# Technology Study: Project Update

the Energy to Lead

## Nationwide Survey of Biogas Cleanup Technologies and Costs

Wednesday May 28, 2014

Biogas Technology Advisory Committee Meeting

South Coast AQMD Project

Contract #: 13432


VRONAY ENGINEERING SERVICES

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# Project Team

- SCAQMD– Project Sponsor, Mr. Alfonso Baez, Program Supervisor
- Gas Technology Institute - Prime Contractor
- Vronay Engineering Services Corp

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# Introduction and Project Objectives

- Conduct a nationwide survey of landfill and digester gas ("biogas") cleanup technologies
- Determine Efficacy and costs for existing and emerging systems and technologies
- Develop a biogas cleanup system cost estimator toolkit as a Microsoft Excel computer based interactive document
- Provide a summary report which explains the challenges of the biogas clean-up, costs, efficacy, technical difficulties and defines as best as possible the current “best in class” technologies.

# Introduction and Project Objectives

Are Existing Gas Clean-up Technologies Reliable enough to ensure the removal of siloxanes and other harmful constituents in biogas to levels such that biogas fueled engines and turbines could be equipped with exhaust after-treatment systems, most especially Selective Catalytic Reduction (SCR)

# Projects Tasks

| Task # | Task | Duration | Due Date | Status |
|---|---|---|---|---|
| 1 | Gas Composition Analyses | 3 months | 9/14/2013 | Completed 9/30/2013 |
| 2 | Survey of Biogas Cleanup Systems Technologies | 3 months | 12/14/2013 | Completed 3/31/13 |
| 3 | Biogas Cleanup System Costs | 3 months | 3/14/2014 | Completed by 4/30/14. |
| 4 | Development of Biogas Cleanup System Cost Estimator Kit | 3 months | 6/14/2014 | Underway |
| 5 | Biogas Cleanup System Cost Estimator Toolkit and User Instruction Manuals | 3 months | 6/14/2014 | Inactive |
| 6 | Technical Support and Management | 24 months | 6/14/13-6/14/15 | Inactive |
| Draft final Report | | | 6/14/2014 | Inactive |
| Final Report | | | 6/14/2014 | Inactive |

# Survey

- Developed a survey and sent out to 20+ manufacturers of biogas clean-up equipment
- Compiled the results from respondents
- Met with as many of the manufacturers / suppliers as possible
- Attended The U.S. Environmental Protection Agency's Landfill Methane Outreach Program (LMOP) and met with vendors and users
- Visited Multiple Landfill and Biogas Sites and discussed user experiences with various technologies
- Visited one-site, with lean burn ICE's on landfill gas, with gas clean-up and and SCR catalyzed engine.

# Survey Form

| Biogas Treatment Survey | Siloxanes Removal System | Company Information |
|---|---|---|
| Company Name | | |
| Contact Name | | |
| Contact Title | | |
| Contact E-Mail | | |
| Contact Phone/fax | | |
| | | **Siloxane Treatment System General Information** |
| Product Name and Type | | |
| When was the product introduced? | | |
| Number of Installations - worldwide | | |
| Number of Installations - US | | |
| Number of Installations in AQMD districts (Southern California) | | |
| Number of installations on SCR or NSCR equipped reciprocating engines | | |
| Are the sites with SRC/NSCR available for visitation? | | |
| For California applications, what are methods to achieve future emission limits of SCAQMD Rule 1110.2 for ICE operating on biogas? | | |
| | | **Siloxane Treatment System Technical Information** |
| Type (Activated carbon, Regenerative, etc.) | | |
| System siloxanes removal efficiency (as %, mg/ml, ppm) | | |
| What other trace biogas components are simultaneously removed along with siloxanes and to what levels? | | |
| Electrical power or supplemental fuel requirement for regenerative systems. | | |
| Does the system require a flare? | | |
| Media life (for passive or regenerative systems). | | |
| Does the system have siloxanes break-through detection? If so what method? | | |
| Does your firm offer media change out, disposal and installation of fresh media? | | |
| What cleanup system waste disposal management strategy will be used? | | |

# Survey Form

| Siloxane Treatment System Specifications | | | |
|---|---|---|---|
| What information is needed for sizing and quoting a system? | | | |
| System Design Flow | 200 scfm | 500 scfm | 1000 scfm |
| Annualized- or SCFM-basis annualized O&M costs for the following systems: | | | |
| Installation costs for the following systems: | | | |
| Approx. size and footprint of the physical system | | | |
| Capacity limitations and scalability of the technology | | | |
| How is system removal efficiency affected for a given biogas composition as a function of flow rate? | | | |
| Any additional information you would like to include. | | | |

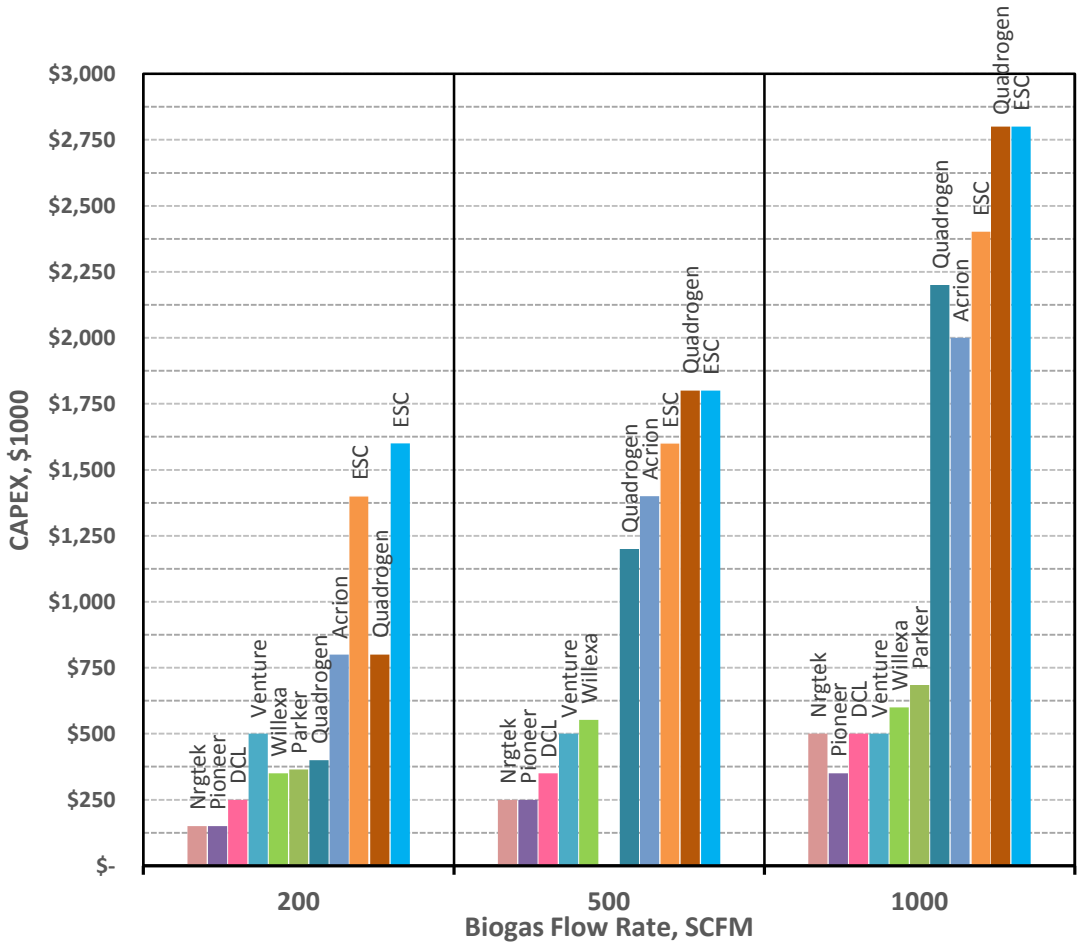
# Respondents

| | |
|---|---|
| 1 | Willexa Energy |
| 2 | DCL America |
| 3 | Parker NLI |
| 4 | Venture Engineering |
| 5 | CC Jensen |
| 6 | Quadrogen Power Systems, Inc. |
| 7 | 2G Cenergy Power Systems Technologies, Inc |
| 8 | Environmental Systems & Composites, Inc. (ESC) |
| 9 | Unison Solutions Inc |
| 10 | Pioneer Air Systems |
| 11 | Acrion Technologies |
| 12 | Guild Associates, Inc. |
| 13 | Theia Air |
| 14 | Nrgtek Inc. |
| 15 | Xebec, Inc. |

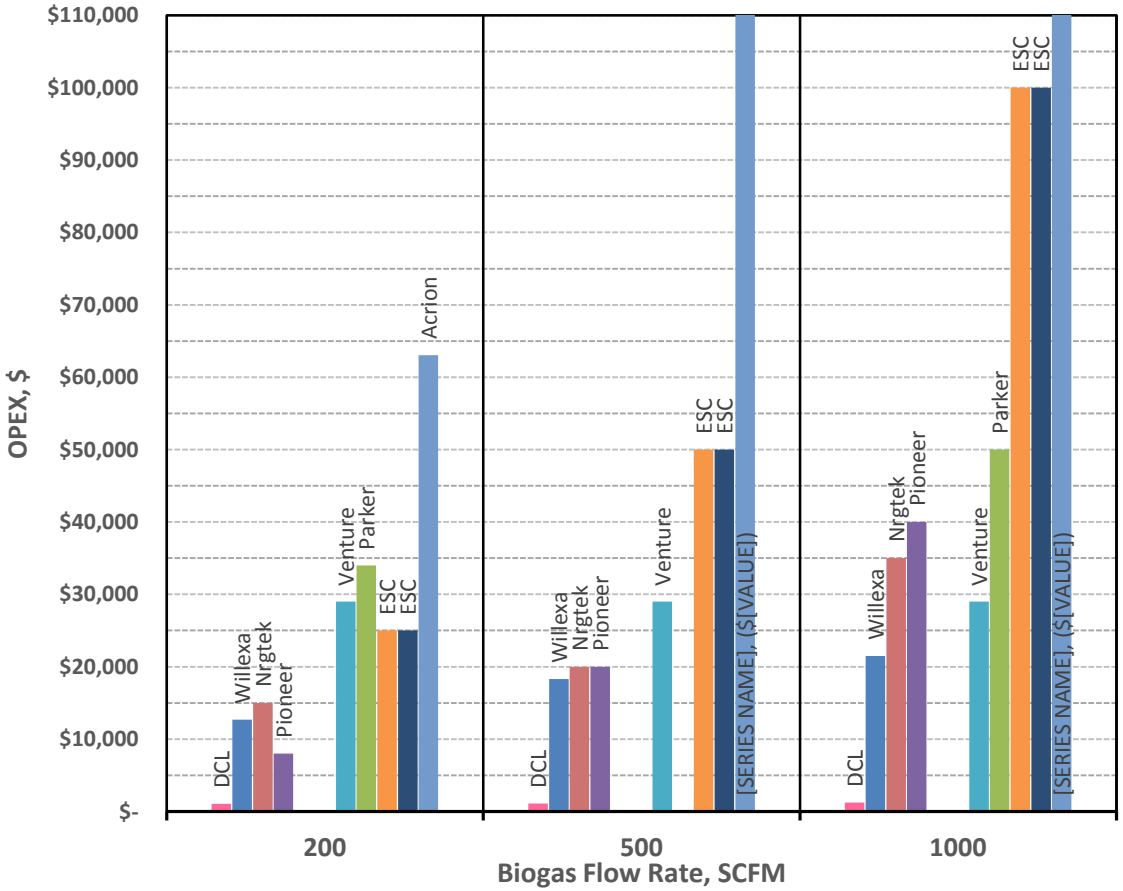
# Preliminary Results

- Regenerative / dual bank Canisters are the dominant Technology
- Temperature Swing Absorption
- Typically two banks of 2 to 8 canisters
- One Bank In Service and One in Regen Mode
- Media typically carbon or alumina-oxide
- Most have refrigerant drying upstream for moisture removal and extension of media life

# Preliminary Results



# Preliminary Results



# Preliminary Results

| Equipment Costs | Willexa | | DCL | | Pioneer | | ESC | | | | Quadrogen | | | | Acric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total, $ | $/SCFM | Total, $ | $/SCFM | Total, $ | $/SCFM | Total, $ (min.) | $/SCFM (max.) | Total, $ (max.) | $/SCFM (max.) | Total, $ (min.) | $/SCFM (max. | Total, $ (max.) | $/SCFM (max.) | Total, $ |
| *200 SCFM* | | | | | | | | | | | | | | | |
| Equipment | 350000 | 1750 | 250000 | 1250 | | | | | | | | | | | |
| Monitoring | 75000 | 375 | | 0 | | | | | | | | | | | |
| Other pretreatment* | | 0 | | 0 | | | | | | | | | | | Included |
| Total | 425000 | 2125 | 250000 | 1250 | 150000 | 750 | 1400000 | 7000 | 1600000 | 8000 | 400000 | 2000 | 800000 | 4000 | 800000 |
| *500 SCFM* | | | | | | | | | | | | | | | |
| Equipment | 552000 | 1104 | 350000 | 700 | | | | | | | | | | | |
| Monitoring | 75000 | 150 | | | | | | | | | | | | | |
| Other pretreatment* | | | | | | | | | | | | | | | Included |
| Total | 627000 | 1254 | 350000 | 700 | 250000 | 500 | 1600000 | 3200 | 1800000 | 3600 | 1200000 | 2400 | 1800000 | 3600 | 1400000 |
| *1000 SCFM* | | | | | | | | | | | | | | | |
| Equipment | 600000 | 600 | 500000 | 500 | | | | | | | | | | | |
| Monitoring | 75000 | 75 | | 0 | | | | | | | | | | | |
| Other pretreatment* | | 0 | | 0 | | | | | | | | | | | Included |
| Total | 675000 | 675 | 500000 | 500 | 350000 | 350 | 2400000 | 2400 | 2800000 | 2800 | 2200000 | 2200 | 2800000 | 2800 | 2000000 |
| **Annualized O&M Costs** | | | | | | | | | | | | | | | |
| *200 SCFM* | | | | | | | | | | | | | | | |
| Power | 4305 | 22 | 58 | 0 | 4000 | 20 | | | | | | | | | 54557 |
| Media | 8400 | 42 | 1000 | 5 | | | | | | | | | | | 8500 |
| Other | | | | | 4000 | 20 | | | | | | | | | |
| Total | 12705 | 64 | 1058 | 5 | 8000 | 40 | 25000 | 125 | 25000 | 125 | | | | | 63057 |
| *500 SCFM* | | | | | | | | | | | | | | | |
| Power | 4305 | 9 | 116 | 0 | 10000 | 20 | | | | | | | | | 136393 |
| Media | 14000 | 28 | 1000 | 2 | | | | | | | | | | | 21250 |
| Other | | | | | 10000 | 20 | | | | | | | | | |
| Total | 18305 | 37 | 1116 | 2 | 20000 | 40 | 50000 | 100 | 50000 | 100 | | | | | 157643 |
| *1000 SCFM* | | | | | | | | | | | | | | | |
| Power | 4305 | 4 | 231 | 0 | 20000 | 40 | | | | | | | | | 272786 |
| Media | 17200 | 17 | 1000 | 1 | | | | | | | | | | | 42500 |
| Other | | | | | 20000 | 40 | | | | | | | | | |
| Total | 21505 | 22 | 1231 | 1 | 40000 | 40 | 100000 | 100 | 100000 | 100 | | | | | 315286 |
| **Total Costs** | | | | | | | | | | | | | | | |
| *200 SCFM* | 437705 | 2189 | 251058 | 1255 | 158000 | 790 | 1425000 | 7125 | 1625000 | 8125 | 400000 | 2000 | 800000 | 4000 | 863057 |
| *500 SCFM* | 645305 | 1291 | 351116 | 702 | 270000 | 540 | 1650000 | 3300 | 1850000 | 3700 | 1200000 | 2400 | 1800000 | 3600 | 1557643 |
| *1000 SCFM* | 696505 | 697 | 501231 | 501 | 390000 | 390 | 2500000 | 2500 | 2900000 | 2900 | 2200000 | 2200 | 2800000 | 2800 | 2315286 |

# Project Status

- Still acquiring some data from Vendors
- Prepared first (BETA) Version of Tool Kit
- Accumulating Data on Engine operating/maintenance savings from 99% removal of siloxanes
  - A complicated subject
  - Dependent on engine type, raw gas quality, engine duty cycle, unit capacity, number of units at site, etc.
  - This data to be analyzed and factors included in the toolkit

# Some Project Challenges

- Competitive Industry and Vendors Reluctant to Share Costs
- Not all gas clean-up technologies are equal
  - Different Purposes for different markets
- Wide disparity in the reported results from vendors and engineering firms versus data collected from user/owners

# Next Steps

- Completion of Toolkit
  - Information some vendors continues to be refined
- Compilation of Engine Maintenance Savings and Availability
- Preparation of Summary Report

# Thank-you

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