Southern Oregon Biogas Plant Feasibility Study
Summary of Findings - April 2012

Introduction
Jackson Soil and Water Conservation District (JSWCD) in collaboration with Rogue Valley Council of Governments, City of Ashland, Energy Trust of Oregon, GEOS Institute, and Jackson County contracted with Good Company to conduct a Biogas Plant Feasibility Study for Jackson and Josephine counties. The information from this study will be used to assess the logistical and financial practicality of developing a biogas plant (or anaerobic digester) in the region and will be used by JSWCD and partners to inform citizens, city officials, individual companies and organizations to empower them to make decisions about implementing a biogas plant in the region.

Biogas plants (or anaerobic digesters) have many benefits. First and foremost they generate biogas from waste organic materials (e.g., food waste, manure, etc.). Biogas contains about 50% methane, which can be combusted for energy. The biogas may be used to generate electricity and heat, combusted in a boiler for heat only, or upgraded into a renewable biomethane (RNG) that can be used as vehicle fuel. Biogas is a biogenic energy source and therefore displaces fossil-fuel based energy, resulting in a net reduction of greenhouse gas emissions. Also, the generation of local energy increases local energy security and reduces the risks associated with volatility in future energy market prices.

In addition to energy, the anaerobic digestion process also produces revenue from a number of other significant commodities including: compost, environmental commodities, and disposal fees. Following anaerobic digestion, the remaining organic materials may be composted and sold as a soil nutrient. Environmental commodities include Renewable Energy Certificates (REC) from the generation of renewable electricity, Renewable Identification Numbers (RIN) from the production of low-carbon vehicle fuels, and carbon credits (or offsets) by reducing business-as-usual greenhouse gas emissions. The facility may also generate disposal fees (i.e., gate fees), which would be a large part of the revenue.

Feedstocks
There are a number of AD feedstocks (i.e., organic materials that produce biogas), technically available in southern Oregon, which include: pre- and post-consumer food waste, fats, oils, and greases (FOG), winery and brewery waste, and manure. See Figure ES-1 for a summary of the feedstocks available by county.

The largest single near-term opportunity identified by the study area is food processing waste from Harry and David, Tree Top, and Amy's Kitchen. Food processing waste produces relatively high biogas yields; is separated from the municipal solid waste stream and therefore has low levels of contaminants; is produced in large quantities; and is already being hauled and composted outside of the larger solid waste infrastructure. A second opportunity is brown grease FOG, which is currently treated and disposed of in the landfill. This material has relatively high biogas yields and is already being collected.

Other opportunities include capturing the organic fraction of the municipal solid waste stream, which in large part is post-consumer food waste. While there are significant quantities of this material there is no existing system to sort and collect it. Establishing this type of system will likely be done in phases, as implementing the infrastructure and educating the public will be time consuming and costly. However, a small-scale, pre-consumer food waste collection program for commercial businesses is operational in Ashland. Portland is beginning a pilot-scale study of 2,000 homes beginning in April and the communities of Seattle, San Francisco, and Dubuque, Iowa already have existing food waste collection programs.

Manure is a well-understood feedstock and is available in significant quantities in southern Oregon. A portion of the existing, operational AD facilities in the U.S. use manure as a feedstock and are typically located directly on the farm producing the manure. While there are a number of farms in the area with significant livestock and dairy operations, none were identified as being a strong potential site based on owner interviews and interest. Manure may also be co-digested with another feedstock such as the food waste. This configuration is likely to be economically feasible only if the digester is located at the point of manure production as transportation is costly and manure has relatively low-biogas yields.

Technologies

Numerous market-ready AD technologies and vendors currently exist for all of the feedstocks identified. Facility design will primarily depend on available feedstock composition and moisture content. AD systems are typically separated into wet and dry systems. Wet systems make up the vast majority of the systems in the U.S., which serve wastewater treatment plants and dairy and livestock operations. Dry AD systems are a new technology in the U.S., but are prevalent in Europe.

The highest quality feedstock in the area is food processor waste. This waste would likely be well suited to a dry batch anaerobic digester system operated at mesophilic temperatures, based on facilities in Europe and the U.S. This recommendation is based on preliminary information. Final design should be based on feedstock samples and analysis to determine the design parameters that are best suited to the feedstock as well as other local conditions.

Regulations and Best Practices

Development of an AD facility in southern Oregon is not expected to experience any regulatory barriers, but this type of facility will experience the same air, water, and waste handling requirements as any other energy or waste handling facility. The applicable regulations for a facility of this type are complex and compliance is expensive – particularly for a facility that isn't already permitted for solid waste handling. The specific regulations that are applicable to a facility will vary on a number of factors including: site location, facility design, the types of feedstocks utilized, and scale of the facility.

A triple bottom line (TBL) screening of AD technologies highlighted a few concerns all of which can be mitigated. One item to note is that anaerobic digestion reduces greenhouse gas emissions more effectively than landfills, by significantly reducing *fugitive* biogas emissions from landfills. Most of the fugitive emissions occur before a landfill cell is capped. Landfills emit 25% of the total biogas generated on average. Because biogas is ~50% methane, which is 21 times as powerful a greenhouse gas as carbon dioxide, fugitive loss of biogas results in a sizable carbon footprint. Anaerobic digesters are designed to maximize biogas collection efficiency. Once collected, the methane is combusted, thereby reducing the GHG impact.

Revenue Potential

AD provides a number of potential revenue streams including: energy products, environmental commodities (carbon credits, REC[1], RIN[2]), sale of compost, and disposal fees. Estimated revenues and associated capital and operational costs are summarized on Figures ES-2 and ES-3 for six different scenarios. The first five are focused on utilizing available food and yard waste in the study area beginning with the smallest-scale dry AD system on the market (5,000 tons per year) and ending with a system scaled to the total quantity of food and yard waste in the study area (~120,000 ton per year). In addition, total manure in the study area was modeled to show the scale of revenue associated with this feedstock material. With manure its important to note that there is not an economically viable way to aggregate the material, so the modeling is only a sense-of-scale exercise, not a potential biogas option.

The near-term AD opportunity in the study area is utilization of the fruit waste produced by local food processors in Jackson County. Unfortunately, the economic modeling completed for this study found that a small-scale (less than 10,000 tons per year) AD facility, with capacity to treat the food processor waste alone is unlikely to be economically viable due to high operational costs relative to throughput. However, *larger-scale facilities are economically viable*, but would require additional a commercial and residential food waste collection programs that do not currently exist.

Regardless of the size of the system, the most profitable energy pathway for the biogas is using it as a substitute for gasoline or diesel fuel in an exisitng high annual mileage, low fuel efficiency, local fleet - such as solid waste collection vehicles. This maximum value can be realized by an organization that owns both the biogas and the fleet. Excluding the cost of fleet conversion and capital equipment, the production cost per gallon equivalent is $0.67- $0.98. In addition to avoided fuel costs, this biogas utilization pathway also

---

[1] To help facilitate the sale of renewable electricity nationally, a system was established that separates renewable electricity generation into two parts: the electricity produced by a renewable generator and the renewable "attributes" of that generation. The commodity associated with the renewable attributes is Renewable Energy Certificates (REC).

[2] Like RECs, RINs are the "renewable" attributes of a renewable vehicle fuel. The U.S. Environmental Protection Agency (EPA) uses the Renewable Identification Number (RIN) as a unit for tracking compliance under the Renewable Fuel Standard program.

generates a valuable environmental commodity, compliance credits for the Federal Renewable Fuel Standard which currently average $0.75 per gallon equivalent. This yields a rough estimate production cost of RNG @ $0.25 per gallon equivalent. Considering that the price for gasoline and diesel in the past year has ranged from approximately $3.50 to $4.50, the value of avoiding the per gallon fuel cost is substantial and will likely rise in the future. Selling RNG on the open market does not result the same value as compressed natural gas (CNG) prices are very low.

While our economic modeling did not result in favorable results for a small-scale facility, it's important to keep in mind that the economic modeling is based on industry averages, not site-specific information. Collecting and analyizing site-specific information may very well change the results of the economic modeling. For example, capital and O&M costs may be significantly less for a facility with existing waste handling, composting, or energy generation infrastructure.

Potential Sites for Development

Based on the available feedstocks in the area and site-specific criteria, three potential sites were identified for development of a biogas plant. They include the following:

- **Dry Creek Landfill** is the only operating landfill in southern Oregon and receives MSW from multiple counties in southern Oregon and northern California. As such they are the point of final aggregation for a large quantity of organic waste. Dry Creek is owned and operated by Rogue Disposal & Recycling, Inc., who also provides waste hauling service to Jackson County with an owned fleet of vehicles. The landfill is capped and collects biogas (albeit at 75% of AD collection efficiency) with which it generates electricity. At present DCL collects excess biogas in excess of its electric generation capacity. DCL in conjunction with Jackson County are currently evaluating the feasibility of upgrading excess biogas into renewable natural gas (RNG) to fuel locally owned fleets of vehicles.

- **Green Planet Organics** operates a composting operation on Harry and David's owned land and compost permit. This site receives a large annual quantity of fruit processing waste, from Harry and David and Tree Top, which is mixed with stable waste (mixed manure and straw). This site offers the most immediate potential for development of the three sites listed here because it is the existing aggregation site of the most valuable feedstock and it is already a successful compost business. Other separate, but related sites could be developed as well. For example at existing Tree Top or Harry and David facilities, as they are the largest producers of the food processing waste.

- The **City of Medford's Regional Water Reclamation Facility** (RWRF) currently operates an AD, which is part of their wastewater treatment process. This system generates electricity and is currently installing additional CHP capacity. Currently the energy generated onsite serves internal load only and are not exporting electricity to the grid. Conversations with staff indicate mid-term interest incorporating FOG as a feedstock, but no plans to co-digest other materials such as food waste.

Risks to Development

- Roll-out of a commercial and residential food waste collection system will generate the feedstock quantities necessary to reach economies of scale that increase the revenue potential and lower the operating costs of an of an AD system. The cost of implementing a food waste collection system should be evaluated to evaluate the impact on ratepayer.
- Seasonality of feedstocks – The plant will need a consistent quantity and composition of feedstock. In most communities, the quantity, quality, and composition of the waste stream will vary with changing seasons. For example, fruit processing waste coincide with harvest season. To ensure a predictable schedule of inputs, the operator will need to secure feedstock contracts early in the development of any biogas plant development.
- Proximity to energy customers is required for sale of the heat products from a combined heat and power system (i.e. system that generates electricity and heat from biogas) and RNG fleet fuel.

Figure ES-1: Summary of technical feedstock availability by weight and organics category.

Organics Category	Jackson	Josephine	Klamath	Curry	Douglas	Northern California	Jackson + Josephine Sub-Total	+	Other Counties Sub-Total	=	Total (wet short tons)
Pre-Consumer Food Waste											
Food Processing	14,503						14,503		0		14,503
Supermarkets	2,387	846	576	363	1,260	3,218	3,233		5,417		8,649
Wineries	73	36			62		109		62		171
Pre-Consumer Sub-Total:	16,963	882	576	363	1,322	3,218	17,845		5,478		23,323
Post-Consumer Food Waste											
Restaurants	8,489	2,687	2,616	888	3,612	7,073	11,175		14,189		25,364
Schools (k - 12)	467	179	158	50	301	474	645		982		1,628
Higher Education	228	8	63				236		63		299
Retirement Communities	193	112	44	50	100	132	305		326		631
Jails	52	48	34	9	52	703	100		798		898
All other food waste	14,964	5,306	6,206	1,909	8,953		20,270		17,069		37,338
Post-Consumer Subtotal:	24,392	8,339	9,121	2,906	13,018	8,382	32,731		33,427		66,158
Food Waste Subtotal (pre + post):	41,355	9,221	9,697	3,269	14,340	11,599	50,576		38,905		89,481
FOG Waste											
Yellow Grease	901	367	294	99	478	923	1,268		1,794		3,062
Brown Grease	1,358	553	444	150	720	1,391	1,911		2,704		4,616
FOG Subtotal:	2,260	920	738	249	1,197	2,314	3,179		4,499		7,678
Yard and Agriculture Waste											
Yard Waste (recovered)	17,498	6,514	5,795	0	1,997		24,011		7,792		31,804
Yard Waste (landfilled)	6,615	2,453	2,683	855	3,829		9,067		7,366		16,433
Manure	21,489	71,942	132,632				93,431		132,632		226,063
Animal Mortalities	11	24	40				35		40		75
Wheat Straw	396		8,481				396		8,481		8,877
Agriculture Sub-Total:	46,009	80,932	149,631	855	5,826	0	126,940		156,311		283,252
TOTAL (food + recovered yard):	58,853	15,735	15,492	3,269	16,337	11,599	74,588		46,697		121,285
TOTAL (food + FOG + ag):	65,231	82,733	150,945	1,466	8,345	5,532	147,965		166,288		314,253

Note: All values in wet short tons   = Data not available or category does not apply.

As can be seen in Figure ES-1, food-processing waste in Jackson County is a significant source of high-quality feedstock. Supermarkets, restaurants, and all other food waste (i.e. residential food waste) also generate significant quantities of food waste. Brown grease is a source-separated feedstock with high biogas yields that is currently underutilized in the community – currently landfilled after collection. Significant quantities of yard waste are already being collected in the community through existing programs for composting, which can be blended with food waste in AD to control moisture levels. There are significant quantities of manure in Josephine and Klamath counties. Unfortunately, a combination of high transportation cost and low biogas yields limit the opportunities for central aggregation. Manure AD is best suited to an onsite facility at a large dairy or livestock operation.

Figure ES-2: Summary of estimated tonnage, capital cost, annual O&M costs, and biogas production, by scenario.

Scenarios	Annual Feedstock	Estimated Capital Cost	Estimated Annual O&M	Biogas Production	Biogas Energy	Annual Energy Equivalents	
	short tons / year	$	$ / year	ft^3 / year	MMBTU / year	# of households (annual electricity use)	Gallons of Gasoline
1. Small Dry-AD System[1]	5,000	$1.6 - $1.8 million	$400,000	15,000,000	7,500	160	63,024
2. Dry AD System[1]	10,000	$3 - $4 million	$800,000	30,000,000	15,000	319	126,048
3. Jackson + Josephine Counties[2]	75,000	$22 - $30 million	$2,250,000	225,000,000	112,500	2,396	945,362
4. Other Counties in Study Area[2]	50,000	$15 - $20 million	$1,500,000	150,000,000	75,000	1,597	630,241
5. Total Study Area (all counties)[2]	125,000	$37 - $50 million	$2,500,000	375,000,000	187,500	3,993	1,575,604
6. Total Manure in Study Area[3]	225,000	N / A	N / A	495,000,000	247,500	5,270	1,972,221

[1]Feedstock = Food Processor + Stable Waste + Yard Waste
[2]Feedstock = Total Food Waste + Recovered Yard Waste
[3]Feedstock = Manure Only.

Note: Assumes average household consumes 12,773 kWh per year. Includes heat and electricity output from CHP.

Note: Assumes 580 BTU / cubic feet of biogas and 124,238 BTU / gallon of gasoline.

Figure ES-3: Summary estimated revenue by source, by likely groupings for each energy pathway, by scenario.

Scenarios	Revenue Sources								Estimated Annual Revenue		
	Heat	CHP (electric + heat)	RNG	Compost	REC	RIN	Carbon Credit (Offsets)	Tip Fee	Heat + (Compost + Offset + Tip)	CHP + (Compost + Offset + REC + Tip)	RNG + (Compost + RIN + Offset + Tip)
1. Small Dry-AD System[1]	$65,250	$97,085	$197,019	$50,000	$10,709	$39,811	$0	$125,000	$240,250	$282,794	N / A
2. Dry AD System[1]	$130,500	$194,169	$394,038	$100,000	$21,419	$79,622	$0	$250,000	$480,500	$565,588	$823,660
3. Jackson + Josephine Counties[2]	$978,750	$1,456,271	$2,955,283	$750,000	$160,639	$597,165	$275,000	$1,875,000	$3,603,750	$4,516,910	$6,452,448
4. Other Counties in Study Area[2]	$652,500	$970,847	$1,970,189	$500,000	$107,093	$398,110	$176,000	$1,250,000	$2,402,500	$3,003,940	$4,294,298
5. Total Study Area (all counties)[2]	$1,631,250	$2,427,119	$4,925,472	$1,250,000	$267,732	$995,274	$423,500	$3,125,000	$6,006,250	$7,493,350	$10,719,246
6. Total Manure in Study Area[3]	$2,153,250	$3,203,797	$6,139,288	$506,250	$353,406	$1,245,809	$0	N/A	$2,659,500	$4,063,452	N / A

[1]Feedstock = Food Processor + Stable Waste + Yard Waste
[2]Feedstock = Total Food Waste + Recovered Yard Waste
[3]Feedstock = Manure Only.