Frying Up Energy Independence: The Feasibiliy of Fats, Oils & Grease (FOG)-Derived Biofuel Production

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As part of a grant from the Massachusetts Technology Collaborative, the Upper Blackstone Water Pollution Abatement District and the city of New Bedford evaluated the feasibility of siting a fats, oils, and grease (FOG)-to-biofuel refining facility at their respective 45-million-gallon-per-day (MGD) and 25-MGD wastewater treatment facilities.

As with most wastewater collection and treatment facilities, FOG has been an ongoing frustration to the Water Pollution Abatement District and New Bedford. FOG can restrict—and in some cases entirely block—a sewer line and result in sanitary system overflows, which can be a public health and/or an environmental hazard. The cost to maintain and clean the collection system to avoid these situations is substantial. In addition, once the FOG arrives at the wastewater treatment facility, it becomes a nuisance that can clog process pipes, foul instruments and equipment, and be difficult to manage and dispose of.

As energy costs continue to rise, FOG-derived biofuel has the potential to offset current natural gas and diesel consumption at the Water Pollution Abatement District's and New Bedford's treatment facilities. By redefining FOG as a commodity rather than a waste product, the volume of FOG in the sewers and WWTFs should decrease as restaurant owners and other generators of FOG facilitate the collection and processing of FOG into a renewable biofuel.

Methodology

The scope of the feasibility study includes an evaluation of existing technologies available for the conversion of FOG to a biofuels; the evaluation of siting such a facility at the two wastewater treatment facilities; and the potential for use of the product at each treatment facility, as well as other uses within the facility service area.

Technical feasibility considerations include the process type, the process requirements (feedstock, fuel, water, chemicals, etc.) and the wastestream quantity and quality. Siting considerations include the space and access needs for the FOG receiving, processing, and storage facility and potential environmental impacts such as noise, odors, and air emissions. A preliminary financial feasibility analysis considers capital, O&M costs, and other indirect benefits achieved from operating such a facility. FOG resources and the use potential of biofuels are also examined for each community.

Technical Feasibility

Fourteen companies specializing in refining FOG to biofuel were identified and investigated. The following three FOG-to-biofuel refining companies were selected for further review:

- Viridia Energy
- BlackGold Biofuels
- Changing World Technologies

Viridia Energy

Viridia Energy Inc. (VEI) is a third-party company specializing in converting trap grease into a renewable fuel oil. The company's liquid waste separation technology has been in service for two and a half years in Mississippi, separating trap grease real-time into three streams: water, oil, and solids. The system uses no chemicals and is considered suitable for incinerators, boilers, and other stationary applications with air pollution control devices.

Figure 1 shows a process flow schematic of the VEI liquid waste separation technology. Influent trap grease enters a centrifuge separation unit and is separated into three streams: oil, water and solids.

The VEI system is scalable, but the minimum amount of influent feed is approximately 50,000 gallons of trap grease per day, including water. VEI's liquid waste separation unit accepts trap grease directly from trucks and can unload a 3,500-gallon truck in approximately 20 minutes.

The total area needed for a 0.9-million-gallon-per-year (MGY) VEI liquid waste separation facility is one acre. The 0.9-MGY liquid waste separation unit costs approximately $1.5 million and is expected to generate $1 million per year in revenue.

BlackGold Biofuels

BlackGold Biofuels, founded in 2004, focuses on converting low-quality, low-value FOG to high-quality biodiesel. The company's proprietary process transforms highly variable trap grease to ASTM-grade biodiesel through a dewatering, chemical processing, and a multi-step fuel polishing process that is patent-pending.

Figure 2 shows the BlackGold Biofuels

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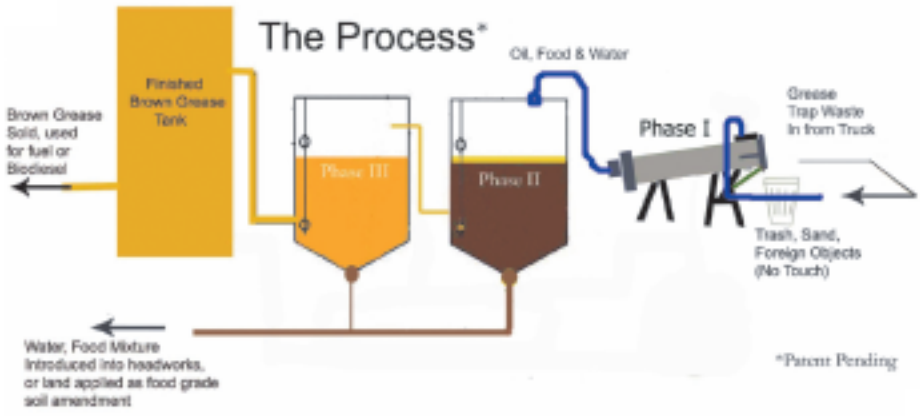

Figure 1: Viridia Process Flow Schematic

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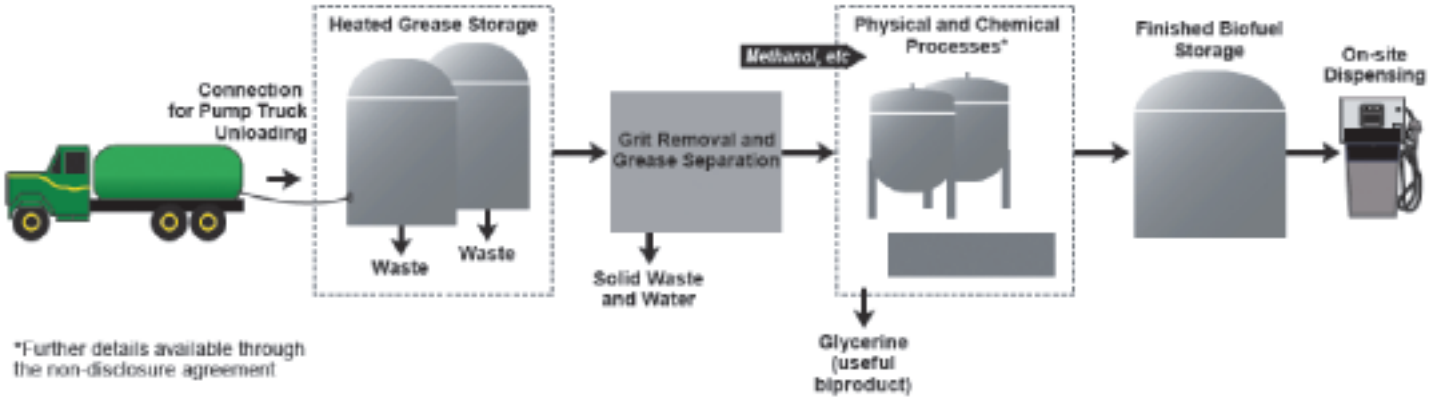

Figure 2: BlackGold Biofuels Fry-O-Diesel Process Flow Schematic

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process flow schematic. Certain steps in the refining process are proprietary and can be shared only through a non-disclosure agreement.

The technology is designed to manage trap grease's high level of chemical variability (including variable free fatty acids content) and can accept crude trap grease or a variety of low-quality FOG materials. The process can handle virgin vegetable oils, yellow greases, animal fats, and brown greases – individually or combined in any ratio.

Regardless of the FOG input quality, BlackGold Biofuels' process produces two streams of valuable fuel. The first is biodiesel that exceeds the specifications of ASTM D-6751. Figure 3 shows a sample of dewatered trap grease, filtered trap grease, and the biodiesel produced from the process.

Biodiesel yields are approximately 95 percent of incoming dewatered, degritted grease and qualify as ultra low sulfur diesel that can be utilized in on-road vehicles of all duty cycles, as well as off-road applications like residential heating. The second fuel is a lower-grade biofuel, suitable for industrial burner applications and incinerators or process heat generation. Typically, the volume of low-grade biofuel produced by the process is enough to fuel the biodiesel facility.

The footprint of the BlackGold Biofuels facility is approximately 0.8 acres and includes space for tanks, processing equipment, and storage. The capital cost of a 1-MGY biodiesel plant is approximately $2 million.

Changing World Technologies

Changing World Technologies Inc. (CWT) is a third party FOG-to-biofuel company that uses technology called the Thermal Conversion Process (TCP) to convert agricultural, industrial, municipal, and food processing waste, including FOG, into renewable diesel fuel oil. TCP is a patented, continuous flow-through process in a controlled environment using water, high temperatures, high pressures, and short residence times to convert waste to renewable diesel fuel oil. Figure 4 shows the process flow schematic of the TCP process.

CWT has over 10 years experience in developing applications for fats and greases. In 1997, the company started a full-scale commercial operation facility in Carthage, Missouri, dedicated to processing agricultural wastes (fats). The facility processes approximately 250 tons per day of animal byproducts from a Butterball turkey processing facility: dead animals, fats, greases and DAF sludge. TCP can accept and process yellow grease, trap grease, and wastewater treatment facility scum simultaneously.

The fuel produced by TCP is a high-quality, renewable diesel fuel oil with properties and a shelf life similar to an ASTM D-396 petroleum No. 2 fuel oil. Boilers already configured to burn fuel oils can burn the renewable fuel oil produced by TCP by replacing select components of the fuel delivery system (e.g. pumps, meters, and nozzles). Natural gas-fired boilers require more extensive modifications and additions, such as the installation of fuel storage tanks and liquid fuel delivery systems.

The total facility footprint is estimated at 1.7 acres, including setbacks and room for expansion. Capital and start-up costs would be approximately $23 million for a facility that would produce approximately 6.5 million gallons of fuel per year with an average cash flow of $9 million for the plant in the first three years of operation. The equipment costs will be about $20 million with start-up expense including working capital of about $3 million. O&M costs are estimated to be approximately $4 million a year.

Site Feasibility

All three technologies are applicable for the Upper Blackstone Water Pollution Abatement District multiple hearth furnace (MHF) and New Bedford's boilers. Equipment modifications may need to be made in order to use the Changing World Technologies and the Viridia

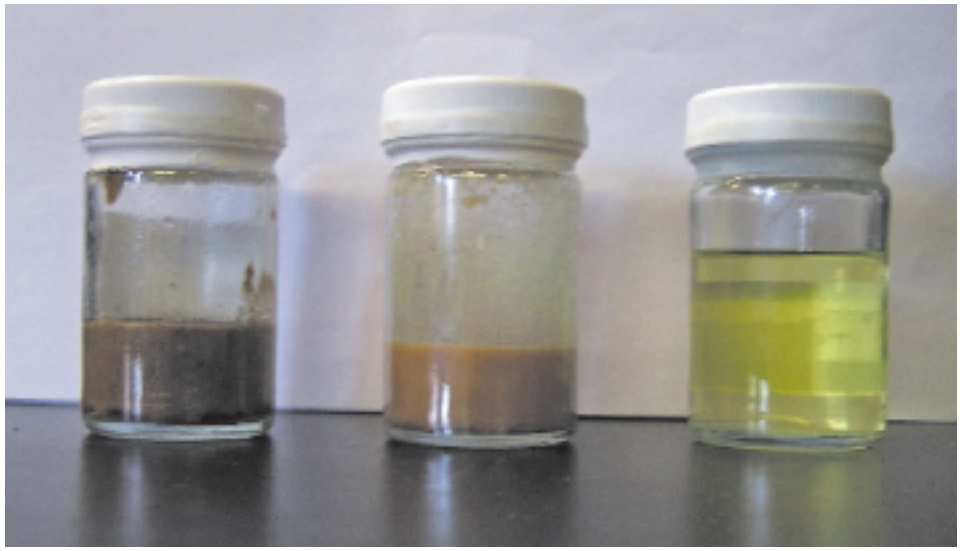

Figure 3: BlackGold Biofuels Process Samples

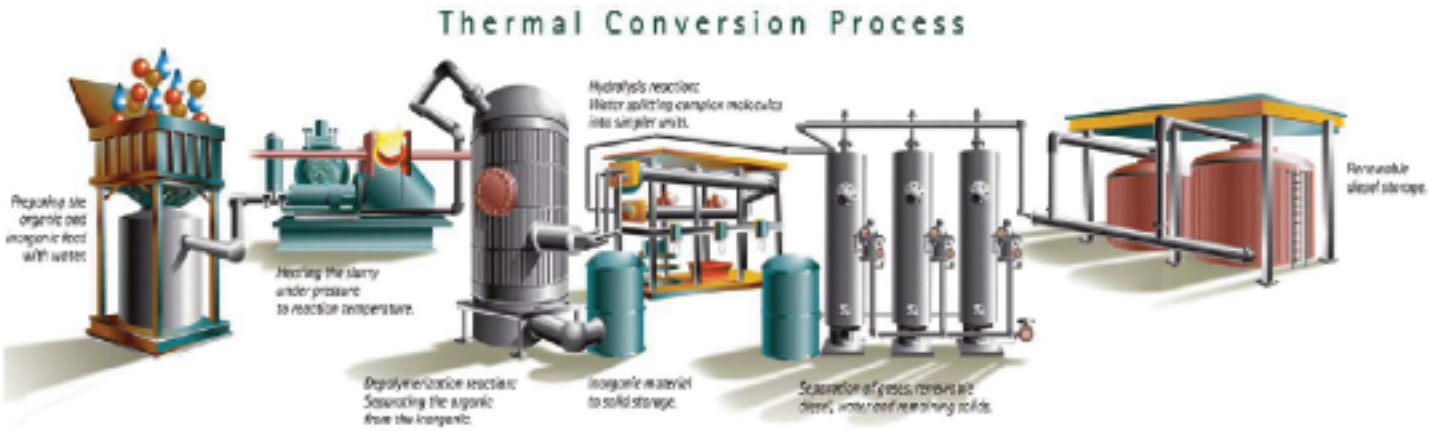

Figure 4: Thermal Conversion Process Flow Schematic

Energy biofuels in the MHF and boilers.

Of the technologies, Changing World Technologies requires the largest site because of its scale of operations; however, Changing World Technologies contributes the least biochemical oxygen demand load to the wastewater treatment facility because of the pretreatment process its sidestreams undergo before disposal.

Changing World Technologies uses more energy for trap grease processing than Viridia Energy or BlackGold Biofuels. BlackGold Biofuels is the only technology capable of producing a biodiesel suitable for the city of Worcester and the city of New Bedford vehicle fleet.

Financial Feasibility

Third-party ownership and operation of a FOG refining facility would allow the Upper Blackstone Water Pollution Abatement District and the city of New Bedford an opportunity to produce a sustainable biofuel without the risks associated with new technologies. The third party would finance the design and construction of the FOG facility, as well as operate and maintain the facility. The district and the city would benefit from the decrease of FOG in their collection and treatment systems and reduced energy costs.

The third party would benefit from the sidestream disposal provided by the wastewater treatment facilities, as well as the land. Changing World Technologies and Viridia Energy are interested in owning and operating a FOG refining facility in the district and also in the city. BlackGold Biofuels, in coordination with a third-party financer, is also interested in constructing a biodiesel plant at each municipality's site.

Results

The development of a FOG refining facility at the Upper Blackstone Water Pollution District and the city of New Bedford is recommended. A unique set of circumstances make the project a worthwhile opportunity for the district and the city to demonstrate their commitment to renewable energy:

- Grease trap separation and refining has proven to be successful at the pilot and full scale.
- The Upper Blackstone Water Pollution Abatement District location and the New Bedford site are convenient for truck deliveries of trap grease, disposal of wastewater, and the use of biofuel.
- The simple payback periods are within range considered economically viable for a private investment; the project represents good public policy and is a worthwhile use of public funds.
- Third-party vendors are interested in financing the design and construction of a FOG refining facility, as well as owning and operating the facility. These third parties are also interested in developing a private-public partnership with the district and the city in which profits from the FOG refining facility would be shared.
- Trap grease is currently an operations and maintenance (O&M) nuisance in the district and the city. Collecting FOG for refining would reduce O&M costs and problems associated with FOG in sewers and at the wastewater treatment facilities.
- The timing is right at the district and the city, considering that new grease trap regulations and enforcement have been initialized, promoting the regular collection of trap grease from FOG-producing restaurants and other institutions.
- Trap grease haulers are in need of disposal locations and are interested in bringing trap grease to the proposed FOG refining facilities.
- The Commonwealth of Massachusetts is actively pursuing the development of biofuel refining and promoting the use of biofuel through the governor's Advanced Biofuels Task Force. The task force supports the FOG refining companies evaluated in this report and encourages the district and the city to develop FOG refining facilities.

Discussion

In order to proceed with the design and construction of a FOG refining facility at the Upper Blackstone Water Pollution Abatement District and the city of New Bedford, resolutions must be made regarding the site, technology, financing, ownership, and operation. Further evaluations must be completed regarding construction and O&M costs, permitting requirements, feedstock availability, modification of existing equipment to accept biofuels, and the availability of federal and state incentives.

It is recommended that a Request for Proposal (RFP) be sent to prospective FOG refining companies in order to obtain detailed cost estimates for each of the technologies evaluated in this report. The size of the facility, as well as the quality of biofuel product, should be clearly defined in the RFP response.

Preliminary permitting requirements have been identified, but further permitting investigations should be completed once a site is chosen. All potential permits should be identified during design and applied for during and after design. Permit approvals should be acquired before construction begins.

The district and the city should include a provision in the RFP requiring third parties to identify all potential sources of feedstock for their proposed FOG refining facility. If the district or the city does not coordinate with a third party for financing, owning, and operating the facility, an extensive survey of trap grease haulers should be completed to determine feedstock availability.

In order to determine all of the modifica-

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tions required for existing equipment at the district and the city to receive biofuels and in order to obtain detailed estimates of the associated costs of these modification, information on the existing equipment should be included in the RFP and a provision should require the FOG refining companies to detail the modifications and associated cost estimates.

The Commonwealth of Massachusetts and the federal government offer incentives to produce alternative fuels. In most cases, private entities are better positioned to take advantage of those incentives. Many incentives are linked with tax rebates and benefits, for which a tax-exempt municipality is not eligible.

Incentive packages such as Clean Renewable Energy Bonds, Federal Economic Stimulus Funds, and MTC LORI Design and Construction Grants, should be explored in order to better understand the economics of the third-party business partners. The timing of these incentives and their expiration dates also should be considered and coordinated with the scheduling of this project.

Conclusions

The Upper Blackstone Water Pollution Abatement District and the city of New Bedford should proceed with the development of a FOG refining facility by following these steps:

- Select a site for the FOG refining facility.
- Develop and issue a request for proposal (RFP) for complete design/build/operate services for a FOG refining facility.
- Explore federal and state incentives.
- Select a FOG refining company based on RFP responses.
- Complete a site assessment to determine permitting requirements.
- Develop and issue a contract for the design, construction, and operation of the FOG refining facility.

A very important step is the development of the RFP. Because the companies and technologies identified vary significantly in their scale of production, the type of biofuel produced, and their business model, the RFP will not only satisfy Massachusetts bidding requirements, but allow the district and the city to compare each technology on an equivalent basis.

The RFP should be based on performance specifications and should detail the intended outcomes of each FOG refining facility. At a minimum, the two facilities should be able to produce the volume and quality of fuel to satisfy the fuel requirements of the district and the city, with minimal disturbances to surrounding communities and to wastewater treatment operations.