A J-OP Case Study: Dakar, Senegal

STeP Sanitation Technology Platform

Key Takeaways

- The Janicki Omni Processor (J-OP) is being deployed in Senegal to expand fecal sludge treatment capacity. After initial success with a pilot-scale unit, a commercial-scale unit is planned for 2019.
- Estimates indicate that a self-sustaining business model can be achieved by generating electricity and water that will be upgraded and sold as coolant, resulting in a net present value (NPV) of approximately 2 million USD at 20 years.

Dakar's Growing Fecal Sludge Challenge

Dakar, Senegal, has a population of more than 3.5 million, making it Senegal's largest city. Dakar makes up about 50% of the urban population in Senegal, and sewer expansion has not kept pace with urban population growth.[i,ii] The share of the urban Senegalese population dependent on on-site sanitation (OSS) stands at 54%—representing a 9% increase between 2000 and 2015.[iii] OSS necessitates a full fecal sludge management (FSM) value chain, from emptying septic tanks and latrines through transportation to storage and treatment, but estimates published in 2015 suggested that nearly 70% of fecal sludge (FS) in Dakar is unsafely disposed. Four FS treatment plants (FSTPs) are operational in Senegal, but waste deliveries are exceeding capacity and dewatered FS solids are used for fertilizer, despite not being pathogen-free.

The J-OP Solution

Designed by Sedron Technologies,[1] in partnership with the Bill and Melinda Gates Foundation (BMGF),[2] the J OP is a community-scale treatment system that processes FS solids, biosolids, and other waste streams into clean water, electricity, and ash. When located in a community in need of improved sanitation (either as a stand-alone solution or co-located with an FSTP or wastewater treatment plant [WWTP]), the J-OP can achieve complete pathogen destruction, resulting in improvements to human health and the environment.

Revenue from the sale of end products can help offset project costs or may offer a sustainable business model. Surplus electricity can be sold or used to offset on-site energy demands. The water produced meets World Health Organization and U.S. Environmental Protection Agency drinking water standards, and the ash can be sold as fertilizer. One J-OP can serve a community of hundreds of thousands, depending upon feedstock characteristics.

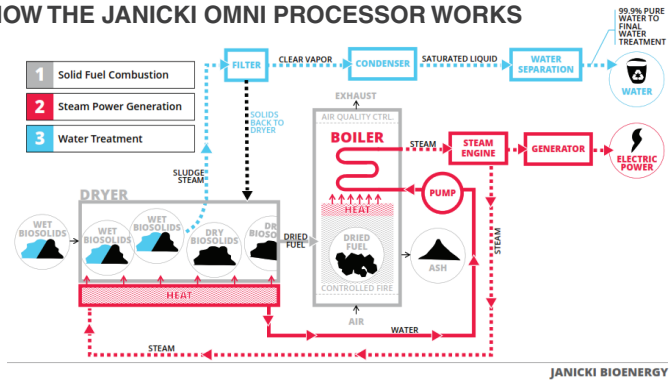

Figure 1. The J-OP processes biosolids and other organic waste streams into clean water, electricity, and ash.

Initial Outcomes and Lessons Learned

Beginning in 2014, Delvic Sanitation Initiatives (DSI), a Senegalese company operating four FSTPs in Dakar, partnered with the BMGF and the Office National De L'Assainissement Du Senegal (the public agency responsible for sanitation in Senegal) to demonstrate the viability of the J-OP solution in West Africa. The project began with a pilot-scale unit intended to demonstrate technical viability, enhance DSI's operating capabilities, and achieve integration with the broader FSM ecosystem. Installed in 2015, the pilot unit was located adjacent to the drying beds at the FSTP at Niayes to provide a consistent source of dewatered FS, along with filtrate treatment in the nearby WWTP.

[1] Formerly known as Janicki Bioenergy

[2] The J-OP is based on patent application no. WO 2016-077241 and associated family of granted patents and applications. Intellectual property and licensing rights are retained by the Bill and Melinda Gates Foundation for the manufacturing, sale and distribution of the technology in accordance with the Foundation's Global Access Policy.

Headline Image: The Phase 1 Pilot-scale J-OP unit located adjacent to the Niayes FSTP in Dakar, Senegal.

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Since then, the pilot unit has successfully

- processed an estimated 700 dry metric tons of FS in year 1,
- generated ash and water with an absence of pathogens,
- produced clean water, and
- maintained key operating parameters such as boiler temperature within desired ranges.

The pilot has provided both programmatic and technical learning opportunities. The team has improved FS supply consolidation across FSTPs, added flocculation in the Niayes drying beds to maximize sludge recovery, upgraded the drying beds from a sand base to stone pavers to minimize sand introduced into the J-OP boiler, and improved the J-OP's corrosion resistance. The pilot unit also provided an opportunity to enhance the ecosystem of partners required for FS collection and delivery and J-OP product offtake.

Progress Towards a Commercial Installation

Planned for installation in 2019, a commercial-scale unit will expand upon the early successes by proving the technical viability of a larger-scale J-OP and testing business model viability. The commercial unit will be installed at the Tivaouane Peulh FSTP to maximize FS deliveries and leverage available space. Throughout 2019 and 2020, DSI and BMGF plan to complete commissioning and site acceptance testing, installing the J-OP in Dakar, and working through start-up and training to reach full-scale operation.

Figure 2. The Commercial Unit being tested in Washington, USA, prior to being delivered to and assembled in Dakar.

Based on markets for end products, the operating parameters of the commercial unit can be optimized to produce power, water, or a mix of the two. DSI undertook a financial analysis to evaluate optimal output configuration and determined that neither bulk potable water nor electricity sales in the Dakar market were likely to provide a positive NPV at 20 years. To achieve a sustainable business model, DSI then searched for opportunities to produce a value-added product from the water. In Dakar, the wholesale price of engine coolant sold to bottlers (slightly more than 1 USD per liter) may be at least seven times higher than the sales price of bulk potable water, driving an increase in profitability.[3] By optimizing J-OP operations to produce distilled water that is then blended to produce coolant, typical annual revenues are expected to increase from approximately 680,000 USD per year (optimizing for electricity production, with minimal potable water and coolant sales) to nearly 1.8 million USD per year (optimizing for coolant production with some electricity sales). By optimizing for coolant production, the team expects to achieve a positive NPV around year 6, with an estimated 20-year NPV of more than 2 million USD.

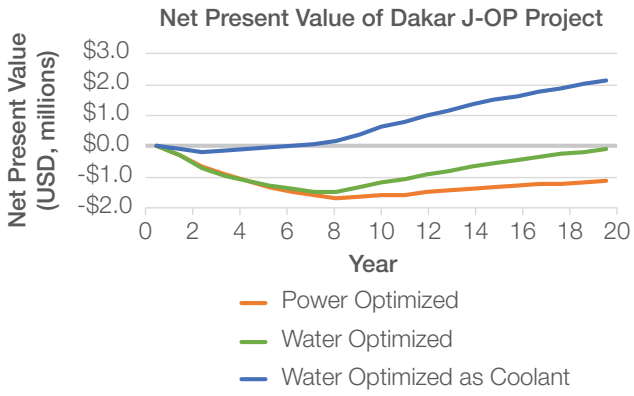

Figure 3. NPV of the commercial J-OP installation in Dakar.

A sensitivity analysis of the financial model highlights that in any J-OP installation with the potential to produce a value-added product, the sales price and cost of producing that product have the largest impact on profitability. Demand for water-based products in the first year of operation also has a significant profitability impact, suggesting that rapid market penetration is important. Financial considerations, especially cost of capital and subsidies that reduce the initial capital expense, also impact profitability.

Is the J-OP right for you?

The funding model and technical performance of the J-OP creates sustained social, environmental, health, and economic benefits for local utilities, sanitation operators, and municipalities, as well as the populace lacking adequate sanitation treatment. This example shows that the J-OP may be successful in communities that need FS treatment, have an adequate FS supply and infrastructure, and have market demand for one or more J-OP outputs, especially value-added end products.

Acknowledgements

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[3] Based on current estimates of prices in the water market and the historical wholesale price of coolant to DSI's customer. Some research suggests that the difference in bulk price between water and coolant may be much larger.

References

[i] World Health Organization. (2015). Senegal country sheet. Retrieved from http://www.who.int/water_sanitation_health/glaas/2014/senegal-3-nov.pdf

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