Proposal for an affordable and sustainable solution to the Arsenic Disaster

Summary

Arsenic poisoning from well water occurs in many areas of the world but nowhere is it as prevalent and nowhere are the concentrations of arsenic as high as in Bangladesh. The contamination is found in wells that have mainly been financed by international aid agencies in order to reduce the earlier scourge of cholera from surface waters. But it has introduced a new health hazard. When the poisoning was discovered, WHO and the World Bank called for a major intervention but few efficient and affordable methods were at hand. Tens of millions of people have therefore been slowly poisoned over the last decades.

Scarab has designed a sustainable and affordable polygeneration system that would solve the problem by creating local polygeneration systems that supply electricity, water and other amenities. These systems can be supplied under leasing contracts and therefore do not require international aid or charity.

The Swedish organization for international co-operation, Sida, has financed a feasibility study for this solution which was carried out by the Royal Institute of Technology of Sweden in co-operation with Grameen Shakti of Bangladesh. The study turned out to be positive and Sida completed the evaluation by a study performed by Swedish Institute of Public Administration (SIPU International) in consortium with Orgut and Adam Smith International with the title: Influencing results in four target areas of Sweden's development co-operation with Bangladesh: Opportunities for private sector collaboration. This study concluded that the project is highly desirable for Bangladesh and ranked it in the top of the projects recommended for Sida financing in Bangladesh.

The Arsenic Disaster is still there

"Bangladesh is grappling with the largest mass poisoning of a population in history because groundwater used for drinking has been contaminated with naturally occurring inorganic arsenic", the monthly bulletin of the United Nations World Health Organization (WHO) reports in September 2000. WHO also predicted that one in ten adult deaths across much of southern Bangladesh will be caused by cancers triggered by arsenic.

Later research has shown that a good portion of Ganga-Meghna-Brahmaputra (GMB) plain of an area 569749 km2 and population over 500 million may be at risk from groundwater arsenic contamination. http://www.soesju.org/arsenic/arsenicContents.htm?f=alb_11.htm

Although Arsenic poisoning from ground water had been reported earlier, the first international attention to the problem was in 1995 by the First International Conference on Arsenic that was arranged by Professor Dipankar Chakraborti at Jadavpur University in West Bengal.

One of Scarab's ambitions is to enable supply of electricity, water and food by designing sustainable and affordable polygeneration systems for marginalized communities.
The systems are designed to be financed by the beneficiaries and not depend on charity. The underlying design and development work is mainly financed in the context of Scarab's high-tech commercial industrial projects.

The cost of mitigation

After the initial efforts in the 1990's to understand the problem, discussions were held among the afflicted Governments and international organizations on how to tackle the problem. Some estimates were discussed among donor organizations. They all involved several billions of dollars. No exact calculations were made, (perhaps) because the cost of the intervention was considered prohibitive in any case.

Efforts at mitigation

Many innovations were made in the years to follow in order to find a cheap way of removing arsenic on the individual or community level. Although some of them have been sponsored substantially by various aid agencies, they have all failed. Either because of technical short-comings, social unacceptance or high long-term costs.

The only intervention that has led to measurable success is the World Bank program for sinking deeper wells to reach strata that are not contaminated with arsenic. There are however draw-backs also with this program. The wells are expensive, they lead to long transports of water and there is a risk for re-contamination with arsenic or contamination from other matter.

A solution has now emerged

Ever since the problem became widely known in 1995, Scarab Development AB has worked on developing a solution that would be ecologically sustainable, socially acceptable, affordable and completely safe.
By using technology that has been developed for advanced industrial systems for the manufacture of ultrapure water, the proposed system can guarantee the total removal of arsenic and also all other contaminants from the water.

Therefor it can also be used for purification of surface water and for desalination of sea-water in areas where that would be more appropriate.

By including the system in a polygeneration system for local production of electricity and other amenities from the same energy input, the water becomes a by-product that can be prized as appropriate at the local market.

A financial model has been developed for local banks to be able to lease the systems to the users for monthly payments with no up-front costs. The leasing bank/company/NGO will therefore also be driven to service the equipment.

Benefits of the system

- Less suffering from illness from contaminated water and indoor smoke for all categories
- Emancipation for women by less care for illness
- More time for productive work because of less work with fetching water and collecting fuel wood
- Higher living standard for all because better health enables higher work input
- Climate gains because of renewable energy use for water treatment and more efficient electricity production and cooking
- Lower cost by combined production (polygeneration)
- Political empowerment because of local control of basic infrastructure resources

The project attends to major development issues

Energy poverty. Lack of energy hampers all development. *The project provides access to low-priced renewable electricity in a local grid (off-grid).*
Contaminated drinking water. Drinking water is contaminated all over the world. Polygeneration uses waste heat from electricity production as the only consumable for making absolutely pure water. *This project removes all conceivable contaminants from water and provides absolutely pure drinking water in containers at the door-step.*
Poor sanitation. The lack of sanitation is a major health and social problem in many densely populated areas. Polygeneration uses local human feces, animal manure, agricultural waste and garbage to make biogas in order to run the electricity generators. *This project turns waste into electricity.*
Indoor air pollution. Indoor air pollution is often considered the world's greatest environmental hazard. It harms women and children disproportionately. The World Health Organization estimates that indoor pollution kills 4.3 million people a year. *The project replaces biomass with gas for cooking.*

The Polygeneration technology is not an "end-of-the-pipe" solution because it involves no drinking water pipes, no waste water pipes, no large scale electric grids, no large scale waste collection and transport. It promotes local infrastructure which is actually superior to the centralized systems in the industrialized world.

History and status of the proposed system

Scarab Development AB has together with the Royal Institute of Technology, Stockholm, Sweden, (KTH) developed systems for polygeneration.

The commercial product is a system that combines generation of electricity and purification of water. The fuels will be Biomass, Biogas and Solar. Water will be purified in a low temperature distillation process driven by the waste heat from electricity generation. This way, arsenic and all other contaminants will be completely removed in an affordable way.

In 1995, Scarab was asked if our new technology could separate arsenic from water. We tested water spiked with arsenic at Karolinska Institute in Stockholm. The arsenic was removed completely. After that we sent test equipment to Dhaka and researchers at Bangladesh University of Engineering and technology (BUET) tested actual well water containing arsenic with the same successful result. These results were documented in a Master Thesis from Chalmers Technical University in Goteborg, Sweden, *Membrane Distillation Process for Pure Water and Removal of Arsenic* by Ashiq Moinul Islam, 2004.

The next step was to conceive an ecologically sustainable and technically well designed system. These developments are documented in a Master of Science Thesis by Ershad Ullah Khan in 2007, *Biogas driven Stirling engine micropower generation and integrated membrane distillation process for arsenic removal*.

A solar powered version was also examined in the field: *Removal of arsenic from contaminated groundwater by solar-driven membrane distillation* Ajay K. Manna, Mou Sen, Andrew R. Martin and Parimal Pal, 2009

Work in improving the design of the equipment continued in co-operation with KTH. Successful results were obtained in removing salt from sea water, treatment of desalination brine (concentrate), purifying power plant effluents and removal of pharmaceutical residues and nanoparticles.

Finally a grant from the Swedish international development cooperation agency (Sida) enabled KTH to execute a field study to model the social and financial conditions for making the system culturally and economically viable. This study resulted in a report to Sida, *Biogas based polygeneration for rural development in Bangladesh*, February 2015.

At the same time Sida completed a study performed by Swedish Institute of Public Administration (SIPU International) in consortium with Orgut and Adam Smith International with the title: *Influencing results in four target areas of Sweden's development co-operation with Bangladesh: Opportunities for private sector collaboration*. This study concluded that the project is highly desirable for Bangladesh and ranked it in the top of the projects recommended for Sida financing in Bangladesh.

Based on these results, a subsidiary of Scarab, HVR Water Purification AB, has proposed a plan for demonstration of four biogas polygeneration systems in the field: *Demonstration phase for biogas based polygeneration for rural development in Bangladesh*, October 2015. The proposed budget for the three year demonstration program is 3.5 M€.

Improved prospects for development

When the development work started there were no clear avenues for implementation of a successful outcome. However, during the last decades industrial and business activities in

Bangladesh have developed rapidly. During these years, Scarab has discussed co-operation with Swedish companies such as Volvo, Alfa-Laval, HM and IKEA and several local companies. In recent years strong local companies have emerged as potential implementers. Among the present partners are (for instance):

Milk Vita Milk Vita is a government run co-operative in dairy. It has large stables and wants to utilize its manure for making electricity from biogas and high quality organic fertilizers. Ultra-pure water will be a byproduct which has good use in the dairy operations. It can also be converted into high-quality bottled water for which the company has excellent distribution channels. http://www.milkvita.org/

Sigma Pumps Sigma is a private entrepreneurial water equipment company with decades of experience in building and installing advanced water treatment technologies. By working with Sigma we will also be able to make an attempt to start local manufacture of advanced industrial products. http://www.sigma-bd.com/

Grameen Shakti Grameen Shakti is an NGO interested in financing and servicing local polygeneration units. It will supply the units on a leasing contract and has good access to international credit lines through its parent company Grameen Bank. Grameen Shakti also has long experience in financing and servicing solar power units for small communities and individuals. http://www.gshakti.org/

CONCLUSION: **The proposed Polygeneration project is economically viable and therefore financially feasible.** It does not depend on subsidies or donations. The running costs are minimal and the capital costs can be arranged as a lease contract from a commercial bank that is serviced by the bank collecting monthly payments for cooking gas, electricity and drinking water.

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