

INCLUSIVE INNOVATIONS

Bringing Clean, Affordable Water to Poor Communities Through Decentralized Water Treatment Kiosks

Water treatment kiosks for the underserved provide a quicker, sustainable safe drinking water solution to improve health and economic outcomes

HIGHLIGHTS

- Decentralized water treatment kiosks can be constructed in just six weeks, providing immediate access to clean drinking water.
- The kiosks can reach thousands of users not connected to public infrastructure, at a lower cost than alternatives.
- Community members are trained to run and operate kiosks, helping ensure project sustainability and accountability.



Summary

Access to clean water in developing countries is constrained primarily by the limited reach of piped infrastructure, which many countries lack the resources to expand. Decentralized models of water treatment and distribution present an innovative, affordable, and sustainable solution for providing clean drinking water to the poor.

Development Challenge

An estimated 748 million people in the world lack access to an improved drinking water source, and 73 million of them rely on untreated surface water (WHO/UNICEF 2014). The World Health Organization (WHO) estimates that inadequate drinking water, sanitation, and hygiene caused 842,000 diarrheal disease deaths per year in (2014). In addition to negative impacts on health, lack of access to water stifles economic growth by keeping people out of work and school, with disproportionate effects on women and girls. In some countries with large populations without access to drinking water, such as India, the health and other costs associated with consuming untreated water are estimated at USD 600 million a year (WB, 2015). Discharge of untreated water also pollutes and damages the environment.

Centralized filtration and expansion of existing piped water distribution systems are resource intensive and time consuming, and they require government capacity that is often lacking. In contrast, decentralized water treatment models treat ground and surface water locally, providing safe, healthy, and affordable drinking water to communities previously without access. These solutions usually require construction of a treatment plant and the design of a low-cost sales and distribution systems.

Decentralized water treatment models were initially developed to address the water access gap in rural areas. Many of the new units are being set up in urban and peri-urban areas, to help cope with increasing urbanization.

Business Model

This business model is used where local water sources are contaminated and a piped distribution system that provides clean water is not in place. Contamination may include severe microbial pollution and high levels of arsenic, fluoride, iron, or nitrate, which may render simple, low-cost solutions (such as pumping, water harvesting, filtering through individual filters, or using chlorine tablets) ineffective.

Components of the Model

The structure of the model varies across enterprises and organizations. Some models (such as that depicted in Figure 1) construct treatment plants near ground or surface water, which it then extracts, purifies, packages, and distributes to local customers. The location of the plant (and acquisition of the land required) is determined in collaboration with the local government. Other enterprises (such as the Safe Water Enterprise in Kenya) use membrane-based treatment of water.

Different enterprises have developed innovative methods of treatment, often relying on alternative and renewable sources of energy in areas where electricity is not available. Water treatment facility can be run on solar power, reverse osmosis, or the power of gravity.

The nature of water contamination often determines the type of treatment technology required, which may have cost implications. Microbial contamination, for example, requires only a low-cost tank and chlorine treatment, whereas high levels of arsenic, fluoride, or nitrate require more sophisticated treatment processes.

Most customers of decentralized water treatment models are households. Local schools, offices, and other institutions also use the systems.

Some companies provide customers with containers (the design of which plays an important role in product marketing), disinfecting them at every visit to the store or plant for water refilling. Others regularly disinfect customers' own containers.

Figure 1. Providing safe drinking water through decentralized water treatment units



Many organizations involve local communities and entrepreneurs in creating distribution networks and sales forces, generating local employment and contributing to economic growth. Customers who live near the plants usually pick up their water themselves. Customers farther away often have their water delivered, by bicycle or moped. Some customers purchase water through automatic teller machines (ATMs)—cloud-managed, solar-powered, cashless, vending machines that provide clean water 24 hours a day to customers using prepaid cards.

Cost Factors

Decentralized water treatment solutions incur two main types of costs: the initial capital expenditure of building the plant and the operational cost associated with managing and maintaining the plant, the distribution network, and sales. The upfront capital cost can be funded through government, a donor grant, or an investor (such as an impact investor), based on the cost-recovery aspect of the model funded. In some models, governments fund the plant construction, recuperating their investment over time through the subsequent sales of water. In others the emphasis is on keeping the price of water as low as possible in order to reach a large number of beneficiaries. In these models, revenues cover operational expenses only (labor, spare parts, consumables [such as chemical substances required in the treatment process], and energy).

Revenue Streams

The main source of revenue is the sale of drinking water. Additional sources could include sales of water containers, charges for home delivery, and sales of retail products for small-scale treatment, such as chlorine tablets, or other products for treatment at a larger scale.

Financial Viability

Most decentralized water treatment models aspire to operate as financially sustainable for-profit businesses. Financial viability depends partly on the nature of the contamination and the process of purification required.

Revenues from the sale of water and other services are designed to recover operational and in some cases capital expenditures. Recovery of capital expenditures can take from just a few years to 15–20 years (Safe Water Network 2014).

Many organizations face financial challenges. Low prices of water keep profit margins very low, especially where maintenance and operation costs are high. To increase revenues, many enterprises offer services to urban and semi-urban areas at higher prices, to cross-subsidize their rural sales.

Partnerships

Water treatment enterprises need to work very closely with the communities they serve. Strong community involvement increases transparency and helps raise awareness and trust in the company's product.

Many enterprises recruit and train people from local communities to manage and maintain the plants as well as distribute and sell the final product. Some models put the water utility in community ownership and appoint local entrepreneurs to handle day-to-day management. Others lease the asset to local entrepreneurs through a franchising scheme and share revenues with them. Still others control water quality and manage collection of payments while putting the community in charge of operating the treatment plant. In this model the community provides the land, energy, and water.

Another critical partner national and local governments, which can provide grants and other sources of funding, including subsidized leasing of land. Every water provider must comply with national water safety and health standards and have a license to extract from a given water resource.

Some organizations partner with NGOs, hospitals, schools, and colleges to raise awareness about health benefits of drinking safe water to help create demand.

Implementation: Delivering Value to the Poor

Awareness

Many enterprises create and raise awareness about the health and other benefits of drinking clean and safe water, sometimes in partnerships with local institutions. Activities include information campaigns in collaboration with local authorities and NGOs and lectures at local schools. Awareness-building is particularly important in regions where the harmful consequences of consuming contaminated water are not immediate. Where NGOs once provided water for free, the new requirement to pay may need to be explained.

Acceptance

Water providers win acceptance among customers by engaging local leaders, partnering with the community, employing local people, and keeping prices affordable. As in many other areas, people at the bottom of the pyramid often spurn goods and services designed, branded, and marketed “for the poor.” In rural communities expensive national and international brands of bottled water are often considered signs of high social and economic status. Accordingly, decentralized water treatment enterprises strive to be perceived as providers of a better and healthier life and higher social status, sometimes selling water in attractive, clean, and reusable containers in order to compete with products sold by the bottled water industry.

Accessibility

Decentralized water treatment centers are located close to the communities they serve. Customers pick up their water at the plant, at an ATM, or at a local retail store, or they can have it delivered it to their home. Water sales points must be located in areas with a sufficiently large customer base and/or traffic. By generating employment within poor communities, water treatment enterprises can provide access to other goods and services that may not previously have been available to some community members.

Affordability

Decentralized water treatment solutions are much more affordable than extension of piped water infrastructure. They are therefore a good solution in many developing countries. Treated water is priced based on many factors. The price has to be lower than that of expensive bottled water and low enough to be affordable to a critical mass of poor customers so that revenues earned are sufficient to cover operational and other costs

Results and Cost-Effectiveness

Scale and Reach

Community-managed decentralized water treatment systems are serving millions of people around the world. India alone has an estimated 7,000–12,000 water treatment systems in 2014. In 2012 WaterHealth, a social enterprise (SE) with operations in South Asia and Sub-Saharan Africa, had 500 sites reaching more than 5 million customers. In India the company’s customer base rose from 15,000 in 2009 to more than 1.4 million in 2011 (Waterhealth International, IFC Case Study). The SE Naandi Foundation will soon be providing more than half a million people with safe water through its 400 operational plants across 14 states in India.

The model is highly effective in reaching people with no options other than drinking contaminated or expensive bottled water. Some challenges remain in terms of reaching the very bottom of the

pyramid, however. In the Naandi Foundation's catchment area in India, for example, 10 percent of households still cannot afford its products (Kumar and Muckerjee 2014).

Improving Outcomes

Virtually all of Waterlife's customers in rural areas have seen improvement in their overall health, leading to lower expenditure on medicine and healthcare (WBG/DM Case Study of Waterlife India). Data from a public health center in Madavganfarata, Maharashtra indicate a 65 percent decrease in diarrhea, a 57 percent decline in urinary stones, and a 57 percent drop in skin diseases in the district where Waterlife operates. Average monthly savings as a result of decentralized treated water was USD 28 for rural households and USD 15 for urban households (IFC 2013). The provision of clean water also cuts down on the need to boil water, reducing indoor pollution and fuel costs.

Just providing clean water is not sufficient to improve health outcomes, however. Clean water can get easily decontaminated once purchased. It is therefore necessary to periodically sanitize containers used for water transfer and to raise awareness regarding hygienic practices, such as hand-washing and safe water storage (Cherunya and others 2015).

Access to safe water makes people healthier and better able to work and attend school. It reduces the need to fetch water from resources located far away, a function usually performed by women and girls. Through emphasis on community ownership and management, the models support local entrepreneurs and retailers and generate employment.

Cost-Effectiveness

The cost of providing water through conventional pipes in India is USD 0.25 per month per household for unlimited volume plus USD 8 million for infrastructure expansion (WBG/DM Waterlife Case Study. Under the Waterlife model, the cost is USD 0.0004 per liter (to the customer) and USD 60,000–USD 65,000 (the more expensive option runs on solar power) for construction of the treatment plant (IFC 2015).

In many countries it may take years to expand water pipelines to remote areas. In contrast, a decentralized water treatment system can take as little as 45 days to set up.

Scaling Up

Challenges

Decentralized water treatment plants face several challenges—and opportunities—in reaching scale. In many areas with access to free but polluted water, it may take considerable effort to build awareness about the long-term negative effects of drinking unclean water, especially where the consequences are not immediately apparent, as is the case with water polluted by arsenic. Local communities may be used to receiving free water from NGOs or other development actors, a model that is not financially sustainable. To address these issues, SEs often form partnerships with local authorities, schools, and other institutions respected by the communities to launch information campaigns.

To keep distribution cost low, it is important that treatment plants be located in dense areas with easy access to customers. To reach more remote areas, services can either be cross-subsidized by operations in dense or urban areas (where higher prices are charged) or subsidized directly by the government.

The availability of skilled personnel to manage, operate, and maintain the plant is often a limiting factor. Some organizations have built recruitment and training of local people into the core of their models, generating employment in addition to providing safe drinking water.

Role of Government and Public Policy

Government can support the scaling up of decentralized water treatment solutions in several ways. It can address public perceptions regarding water quality and health hazards, ensuring the population that it is safe to drink and use the locally treated water. It can adjust governance structures according to financing strategies and establish clear relations (roles and responsibilities) among stakeholders, including municipalities, property owners, and SEs. If necessary, the government can reform existing (or create new) institutions to maintain relations among stakeholders and monitor water quality and uses. It can adjust the regulatory framework at various levels. In Kenya, for example, the Water Act of 2002 created a “delegated management model,” which provided criteria for small-scale private water providers to be formally recognized and therefore subject to regulation.

Most decentralized water treatment models depend on public funding. Governments can access new sources of financing for water development projects in various ways. They can capture the value of the land through a land value tax in which a proportion of the increased value that accrues to landowners benefiting from new or improved infrastructure is captured and used to fund the infrastructure provided. They can capture the value added by the decentralized water systems by issuing land-based bonds (with the land as collateral). They can attract private financing from engineering firms that build and service water systems or from landowners, owners of houses, and land and housing developers (in Mexico housing developers are the second-largest investors in water supply and sanitation after the federal government). They can also leverage private finance through public-private partnerships.

Table 1. Examples of SEs providing decentralized water treatment

Company	Country	Description
Grameen Veolia Water Ltd.	Bangladesh	Built filtration plants in five low-income communities and connected them to network of water taps. Plants are run as businesses, aiming to cover all operating expenses.
Naandi Foundation	India	Operates more than 400 mini-water purification plants in mainly rural communities, financed through public-private partnerships. Model is based on Design-Build-Operate-Transfer concept, whereby community ends up operating plants and Naandi is responsible only for monitoring and quality control.
Safe Water Enterprise	Kenya	Equips small kiosks with mobile SkyHydrant water filters, which remove suspended solids, bacteria, and viruses from water with hair-thin membrane fibers. Filtration process operates without electricity, requiring no grid connectivity.
Safe Water Network	Ghana and India	Has provided more than a quarter of a million people in Ghana and India with access to safe water, by working with communities. Provides training, tools, and support to ensure that system is locally managed and operated.
Sarvajal	India	For-profit SE (part of Piramal Enterprises) operates community water filtration plants through local franchisees in Indian villages of about 5,000 inhabitants. Is experimenting with water distribution through ATMs.
Water Health	Bangladesh, Ghana, India, the Philippines	Uses new technologies (including UV light disinfection) to purify any available local water source. Centers employ local workers to maintain, test, and dispense water at affordable prices. Investment of just USD 25,000 (less than USD 10 a person) provides a typical community in India with its own WaterHealth Center and service for 10 years.
Waterlife	India	Provides clean water to households, apartment complexes, and offices in underserved and challenging areas, operating in partnership with

		the government, NGOs, <i>panchayats</i> , self-help groups, commercial institutions, and international agencies. Hallmark of model is focus on quality by providing reliable service and maintenance.
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Profile: Safe Water Network India

Providing potable water to communities that lack access to drinking water



Challenge

Some 97 million people in India lack access to safe water, according to the World Health Organization. Three-quarters of India's surface water is contaminated by waste, and groundwater often contains high levels of fluoride, nitrate, and other mineral contaminants. Water- and sanitation-related illnesses account for 70–80 percent of the country's disease burden. The challenge is to provide safe drinking water at an affordable rate to low-income communities.



iJal stations like this one in the village of Peddapur, in Telangana, provide residents with relatively inexpensive clean water.

Innovation

Safe Water Network was co-founded in 2006 by the actor and philanthropist Paul Newman. Although it is a nonprofit organization, it is based on market principles and a customer-oriented approach.

In 2008, the organization launched its first effort, a rooftop rainwater harvesting program that built or refurbished more than 1,000 community and household cisterns. Soon after, it set up water treatment and sales points. These Safe Water Stations (locally called iJal Stations) are equipped with water treatment technology to treat groundwater contamination in affected areas.

Sites for Safe Water Stations are identified based on the following criteria:

- Water quality is very poor.
- Households demand and are willing to pay for safe drinking water.
- The community has at least 400 households, and at least 75 percent of households are likely to participate. (If half of the population buys water regularly, the program needs at least 2,000 people in 500 households to be financially viable.)
- A local elected body has the authority and is willing to sign a tripartite agreement with Safe Water Network and the local operator giving Safe Water Network the right to operate. The agreement includes a mechanism for setting an affordable but viable price for water and ensuring equitable access to all community members.

In consultation with the community, a local entrepreneur or community-based organization is selected to operate the water station. Safe Water Network selects the most appropriate water treatment technology, provides the funds for capital investment, builds the station, and subsidizes the marketing costs.

All stations are equipped with a remote monitoring system that enables 24/7 monitoring of plant performance and water quality. Monitoring enables technical issues to be addressed by the project team immediately, keeping downtime to less than 2 percent. Each station is expected to cover its operational costs from the start. The local entrepreneur, while setting aside some percentage toward plant maintenance, earns fixed fees from the water sales, and the balance is returned to Safe Water Network. Safe Water Network uses its revenues toward plant repayment and is used as a revolving

grant to invest in other communities. It takes about 7-8 years to recover the costs of setting up a station. If a station proves nonviable, either operationally or financially, Safe Water Network has the right to terminate operations and relocate the treatment plant.

Impact

Safe Water Network India has brought access to safe, affordable drinking water to more than 672,000 people through 180 iJal Stations in the states of Telangana, Uttar Pradesh, and Maharashtra (2017), having doubled the number of its stations in just the past couple of years.

Water is priced to make it as affordable as possible while covering operating costs. In 90 percent of communities served, it sells for USD 0.06–0.08 per 20 liters—a fraction of the USD 1.20 charged for the cheapest branded bulk-packaged treated water. iJal water is also less expensive than untreated water from tankers or boreholes.

Education about the health benefits of properly treated water is part of the model, particularly in areas where dissolved minerals have contaminated the water. Education is also necessary to counter the belief that boiling water can make it safe to drink.

Safe Water Stations generates livelihoods for local station entrepreneurs, operators, and drivers who transport the water. They also provide training on how to manage a small business.

Scaling Up

The main external driver of this model is the vast unmet demand for safe drinking water. Safe Water Network in India and Ghana have reached nearly a million people (2017). Five variables drive the financial viability of individual stations: the population of the community, household size, household participation, distribution, per capita consumption, and most critically, willingness to pay.

Internally, two drivers underpin design and scale-up: cost reduction and a commitment to sharing knowledge. The network keeps costs low by using technology and limiting its staff to a small team – half of which are for awareness raising and knowledge dissemination, an important part of the company's social mission and also improves willingness to pay.

While the Indian government has become more involved in procurement of decentralized water treatment plants, its focus on the lowest price, without incorporating quality and social impacts, limits the network's ability to win public sector contracts.

Profile: WaterHealth International

Treating and selling treated, affordable drinking water to urban and per-urban communities in Ghana



Challenge

More than 3 million people in Ghana lack access to an improved water source. The country's large chemical, mining, and agriculture industries have led to severe arsenic, mercury, and cyanide pollution, as well as microbial contamination. Expensive water treatment solutions are needed to filter the water to make it safe for drinking. In addition, many parts of the country lack basic water infrastructure. The challenge is to provide safe drinking water at an affordable rate to low-income communities.



Water treatment plants like this one in the Greater Accra region are manufactured as kits that can be easily assembled and maintained by local workers.

Innovation

WaterHealth International (www.waterhealth.org) has been operating in Ghana since 2008, using a build-operate-transfer model based on management contracts of 20–25 years. Once WaterHealth builds a center, it contracts it out to a local community or agency to operate and maintain for a period of time. Its unique UV treatment technology and innovative business model make high-quality, potable water affordable to households earning just USD 2 dollars a day.

The plant sells both "utility water" (used for washing and cleaning) and potable water. Their "Dr Water" branded product is consumer friendly to encourage widespread adoption. Utility water costs USD 0.05–0.08 per 20 liters. This water is filtered to safe drinking water standards but does not go through the final reverse osmosis process. Drinking water can be collected from the plant (at a cost of USD 0.20 per 20 liters) or delivered to homes (at a cost of about USD 0.50 per 20 liters).

WaterHealth reaches areas where it is not profitable or feasible for traditional water utilities to operate. Its system is flexible, as units of various sizes can be installed. Smaller treatment units cost USD 50,000 to equip and install; a large unit can cost up to USD 90,000. The plants are manufactured as kits that can be easily assembled and maintained by local workers. Waterlife owns and operates the center, then transfers it to the community after 20-25 years.

The local authority (a village chief or district council) provides the land, access to electricity, and rights of access to the water source. WaterHealth employs and trains staff who run the center and helps the local community set up a water board to liaise between the community/users and those that run the water center to ensure a smooth operation and transition to community ownership at the end of the contract.

Several centers are developed at the same time in villages that are close to one another, in order to ease replication and allow efficiencies in management services across the centers. WaterHealth tests the water regularly and maintains the unit, using revenue from the water center to do so. It achieves break-even on operational costs in four to six months. To be fully sustainable, the unit needs to serve a population of at least 5,000 people.

Impact

WaterHealth provides 250,000–300,000 people in Ghana with access to clean drinking water treated at 35 plants. Each plant typically serves about 10,000 people—significantly more than bore wells, which provide just 300–500 people with access to unfiltered water. Although WaterHealth initially worked in rural areas, 50–70 percent of its new facilities are in peri-urban or urban areas, where demand from people living in informal or unplanned settlements is growing.

An independent review of the cleanliness of a sample of water from WaterHealth plants showed that at the treatment center, WaterHealth water had 93 percent less *E. coli* contamination than surface water (Opryszko and others 2015). However, as water quality degrades after it leaves the plant (due to contact with unclean hands, the mixing of surface water with clean water, and contaminated storage vessels)-- WaterHealth also chlorinates some of its water in at-risk areas.

Scaling Up

Grants of USD 4.5 million from the Coca-Cola Africa Foundation and the Diageo Foundation have allowed WaterHealth to expand its activities. Access to finance for capital investment and partnership support from local government will determine future growth. Support from local government is also needed as the system complements public provision. Constraints to scaling up include lack of access to land, as water centers need to be in a central place to ensure sufficient customers, and lack of relevant skills in the workforce in Ghana for employees to maintain the water filtration systems.

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