social
• *For the power plant.* Treated wastewater is less expensive, of more consistent quality and quantity, and more sustainable than freshwater. The power plant pays INR 3.4 instead of INR 9.6 per cubic meter of water. Using wastewater also results in increased resilience to droughts, reducing supply risks • *For NMC.* The revenue stream from treated wastewater fees can cover the O&M costs of other wastewater treatment plants.	• The project reduces net freshwater extractions by the power sector, freeing up freshwater resources for other uses (around 47 Mm^3 per annum (Sharma, 2013)). • Increased urban wastewater treatment capacity results in cleaner and healthier water bodies, with the associated environmental and social benefits • The project serves as model for other cities and states to follow.

Institutional and Policy Environment

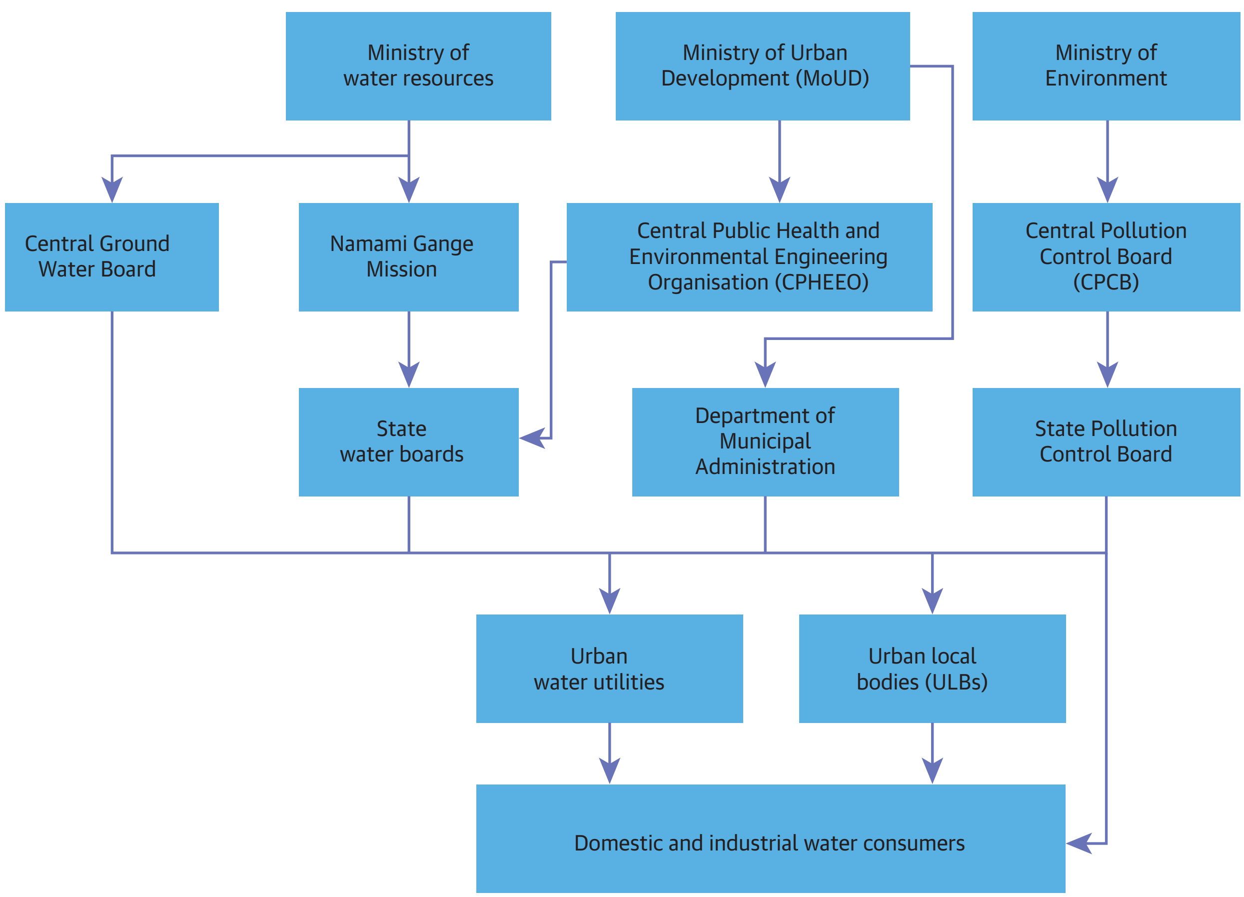
Local governments in India are responsible for providing wastewater services. Various central, state, and local government agencies regulate wastewater reuse (Figure 2).

The key policy documents supporting wastewater reuse throughout the country include the following (ECA, 2019):

- The Water (Prevention and Control of Pollution) Act of 1974 sets out norms for sewage and industrial effluent discharges. It mandates that industries and local bodies treat wastewater to a specified quality level before discharging it.
- The National Urban Sanitation Policy of 2008 promotes the reuse of recycled water. It suggests a minimum target of 20 percent wastewater reuse in every city.
- The National Water Policy (2012) recognizes the importance of reusing treated wastewater to meet the country's environmental objectives and encourages the reuse of reclaimed water over freshwater through preferential tariffs.

State policies: In 2017 the State of Maharashtra adopted a new policy that makes wastewater reuse a primary responsibility of municipalities and directs them to draft action plans to increase wastewater reuse (NDTV, 2017). To make the projects economically viable, the state government mandates that power plants and industrial units located within 50 kilometers of the municipalities buy and use treated wastewater for nonpotable uses once it is available. Public funding has been approved to build more wastewater treatment plants in the region. However, the government is also encouraging a private funding model.

FIGURE 2. **Institutional framework for municipal wastewater reuse in India**



Source: PwC 2016.

Lessons Learned

Thanks in part to this project, the city of Nagpur is on its way to becoming the first Indian city to reuse more than 90 percent of its wastewater.[2] Many factors contributed to the project's success, which became a catalyzer for the development of other wastewater reuse projects in the city:

- A well-designed contractual arrangement facilitated clear project ownership and management by the end-user and the urban body. The main driver of the project was the end-user's need to obtain secure sources of water at an affordable cost.
- The BOT end-user PPP model ensured that wastewater treatment was done according to the requirements of the end-user (the power plant).
- Having a single end-user that committed to take all the treated wastewater reduced the wastewater demand risk.
- Government support and political will: Central, state and local governments have a number of support schemes and initiatives to promote wastewater reuse. Government policies on water resource management and wastewater reuse were clear. The Government of Maharashtra and NMC were strongly committed to the project.
- Strong communication and coordination between the water utility and the end-user helped fully exploit the synergies of wastewater treatment and reuse. Reusing treated wastewater met the water demand of the thermal power plant allowing the limited availability of freshwater in the region to be used for other purposes. The case study highlights the benefits of taking advantage of the linkages between the water and energy industries.
- Physical Factors:
    - The shortage of freshwater in the region, and the high costs of sourcing additional freshwater for the project, encouraged MahaGenCo and NMC to explore other options, such as the reuse of treated wastewater.
    - The proximity of the power plant to the wastewater treatment plant, which lowered water transport costs.

Notes

1. Thermal power plants require water for cooling purposes. More information on the water requirements of power plants can be found in the website of the "Thirsty Energy" Initiative by the World Bank: https://www.worldbank.org/thirstyenergy
2. https://timesofindia.indiatimes.com/city/nagpur/nmc-to-become-nations-first-city-to-reuse-91-sewage/articleshow/67494230.cms

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