Developing Programs to Manage Fats, Oil, and Grease (FOG) for Local Governments in India

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Abstract

Sewerage is a major source of water pollution in Indian cities. Delhi is a prime example: in 2007, of the 931 million gallons per day (MGD) of sewage generated, less than half (430 MGD) received treatment. With a treatment capacity of 665 MGD, the under-loading is indicative of a major problem with sewage collection systems, which are often poorly maintained and clogged with grease. Fats, oil, and grease (FOG) are generally present in high concentrations in wastewater from restaurants. If discharged into sewers, FOG clogs pipes, pumps, and downstream equipment, resulting in high operation and maintenance costs. If it enters the environment, FOG can rob surface waters of dissolved oxygen, leading to fish kills and eutrophication.

Managing FOG through comprehensive programs improves wastewater treatment efficiency while reducing operation and maintenance costs. FOG can also be used as a feedstock for biodiesel production. India is a net importer of crude oil to satisfy demand for diesel (estimated at five times that of gasoline). Biodiesel is generating interest as an alternative, with energy independence being the main driver. There are several existing and proposed initiatives for biodiesel production, mostly from non-edible oil crops, but biodiesel from brown grease (FOG collected in grease traps) remains a virtually untapped resource.

Brown grease contains high levels of free fatty acids (FFA), ranging from 90% to 100%. As a result, traditional methods of biodiesel production, such as sulfuric acid catalyst pretreatment, are costly and wasteful. An alternative method first utilizes high-efficiency grease interceptors to minimize grease hydrolysis and couples this with a biodiesel manufacturing process that uses enzymes for catalysis. The enzyme catalysis does not yield any hazardous waste and operates at lower process temperatures than acid pretreatment. The result is a simpler, more efficient and lower cost process that minimizes waste byproducts.

Local governments can take the initiative in FOG management to improve wastewater treatment and begin realizing the associated economic and environmental benefits. Such programs are built on a platform that includes infrastructure, promotion, and an enabling environment that establishes incentives for local businesses to participate.

Infrastructure: This includes properly sized grease traps or interceptors and on-site grease storage receptacles. Collection equipment (vacuum trucks and pump carts) and the systems used to convert FOG into biodiesel complete the process.

Promotion: Campaigns targeting restaurant operators encourage program participation. Education on the best practices for FOG management and promoting the use of high efficiency grease interceptors helps maximize program efficiency.

The Enabling Environment: Local FOG management ordinances set the regulatory stage and include incentives for participation. Local government fleets can use biodiesel to substitute for purchased fuel. These savings fund the purchase of grease from participating restaurants and subsidize the cost of collection.

Keywords: brown grease, restaurants, FOG, wastewater pre-treatment, waste-to-energy

Introduction

Figure 1. Sewer line clogged by restaurant grease: improper FOG management increases operation and maintenance costs for sewerage utilities.

Sewage is a major source of water pollution in Indian cities. Delhi is a prime example: in 2007, of the 931 million gallons per day (MGD) of sewage generated, less than half (430 MGD) received treatment. With a city-wide treatment capacity of 665 MGD, the under-loading is indicative of a major problem with the sewage collection systems, which are limited in their coverage and often poorly maintained and clogged with grease (***Figure 1***) (Singh, 2010). According to Delhi Water Board Technical Director Mr. R. K. Garg, there is a fairly good understanding of the magnitude of the problem stemming from grease from commercial kitchens. "We know there is a problem with grease from restaurants entering our sewer system. Our main issue seems to be in getting our commercial customers to comply [with existing regulations]. It is a problem we are very much interested in solving" (Garg, 2011).

Additionally, much of the biochemical oxygen demand (BOD) from the wastewater generated by commercial kitchens is a direct result of fats, oils, and grease (FOG). If discharged into sewers, FOG not only clogs pipes, pumps, and downstream equipment, resulting in high operation and maintenance costs, it increases overall BOD levels, requiring additional treatment. Often however, in many Indian cities, centralized sewerage systems are not available, and the wastewater from commercial kitchens is discharged with little or no treatment. When FOG-laden wastewater enters the environment, it can rob surface waters of dissolved oxygen, leading to fish kills and eutrophication.

Increasingly, wastewater from point sources, such as hospitals, schools, subdivisions and small communities is being addressed through decentralized wastewater treatment systems (DEWATS). These are smaller wastewater systems that utilize sewers, tanks and basins to connect various sources of sewage for local treatment and reuse. There are already a number of DEWATS in operation in India, providing good case studies of the technologies (Bugey, 2011). Grease traps are necessary components of any DEWATS system that treats wastewater from commercial kitchens. DEWATS technologies, such as constructed wetlands and media filters are especially susceptible to fouling from grease.

Whether decentralized or centralized, FOG management programs will help ensure that those facilities that require grease traps actually install and maintain them. The programs will reduce operations costs and help sustain local investments in wastewater treatment. Effective FOG management programs also add value through resource recovery, jobs, and economic development. FOG can be recovered and processed as a feedstock for manufacturing a variety of commercial goods, which add value and provide incentives for collecting this commodity. One of the commercial products that can be made from FOG is biodiesel, which is generating interest as an energy alternative, with energy independence being the main driver (Gopinathan & Sudhakaran, 2011).

Managing FOG through comprehensive programs improves the efficiency of centralized wastewater collection and treatment systems while reducing costs of operation and maintenance. Not only do these programs strengthen utilities, they spur economic development through the creation of business and service opportunities, which results in jobs. Programs should be as transparent as possible to engender citizen trust that the program is being implemented fairly and honestly, which will increase participation. This is a key concept in the sustainability of the program.

This paper presents a model program that local governments in India can adopt to help them effectively mange FOG. It discusses opportunities for adding value through FOG recycling and identifies the program elements of infrastructure, promotion, and the enabling environment required for effective programs. Finally, the implementation steps that local governments can take to start the process, which are the feedstock and financial analyses, are identified and discussed.

FOG as a Feedstock for Biodiesel Production

Yellow and brown grease are two types of low quality, affordable feedstocks for biodiesel production. Yellow grease is also another name for used cooking oil or waste fryer oil. Yellow grease typically has a free fatty acid (FFA) content of 2% to 15%, with moisture under 5,000 parts per million or less than 0.5%. Yellow grease is a higher value product and is commonly traded on the commodity markets.

Another feedstock source is the FOG which is caught in grease traps used to prevent FOG from entering local sewer systems. This “trap grease,” which is about 95% water, 3% solids, and 2% brown grease (the usable feedstock portion), represents a significant quantity of biofuel feedstock that is currently being discharged with virtually no treatment into the environment: sent to landfills, land applied (i.e., injected into the ground), or composted. This brown grease typically has an FFA content of 35% to 100%, with varying moisture levels depending on the grease extraction technology used to remove the water from trap grease. Brown grease, when collected through municipal FOG-to-biodiesel programs, is first chemically converted into biofuel. The biofuel then undergoes several polishing steps to remove contaminants and separate it into glycerin, bunker fuel, and biodiesel. The biofuel may be used in commercial boilers or used for powering municipal vehicles. The value of the fuel can be used to offset much of the program’s managing costs.

Under this model program, the biodiesel produced is intended to be used by the local government for its own consumption, so the finished product delivery train is simplified. It may be used in fleet vehicles, such as buses and trucks, and even *tuktuks*. An existing program in India uses a mix of biodiesel and petroleum diesel to run train locomotives. Biodiesel is cleaner burning than its petroleum-based counterpart, releasing far fewer nitrogen and sulfur emissions or particulates and unburned hydrocarbons into the atmosphere. While this is an important benefit, the main driver in India for biodiesel development is India's interest in energy self-sufficiency. On September12, 2008, the Indian Government announced its "National Biofuel Policy." This policy aims to meet 20% of India's diesel demand with biofuels. Brown grease-to-biodiesel programs could help to achieve this goal.

While there are no at-scale programs to manufacture biodiesel from FOG in India as of this date, technology to convert low value, low quality feedstocks into biodiesel have been shown to be highly effective in the United States. Groundbreaking work from the Idaho National Laboratory introduced a process that works by mixing in solvents and alcohol at specific temperatures and pressures to produce high-grade biodiesel from low-grade waste (Shifrin, 2010). Other initiatives, such as the comprehensive FOG biodiesel program in San Francisco, not only illustrate that the technology is feasible and scalable, but that it can generate revenue as well (Zeller & Ving, 2011).

The key challenge is to determine how to transfer the concepts and technology into a context that works for Indian cities. As with other environmental initiatives, this can best be achieved through programs that address not only infrastructure, but promotion as well as development of an enabling environment through incentives and regulation to drive participation in the program.

Program Elements

Municipal FOG management programs may be implemented by local governments, preferably with the cooperation of the local water or sewerage district. To achieve success and sustainability, such programs include the mechanisms for collecting, transporting, and processing the FOG (infrastructure); activities to generate interest and sustain the program over the long term (promotion); and regulations and incentives to gain compliance (enabling environment). Local governments may work with the private sector through contracts or other arrangements to achieve program efficiency.

Infrastructure:

The infrastructure component includes the services and equipment to collect, transport, and process FOG into biodiesel. It starts with the provision of properly sized and configured grease traps or interceptors and on-site grease storage receptacles. This equipment comprises the collection component. Transportation equipment, including the vacuum trucks and pump carts, operate similarly to septage management programs, which are proliferating in Asia. There are many model programs that could be adapted for FOG transportation in Indian cities. Finally, the systems used to convert FOG into biodiesel complete the process. Each component is presented below:

Super Capacity Grease Interceptors and Extractors

Grease traps typically function by maximizing the retention time that the grease sits in water to accomplish separation by floatation. This results in a hydrolyzed FOG with a high percentage of

FFA that must first be washed with acidic methanol before biodiesel production may begin. This is a costly process that generates a hazardous waste byproduct that must be handled properly.* As an alternative, super capacity grease interceptors may be used to minimize the grease hydrolysis and percentage of water, and produce a higher quality product ideal for biodiesel conversion.

What makes super capacity grease interceptors super? *The way that the greasy water from restaurants flows into the unit makes the difference between "normal" and "super." Wash water from restaurants tends to flow in batches, such as when a load of dishes are washed. The grease in the hot and greasy water that is deposited in the grease trap solidifies over time, at least until the next batch of hot and greasy water enters the trap. The result is that the water and grease emulsify, which increases the FFAs and water content in the grease. The super capacity grease interceptor uses a horizontal baffle to separate the grease in each batch and places it in a storage container. It does not emulsify when the next batch of hot greasy water enters the trap. The result is a very pure grease product that can be directly used in biodiesel manufacturing*.

To quantify the improved quality of grease that can be obtained through better-designed grease traps, FOG samples from three types of super capacity grease interceptors were analyzed in October 2011.

The samples were collected from units serving restaurants in the United States and Canada, which are believed to be representative installations. The units tested are super capacity grease interceptor models manufactured by Thermaco, Inc., and include the Big Dipper ™, the Trapzilla ™ (***Figure 2***), and the EZClear ™. The feedstock analysis was performed by Piedmont Biofuels, of Pittsboro, North Carolina, USA, which tested the collected FOG to determine the percentage of FFAs, moisture, and water and sediments. The purpose was to compare this product to traditional trap grease and calibrate a model for FOG management programs that utilize super capacity interceptors as their main source of FOG collection. The analysis determined that the FOG from the Thermaco grease interceptors has comparable quality to yellow grease, but with an excess of water and sediment. Compared with brown grease, which is at least 35% FFA by weight (wt%), and very often even close to 100 wt% FFA, all these Thermaco feedstock samples showed a much lower FFA content (between 1 to 2 wt%). For biodiesel production, this is an advantage because converting high FFA feedstock to biodiesel uses more methanol, thus increasing the

Figure 2. Trapzilla ™ by Thermaco, Inc.—a super capacity grease interceptor

* A relatively new method of biodiesel production, using enzymes to drive the catalysis process, is ideally suited for FOG conversion. Traditional manufacturing methods use a sulfuric acid catalyst pretreatment to remove the FFAs. This is a costly and wasteful step. An alternative method first utilizes high-efficiency grease interceptors, referenced in the text box above, to minimize grease hydrolysis and couples this with a biodiesel manufacturing process that uses enzymes for catalysis. The enzyme catalysis does not yield as much waste and operates at lower process temperatures than acid pretreatment. The result is a simpler, more efficient, and lower cost process that minimizes waste byproducts and maximizes biodiesel output.

production cost. The advantages can be increased by removing excess water through gravity water settling. Removing the water reduces hauling costs and improves biodiesel production efficiency. The key takeaway is that utilizing grease trap technology that minimizes hydrolysis and water content produces a feedstock ideal for accomplishing the trans-esterification process used to convert FOG to biodiesel.

A rough estimate of the price of a locally rotomolded super capacity grease interceptor is between $500 and $600 (25,000 to 30,000 INR) in India. Larger restaurants or institutional kitchens would utilize two or more units in parallel.

FOG Collection

Restaurant grease is collected using a combination of vacuum trucks and smaller pump vehicles or carts. Traditional “trap grease” contains 95% water, 3% grease, and 2% solids. The use of super capacity grease interceptors as measured in this analysis produced an output that is approximately 75% grease. This dramatically increases the efficiency of collection programs and minimizes the number of collection vehicles required to service a given number of restaurants. For busier restaurants or those in remote areas, on-site storage containers can be provided to further improve the efficiency of the program. These containers, like the grease traps, may also be manufactured by a local plastics company through the rotomolding process.

Figure 3. Molsta Motorcycle grease pumper

The Molsta Motorcycle-driven vacuum pump cart, (***Figure 3***) is an innovative Indonesian product. The grease from individual restaurants is suctioned and delivered to the centralized biodiesel manufacturing facility or to on-site storage containers (***Figure 4***) that can be placed at strategic locations throughout the city. For larger cities, vacuum tanker trucks may be employed to empty the on-site storage containers. This setup may be ideal for pumping grease interceptors in crowded Indian cities with narrow streets.

Figure 4. Rotomolded plastic grease storage container with locking top—ideal to locate strategically throughout the service area

Grease transportation programs may be very similar to septage collection programs. A manifest or record of every transaction is maintained. Similarly, fees for collection are also established and codified. The difference is that with grease programs, the value of the biodiesel returns a significant portion of the fees to the customer, acting as an additional incentive to operate grease traps properly.

Grease collection is an activity that lends itself to microenterprise opportunities. Thermaco is developing non-proprietary equipment to enable small business opportunities in grease collection. For approximately $300 (15,000 INR), sole proprietors can purchase a bicycle-powered grease pumping unit and have their own grease collection business. The heart of the system is a 55 gallon drum with a small gasoline-powered motor (Fig. 5.). The motor creates a vacuum that pumps the grease from the trap into the drum. So equipped, a sole proprietor could service 50 to 100 restaurants.

Fig. 5. FOG siphoning unit. Drum can be mounted on a tricycle. An operator could service 50 to 100 restaurants.

The goal of these microenterprises is to have neighborhood grease collectors who service the restaurants and place the collected grease in strategically located storage containers. The grease collectors are recognized officially by the city mayor and protected through the ordinance. Those who steal grease face a big fine. The program envisions hundreds of neighborhood grease entrepreneurs that serve as the heart of the collection system. Micro finance and business training can be made available to enable this business sector.

Biodiesel Manufacturing

To calibrate the study for use in India, the project team applied the feedstock analysis to an enzymatic biodiesel production model and determined that if the program collects 100 liters of high capacity grease feedstock, and 25% is water (a conservative estimate), this will provide 75 liters of <2% FFA material for biodiesel production. Assuming a 90% production yield from the trans-esterification process from 75 liters, these 100 liters of feedstock will yield 67.5 liters of biodiesel. While there is some variability in the quality of grease from place to place, the production value of Trapzilla grease in India should be very similar to that in the United States. A local feedstock analysis should be performed to verify and adjust the model for each location where the program is being considered.

Finding a good private-sector, in-country partner with expertise in biodiesel manufacturing is key. The program envisions that the local government or utility would contract out production services. In some cities, collected FOG could be mixed with other feedstocks and processed in existing facilities. In other cities, establishing new production facilities for FOG-based biodiesel will be required. Determining whether a new biodiesel manufacturing plant will be required, or if capacity is available at existing plants, can majorly impact a program's finances. As a general rule of thumb, biodiesel manufacturing plants can be established for $0.25 to $0.35 (12–17 INR) per liter of biodiesel production on an annualized basis. To help calculate the pro forma for target cities, the project team developed an interactive costing tool. One important input is the cost of biodiesel manufacturing. Obtaining cost estimates for production from established biodiesel manufacturers could help to more closely estimate production costs.

There are a number of biodiesel manufacturing facilities in India, some with the capacity to produce product from low quality FOG feedstocks. The first waste-to-biofuel manufacturing facility was recently inaugurated in Delhi Secretariat by Delhi's chief minister, Sheila Dikshit.

While this is a small plant (a half ton of waste capacity per day), it is indicative of an increasing ability to establish waste-to-energy facilities using local private-sector partners.

Management Software

Integrated software packages that help utilities or local governments track, monitor, and schedule grease collection could be especially useful for large Indian cities. The software can help track and schedule pumping events, send compliance notices, integrate billing, and perform other functions. Computerized management systems will likely have some role for larger programs, where the vast number of participating restaurants would make manual tracking impractical.

Promotion:

Sanitation improvement programs will not succeed if they are not promoted effectively. Promotion campaigns educate people about the programs, explain how they work, and provide a rationale for why someone would want to participate. These campaigns should be evidence-based, with the evidence coming from surveys of the user's knowledge, attitudes, and practices related to a specific activity (managing grease). Additionally, focus group discussions and interviews with key informants are tools that can augment evidence-gathering exercises. The main output of the evidence gathering is an understanding of the key motivators, or what people would hope to gain by participating in the program. The motivators are in turn realized through the key promises that will be delivered upon by participation in the program.

Promotion campaigns are developed through a bottom-up planning process, with stakeholders involved at each step of the activity. The campaigns begin with a stakeholder meeting designed to achieve a consensus that the activity is warranted. A Technical Working Group, a subset of the stakeholders, is empowered to take the project forward. Eventually, promotion campaigns are designed to deliver the messages of the key promises through targeted media outlets. When conducted effectively, promotion campaigns drive compliance and help to increase the willingness to pay for services.

There are a number of resources for developing effective promotion campaigns, including the following:

- The Water and Sanitation Program Sanitation Marketing Toolkit: http://www.wsp.org/wsp/toolkit/what-is-sanitation-marketing. This is a comprehensive website that features the SaniFOAM tool for analyzing sanitation behaviors as a basis for promotion campaigns.
- The 10-Step Promotion Program Toolkit: http://10step-toolkit.org/. A product of the E CO-Asia program funded by the United States Agency for International Development, this is a very comprehensive self-guided, step-by-step approach to developing effective promotion campaigns.
- The World Health Organization provides programming guidance on sanitation promotion: http://www.who.int/water_sanitation_health/hygiene/sanhygpromo.pdf.

- International Development Enterprises has developed several excellent programs for market-based approaches to sanitation marketing: http://www.ide-cambodia.org/index.php?option=com_content&view=article&id=57&Itemid=2&lang=en.

Enabling Environment:

The enabling environment is established by the local government and may include local ordinances that provide the policies and procedures that define and regulate the program. One important policy in the local ordinance is the establishment of a tariff structure, where tariffs are paid by commercial kitchens that exceed a set threshold size. FOG programs are services provided by the local utility and, like other utility services, are performed for a fee. Often tariffs for the FOG management program can be attached to utility bills for water and sewerage to facilitate program fund billing and collection. The enabling environment provides provisions for reducing tariffs through economic incentives. Where there are no water utilities, tariffs may be collected as an add on fee to property taxes, as a special environment fee, or during annual business license renewal.

Economic incentives that drive participation in the program can include positive incentives that pay generators based on the volume and quality of grease collected. To further incentivize the program, the pumper drivers may be equipped with grease test kits and can issue cash payments to the restaurants based on the volume and quality of the grease collected.

Additional incentives may provide participating restaurants with free grease interceptors, purchased and delivered through program funding, in exchange for restaurant owners agreeing to install the grease interceptors and follow the best practices for operation. Restaurants that do not participate at the beginning of the program will need to purchase and install their own grease interceptors or face fines levied by the local government.

The enabling environment may also include institutional arrangements that specify how different agencies within the local government and various private-sector players will interact. The arrangements may specify how local government fleets can use biodiesel as a substitute for purchased fuel. Establishing internal markets for the produced fuel eliminates the need to establish markets for biofuel sales and makes the entire program more efficient.

Implementation

To adapt the general program described above to the local contexts, officials need to undertake two key steps. The feedstock analysis assesses the technical feasibility of a FOG program and quantifies the volume and quality of the FOG that may be collected through this program. The financial analysis assesses economic viability of the program.

Feedstock Analysis:

The first step in the process of developing a local government-directed FOG management program is to perform a feedstock analysis. A feedstock analysis is a rapid assessment for municipal FOG programs that estimates the volume and quality of yellow and brown grease that may be collected as a result of the program. It quantifies the likely number of participants in the program and categorizes them as small, medium, and large generators. Local government planning offices can review business permits as a starting point, or they may choose to canvas neighborhoods and count actual establishments.

The volume of grease generated by a food service establishment is a function of the amount of cooking oil consumed, the number of meals served, internal policies for changing grease, and the menu. Estimates can be compared to actual monitoring of grease volume collected over a sample period where existing grease traps are closely monitored.

Once the volume and quality of brown grease is assessed, the volume of biodiesel that can be produced from the feedstock can be determined.

Financial Analysis:

The finances of an integrated local government-run FOG management program are complex. The costs include manufacturing and distributing the grease interceptors and storage tanks; the cost of the collection vehicles and the biodiesel plant; plus the costs to operate, incentivize, and manage the program. The income results from the value of the biodiesel produced plus a tariff that is set by the local ordinance.

The financial model produced for this program indicates that for a city with 1,000 participating medium-sized commercial kitchens, full cost recovery is achieved after 6 years. Following years generate income of $400,000 (196 Lakhs [19.6 million INR]). To be useful and representative, the model must be calibrated for the city in question by using the feedstock analysis and verifying local commodity prices. Once the feedstock analysis is complete, information related to the biodiesel value and cost of production can be computed. The costs of the grease interceptors and storage containers can be obtained through discussions with local partners and manufacturers. The entire program, including the debt service and the cost of the incentives, is funded by the value of the biofuel produced plus tariff.

To assist local governments to establish FOG management programs, an interactive toolkit has been produced by the project team, using standard values for biodiesel production and estimated costs and production outputs from experience in the United States. The toolkit is based in Microsoft Excel and identifies the fields that require inputs from the feedstock analysis and costs of commodities. The toolkit also helps to compute the cost of borrowing the funds by allowing the user to vary the principal amount, repayment terms, and interest rate. While not yet calibrated for cities in India, it provides a starting point where the specific costs and benefits of the program may be considered.

The toolkit helps the project proponent (local government or utility) develop a pro forma to identify the costs and benefits of the program. The variables in the toolkit include the following:

- Anticipated volume of raw feedstocks

- Cost of the collection program
- Cost of commodities, including the grease interceptors, and the market value of the finished biodiesel
- Cost to install, operate, and maintain the biodiesel manufacturing facilities
- Anticipated income from fees, fines, and tariffs
- Cost of the incentive program
- Cost of debt service and principle payment

Through the input of local knowledge and research, the toolkit can be customized and calibrated to provide project-specific and reliable outputs from which to base program initiatives.

There is a third step that local governments must take in addition to performing the feedstock and financial analyses—an assessment of their own capacity for undertaking complex economic development and environmental projects. This includes evaluating the experience of local government with similar programs and identifying the availability of local partners with biodiesel or similar industrial capacity.

Discussion

As in other programs initiated by local governments, to a great extent the degree of success is a direct function of the degree of interest and the level of demand expressed by the elected officials. While private-sector partners may eventually play major roles, the initial steps are driven by local government proponents.

The main challenges in implementing complex environmental programs are in the planning processes and in accurately determining the cost variables as referenced above. Experience in India seems to suggest an integration between the top-down and bottom-up planning processes leads to the best results, as detailed by Roy and Ganguly in their study, *Integration of Top down & Bottom up Approach in Urban and Regional Planning*, presented at the National Town and Country Planners Congress, 2009, Goa, India. Such programs utilize top-down planning for the proactive strategy in the plan formulation stage, and heavy stakeholder involvement to solidify local support for the project in the initial study and information-gathering stages. For the case of FOG management programs, the local government officials might undertake the feedstock and financial analysis components through top-down planning. Then they might involve the stakeholders, including the restaurant owners and operators and biodiesel producers and collectors, for discussions related to the program design, local ordinances, incentives and institutional arrangements.

Experience suggests that such programs require the engagement of multi-skilled third-party experts to guide the process for the best results. This service might be provided by a local nongovernmental organization with experience in developing similar economic development or environmental programs at the local government level, or through contracts with national Indian organizations. Such a third party could involve key technical experts as needed to provide assurance to local officials and stakeholders that the major components of the program are properly addressed.

Conclusion

Local government-directed FOG management programs can reduce wastewater utilities' operating costs while helping local governments meet energy self-sufficiency goals. The programs merge economic and business development and job creation with environmental protection and utility strengthening. Experience in other countries has been built into a toolkit to assess financial feasibility of model programs. Preliminary analysis indicates that the program is viable for Indian cities. Once the concept is proven, the outputs may be packaged for wide-scale replication throughout India and elsewhere in the region. Such packaging would include the following elements:

- Pro forma toolkit with instructions and example from a model community
- Stakeholder involvement guide and model information-gathering and promotion campaign
- Example of a local ordinance for FOG management
- Operations and procedures for FOG collection
- Details of a biodiesel manufacturing facility

The program proponents are currently engaged in initial discussions with donors and municipal officials in New Delhi and Bangalore to determine the level of interest for such a project. Should the interest exist, initial proof of concept activities are expected to begin in early 2012.

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