CDM

15 Cornell Road
Latham, New York 12110
tel: 518 782-4500
fax: 518 786-3810

January 16, 2007

Mr. Paul Rogers, P.E.
Siemens Building Technologies
Performance Solutions
6075 East Molloy Road
Syracuse, New York 13211

Subject: City of Schenectady - Best Use of Methane Gas at the City of Schenectady Water Pollution Control Plant

Dear Mr. Rogers:

CDM is pleased to submit the deliverables for this project, which include the following Executive Summary and Meeting Minutes (attached). This work is a result of the workshops held on September 18 and 19, 2007.

Executive Summary

The City of Schenectady is considering viable options for beneficial use of biogas produced from the Water Pollution Control Plant (WPCP). Several specific proposals have been received from consultants and equipment suppliers. The City has requested that Siemens specifically engage CDM to provide an independent and objective assessment of these specific proposals, plus consider other possible options.

The specific proposals and related information included:

1. Proposal from Aircogen, CHP Solutions, Inc.
2. Proposal from Siemens Building Technologies, Inc. – NYSERDA PON No. 1043
3. Boiler replacement quote from fuel oil to methane gas
4. NYSERDA Renewable Portfolio Standard (RPS) Operating Plan for Customer-Sited Tier Program (2006-2009)
5. NYSERDA "Anaerobic Digester Gas Energy Recovery Study" (1998)
6. NYSERDA "Energy Conservation Study for Sludge Disposal Alternatives" (December 2001)
7. National Grid's. Service Classification No. 7 Sale of Standby Service to Customers with On-Site Generation Facilities.
8. Gas to Energy financing options – Boylan, Brown, Code, Vigdor & Wilson LLP.

A summary table of these proposals and related information is provided in the Meeting Minutes, and discusses whether the item was further evaluated or not analyzed in the workshops.

The goal of this effort is to provide a recommendation for the most promising option(s) to be considered under a more detailed level of engineering and economic evaluation in a subsequent study.

The primary objective of the scope of work is to identify a plan that would allow the most cost-effective beneficial use of digester gas and would best fit with the City's unique needs and circumstances.

CDM conducted two, half-day workshops to clarify the City's objectives and provide planning-level engineering information about the alternatives, and engage the project team to brainstorm and discuss the relative advantages and disadvantages of each alternative.

At the beginning of the workshop on Day 1, the project objectives along with their definitions were reviewed and discussed. The project objectives were reduced down to seven items and prioritized. In descending order, the distribution showed: capital, risk, reliable, biosolids, O&M, biogas, and complexity.

An energy profile was developed and reviewed next. This graph showed the monthly fuel oil and electricity used at the WPCP, digester gas production and digester heat demand all in common units (kW) based on operating data. Under current operations, the electricity used is much greater than the digester gas produced. Typically, the digester gas production is greater than the electricity used at a wastewater treatment plant. CDM discussed future estimates if modifications were made to maximize the potential gas production.

After the group discussed the information to date, the following five alternatives were listed for a weighted comparison:

1. Status Quo
2. Modified Siemens NYSERDA (400 kW recip. engine)
3. Modified Siemens NYSERDA (150 kW recip. engine)
4. Modified Siemens NYSERDA (250 kW Microturbine)
5. Modified Siemens NYSERDA (Two, 150 kW recip. engines)

Key points discussed during the weighted comparison included:

- Status Quo does not get NYSERDA funding.

- 400 kWe recip. engine assumes running at half capacity (200 kWe).
- Capital was defined as value. City wants overall protection on approach with respect to capital cost, equipment, and O&M.

Based on the weighted comparison, the top two alternatives were:

- Alternative 3 - Modified Siemens NYSERDA (150 kW recip. engine)
- Alternative 5 - Modified Siemens NYSERDA (two 150 kW recip. engines)

The team discussed the two alternatives that had the highest weightings and agreed that Alternative 5 gives the most flexibility for future gas production and use to offset electrical costs and heat demand required for the digesters and space heating. The recommended option also allows the City to take advantage of the full $1 Million NYSERDA grant as well as implement necessary plant upgrades. Therefore, Alternative 5 was selected as the recommended option by the team. A summary of the recommended plan is defined below.

Project Definition

- Two, 150 kW recip. engines
- Plant upgrades (boilers, sludge thickening, digestion, further belt filter press upgrades)
- Costs are anticipated $2.0 M (including $500,000 plant upgrades)
- Funding is assumed $1.0 M
- Annual O&M savings $112,000
- Simple payback 8.9 years
- Simple payback 4.5 years (deducting capital cost of plant upgrades)

At the conclusion of the final workshop, Siemens briefly discussed that the performance contract procurement method provides opportunity for savings to the City with the risk undertaken by the performance contractor (as in the previous Siemens project with the City). Furthermore, under NYS Article 9 the performance contractor must provide at a minimum a "revenue neutral" solution to the City.

Benefits of the performance contract procurement method include: potential for better financing, reduced project costs and implementation schedule through design/build

approach, and reduced risk in that there are no change orders presented to City once Contract and terms are agreed upon. Based on the above, the City may wish to give this alternative project delivery method further consideration.

In conclusion, CDM led two, half-day workshops with the team and focused the options to a recommended one. It is apparent that a feasible project exists and that further work is required to better define assumptions, details and the overall implementation of the recommended plan.

If you have any questions or need additional information, please contact me directly at (518) 782-4500.

Very truly yours,

Daniel D. Durfee, P.E., BCEE
Principal
Camp Dresser & McKee

c: Vincent Apa - CDM
Bruce Brown - Siemens Building Technologies
Farzin Kiani - Veolia Water North America
Paul LaFond - Veolia Water North America
Carl Olsen - City of Schenectady
Dave Parry - CDM
Bernie Sisson - City of Schenectady
Sandra Sullivan - Veolia Water North America

encl. Meeting Minutes

CDM

DRAFT Memorandum

To: *Paul Rogers, Siemens Building Technologies*

From: *Dan Durfee, P.E., BCEE*

Date: *January 16, 2008*

Subject: *Meeting Minutes from Workshops - Best Use of Methane Gas at the City of Schenectady Water Pollution Control Plant*

The following is a summary of the workshops held on September 18 and 19, 2007, and along with the Executive Summary, serves as the deliverable for this work.

This memo is organized as follows:

1. Project background
2. Scope of Work
3. Past studies and information
4. Project objectives
5. Energy profile
6. Alternatives
7. Comparisons
8. Recommendations
9. Conclusions

1. Project Background

The City of Schenectady is considering viable options for beneficial use of biogas produced from the Water Pollution Control Plant (WPCP). Several specific proposals have been received from consultants and equipment suppliers. The City has requested that Siemens specifically engage CDM to provide an independent and objective assessment of these specific proposals, plus consider other possible options. The goal of this effort is to provide a recommendation for the most promising option(s) to be considered under a more detailed level of engineering and economic evaluation in a subsequent study.

2. Scope of Work

The primary objective of the scope of work is to identify a plan that would allow the most cost-effective beneficial use of digester gas and would best fit with the City's unique needs and circumstances. Unique needs and circumstances include various funding opportunities,

the WPCP's current and projected energy consumption (electric, natural gas, fuel oil), gas production, existing plant processes, acceptance of commercial/industrial waste well suited for digestion, available procurement methods, as well as the City's strategic goals and obligations regarding energy sustainability and biosolids.

The following alternatives were considered in this study:

- To install a gas engine that would produce electrical power and hot water for process (received from Aircogen CHP Solutions, Inc.)
- To install a reciprocating engine with emission system, integrated sludge drying system, and condensing heat recovery boiler (received from Siemens Building Technologies, Inc.)
- To replace the boiler heating system with one that is fueled by biogas (rather than fuel oil)
- To install microturbines for electric power production
- Other alternatives developed by CDM or City staff

Prior to the workshops, CDM reviewed information provided by the City and Veolia Water (e.g., past studies, vendor quotes, budget information, utility rate schedules, plant operating data, etc.) as noted below to provide an economic context for the alternatives.

CDM then conducted two, half-day workshops to clarify the City's objectives and provide planning-level engineering information about the alternatives, and engage the project team to brainstorm and discuss the relative advantages and disadvantages of each alternative. The ultimate objective of the workshops was to recommend the best apparent alternative for beneficial use of the digester gas that met the City's objectives.

3. Past studies and information

CDM reviewed the background materials provided by the City and Veolia Water including:

1. Proposal from Aircogen, CHP Solutions, Inc.
2. Proposal from Siemens Building Technologies, Inc. - NYSERDA PON No. 1043
3. Boiler replacement quote from fuel oil to methane gas
4. NYSERDA Plan for Customer-Sited Test Program (2006-2009)
5. NYSERDA Program information relevant to this project
6. NYSERDA "Anaerobic Digester Gas Energy Recovery Study" (1998)
7. NYSERDA "Energy Conservation Study for Sludge Disposal Alternatives" (December 2001)
8. Existing plant WPCP data (mainly solids related)
9. Monthly electricity and fuel oil consumption

10. Existing utility rate schedules for electricity and fuel oil
11. National Grid's. Service Classification No. 7 Sale of Standby Service to Customers with On-Site Generation Facilities.
12. Gas to Energy financing options – Boylan, Brown, Code, Vigdor & Wilson LLP.
13. Agreement for Operations, Maintenance and Management Services between the City and Veolia Water

Table 3-1 shows a summary of the specific proposals and related information and discusses why the item was dismissed and not further analyzed in the workshops.

Table 3-1
Summary of Specific Proposals and Related Information

Proposal	Summary	Reason Dismissed
Aircogen, CHP Solutions, Inc.	Turnkey delivery (design, manufacture, installation and maintenance). 300 kW power generator, using portion of biogas to fire a boiler and possibly waste heat from engine cooling water jacket for heating use. Assumes a very high digester gas production rate of 216,000 cf/d.	Proposal is not very detailed. Assumptions have no basis. Installed cost is $1,600/kW, which is very low.
Siemens Building Technologies, Inc.	400 kW recip engine with sludge dryer and appurtenances. The overall approach was design/build through a long term performance contract. Siemens can maintain CAT recip engines. Assumptions, along with terms and conditions need to be better defined.	During the CDM workshops, the proposal was modified to reduce capacity of engine and delete use of dryer.
Boiler replacement quote from fuel oil to methane gas	Estimate for new boiler in Maintenance Building to be run off fuel oil with an adder for digester gas.	Not a complete system; provides heating only to one area and no power generation.
NYSERDA - Renewable Portfolio Standard (RPS) Operating Plan for Customer-Sited Tier (CST) Program (2006-2009)	Customer-Sited Tier refers to smaller sized generation that is sited and used primarily at the electric customer's location and commonly described as "behind the meter" generation. The CST program offers financial incentives in the form of capacity buy-down payments,	For Anaerobic Digestion Systems, $3.67 M has been allocated for each year from 2007-2009. Application for funding should be considered during program implementation.

	performance-based incentives, or some combination of the two. Funds can be used to offset the construction, installation, and operation of customer-sited renewable energy generating systems.	
NYSERDA "Anaerobic Digester Gas Energy Recovery Study" (1998)	Proposed 225 kW generator to be connected as required by National Grid to synchronize the generated power with utility power. The system assumes that cheese whey would be available to be fed into the digester holding tank to increase the gas production. Waste heat from the engine would be used to heat the digesters and recovered digester gas could be used to fuel a boiler.	An arrangement for receiving the whey was never reached and the project as proposed was not implemented. However, many concepts of this proposal were further evaluated in the workshops.
NYSERDA "Energy Conservation Study for Sludge Disposal Alternatives" (December 2001)	Study reviewed various alternatives including sludge dryer, upgrading composting facility, construction of a new composting facility and off-site processing or disposal of sludge. Based on costs, the recommendation was keep the existing sludge disposal system and to consider the alternatives when the debt service on the existing facility is closer to retired and when the costs were favorable compared to the alternative.	The overall impact to the solids handling operation was discussed during the workshops and concluded that the current operation is most cost effective and that changes such as primary sludge thickening could increase digester gas production.
National Grid's. Service Classification No. 7 Sale of Standby Service to Customers with On-Site Generation Facilities	On-site generation includes any electric customer with an electric generator on the premises where the electricity is used. Customers connected to the National Grid system may use the electricity generated on-site for their own purposes, feed excess electricity back into the system or both.	The terms and details are complicated and will need to be further evaluated based on a selected cogeneration system.
Gas to Energy financing options - Boylan, Brown, Code, Vigdor &	Attorneys who represent J&L Consulting and the Upstate Coalition for Renewable Energy. Offer assistance with Clean Renewable	Not a complete proposal or team.

Wilson LLP	Energy Bonds and other financing options.	

The review of these documents focused on the development of each alternative with respect to overall feasibility, financing requirements, procurement issues, and impacts to the City's operations & maintenance contract with Veolia Water. Review of the documents enabled the development of necessary background information such as the WPCP's energy profile.

4. Project objectives

At the beginning of the workshop on Day 1, the following project objectives along with their definitions were reviewed (refer to Attachment A for complete list of project objectives and definitions):

Business

A Capital cost
B Operating cost and contract
C Maximize value of existing assets
D Minimize/manage risk

Operability

E Adaptability to changes in solids handling processes (biosolids)
F Adaptability to changing energy markets
G Complexity
H Proven and reliable system
I Provides standby power

Social

J Minimize noise and odors
K Minimize view obstruction

Environmental

L Adaptability to changing regulations
M Energy efficiency
N Improved emissions (Criteria Pollutants, GHG)
O Beneficial use of digester gas (biogas)

The following comments were discussed regarding the project objectives and respective definitions to assist in the prioritizing process:

- The workshops were conducted with an understanding the City is being represented by a group of partners (e.g., CDM, Veolia Water and Siemens).

- From the City's perspective, capital cost is two part; WPCP and collection system. City envisions more money to be spent in the collection system in the future. Capital is the most important criteria to the City.
- Veolia Water noted that where capital costs are required, improvements primarily address safety concerns and/or are meant to reduce O&M costs.
- O&M includes Veolia's contract, as well as other expenses. O&M costs are fixed for the City, unless a savings can be shown.
- Risk includes assumptions and economics based on limited data at this time.
- Adaptability is related to solids handling processes, as well as a change in energy markets (e.g., electricity or fuel oil costs).
- Assumed alternatives will not be based on the need to purchase a lot of natural gas.
- Complexity includes robustness and level of automation, but not redundancy.
- Proven and reliable relates to redundancy. For example, smaller reciprocating engines were viewed as less reliable than larger higher quality engines. Multiple engines were viewed as more reliable because of increased redundancy.
- City has a standby generator and plans for upgrades to its emergency power system at the WPCP. Use of digester gas is not well suited or required for standby power. Specifically, as reciprocating engines have increased in efficiency and decreased in emissions, the ability to provide back-up power has decreased.
- A system that is noisy, creates odors or obstructs views would not be evaluated or installed. Provisions would be incorporated into the design to result in an acceptable system.
- No air permit regulations would drive a decision at this time.
- System efficiency is not very important as a differentiator, as various technologies are being evaluated (e.g. microturbines, Stirling engines, and reciprocating engines).
- Beneficial use of digester gas includes how much is used. A common mistake is to oversize the cogen system (i.e., not have enough gas for use).
- City may wish to "go with a green/environmentally friendly option" or recommend a higher cost alternative if the payback difference is only a couple of years.
- Impacts to Veolia Water's contract were briefly discussed. CDM noted a performance contract between Veolia Water and the City of Gresham, Oregon. At this wastewater treatment plant, the Contract with Veolia Water was amended to include a new cogeneration system. The Contract stipulated that the City would share with Veolia Water the avoided cost of purchasing electrical power that is produced by the engine generator system when the system operates in excess of 85% of the total hours of any given calendar year. The additional electric power savings resulting from engine generator set operation above the 85% threshold is to be shared 40% to Veolia Water and 60% to the City.
- Risk could include performance, opportunity lost, solids handling, and gas handling system.
- The City expressed that a longer guarantee is desired to minimize risk.

From this discussion on the overall objectives, the list was reduced down to seven items and prioritized. For each pair of objectives, the objective of higher priority and to what degree it is more important was noted. The rating scale included:

1. The listed objective is slightly higher in priority.
2. The listed objective is higher in priority.
3. The listed objective is significantly higher in priority.

A summary of the group prioritized objectives is shown in Table 4-1.

Table 4-1
Summary of Prioritized Objectives

	C	O	R	BS	CX	RE	BG
Capital	X	2C	1C	2C	2C	1RE	3C
O&M	X	X	1O	1O	1O	1RE	2O
Risk	X	X	X	3R	3R	1R	1BG
Biosolids (solids handling)	X	X	X	X	2BS	2BS	2BS
Complexity	X	X	X	X	X	2RE	2BG
Reliable (and proven)	X	X	X	X	X	X	2RE
Biogas	X	X	X	X	X	X	X

By totaling the objectives and dividing by the total number, the following distribution (Table 4-2) was developed and used later in the weighted comparison of various alternatives.

Table 4-2
Distribution of Prioritized Objectives

Total	*37*	*1.00*
Capital	10	0.27
O&M	5	0.14
Risk	7	0.19
Biogas	3	0.08
Complexity	0	0.00
Reliable	6	0.16
Biosolids	6	0.16

5. Energy profile

The energy profile (see Attachment B) shows the monthly fuel oil and electricity used at the WPCP, digester gas production and digester heat demand all in common units (kW) based on operating data and records provided by Veolia Water from January 2005 to July 2007.

The chart shows that under current operations, the electricity used is much greater than the digester gas produced. Typically, the digester gas production is greater than the electricity used at a wastewater treatment plant. This may be due to the percentage of primary sludge (~70%) that is bypassed around digestion now.

Currently, the solids to be digested (primary and thickened waste activated sludge) are fed at less than 3% solids. The solids retention time (SRT) at this low concentration is too low for sufficient digestion to occur if more primary sludge were sent to digestion. In addition, the current blend of primary and digested sludge to the centrifuge has been found to produce the driest cake that composts the best.

Improvements to sludge thickening would increase the SRT in the digester, increase digester gas production, and decrease the digester feed heat demand.

Cursory estimates show that if all of the primary sludge currently produced were digested, the gas production could be as high as 950 kWfuel. This assumes the feed solids to the digester are 5%, volatile solids reduction is 55% and SRT is 15 days.

6. Alternatives

The alternatives discussed included:

- Status Quo
- Siemens Based Proposal
- Modified Siemens Based Proposal
- Other

The components of each alternative were summarized by the team.

Status Quo

- Biogas (or combination) fueled boiler (repair/replace).
- Improved heating (control, flow, biogas quality)
- Sludge thickening (various methods discussed)

- Gas holding tank to dampen fluctuations.
- Miscellaneous improvements to reduce O&M costs (e.g., grinders, more efficient aeration blower, improved primary sludge removal).
- Coating of digester tank interior concrete.
- Obtain additional digester gas data.

Siemens Based Proposal

- 400 kW reciprocating engine with attainment controls (low nitrogen oxides).
- AFT gas treatment (hydrogen sulfide, moisture, siloxanes, particulates).
- Condensing heat recovery boiler.
- Sludge dryer with afterburner (Regenerative Thermal Oxidizer) using recovered heat. Would abandon compost facility and produce pellets. Engine is more difficult to permit than dryer.
- Digester heating control system.
- Issues in getting ~ 1,200 kW input fuel of available digester gas. Could run engine at half capacity or send all primary sludge for digestion. Would need thickening improvements with only 2 digesters to accomplish increased gas production.
- May be able to save on power demand ~10 month/year.
- Life expectancy of industrial grade engine is ~ 20 years with major re-build every 35,000 hours depending on loading. This is compared to ~ 10 year life on smaller, commercial quality engines.

Modified Siemens Based Proposal

- Engine sized for up to 400 kW depending on gas production from future data. Recommend more digester gas related testing and improvements listed under Status Quo.
- Keep composting system, no sludge dryer.
- Biogas treatment.

Other

- Microturbine (250 kW).
- Biogas to new gas boilers.
- Chemically enhanced primary treatment (may be issues with thickening, digestion, dewatering, composting).
- Co-digestion (grease or food waste). City commented that taking additional outside materials like a merchant facility will be viewed negatively by City government.

A brief discussion was held on microturbines and is summarized as noted:

- Capital can be higher than reciprocating engines.
- Less maintenance based on five year history. No long term data on maintenance or overall equipment life. No 250 kW installations running for 5 years yet. Technology is proven, but not as much as recip. engines.
- Emissions and noise are lower than recip engines.
- Efficiency is lower (electrical efficiency is ~ 28%, compared to 33-38% for recip. engines).
- More waste heat is available.
- Fewer moving parts.
- Can be pad mounted (does not require a building) like a recip engine may need.
- Footprint is smaller, less auxiliary components.
- Modular.
- Require higher pressure and thus a compressor.
- Can blend fuel source (e.g., digester and natural gas) easier than engines.
- Package responsibility is recommended for microturbines.

There was discussion regarding funding as noted:

- Status Quo cannot capture $1.0M NYSDERDA grant since grant is for energy performance contract.

- May be able to obtain another NYSERDA Program Opportunity Notice (PON) for WWTP upgrades.

- Intent would be to fully understand NYSERDA funding and modify Siemens proposal.

- City questioned the benefit to do more than the Status Quo and how much would need to be spent versus money available from the NYSERDA grant.

CDM discussed future digester gas production estimates if modifications were made to improve sludge thickening and process all of the primary sludge through the digesters to maximize the potential gas production. The future goal would be to thicken the sludge to a higher solids concentration to the digesters and provide flexibility to bypass sludge to dewatering if needed to reduce composting O&M costs.

The results are as shown in Table 6-1 for various solids loadings to the digesters.

Table 6-1
Estimated Future Digester Gas Production

Total solids (%)	5	5	6.5
SRT (day)	20	15	15
VS reduction (%)	55	55	55
Gas production (kWfuel)	713	950	1,235
Elec. Gen. efficiency	30	30	30
Elec. generation (kWelectric)	214	285	371

After the group discussed the information to date, the following five alternatives were listed for a weighted comparison:

1. Status Quo
2. Modified Siemens NYSERDA (400 kW recip. engine)
3. Modified Siemens NYSERDA (150 kW recip. engine)
4. Modified Siemens NYSERDA (250 kW Microturbine)
5. Modified Siemens NYSERDA (Two, 150 kW recip. engines)

7. Comparisons

A weighted comparison was next performed using the prioritized objectives developed earlier, along with the five alternatives. Each comparison between prioritized objective and alternative is rated on a scale of 1-5. The ratings were as follows:

Great	5
Good	4
Average	3
Poor	2
Terrible	1

Discussion during the weighted comparison is summarized as follows:

- Status Quo does not get NYSERDA funding.
- Increasing primary sludge feed to the digesters and reducing sludge mass in general (e.g., more digestion) can be beneficial and reduce O&M if the impact to dewatering is not negative.
- 400 kWe recip. engine assumes running at half capacity (200 kWe).
- Reliability, track record, operating in range, and redundancy were all important criteria of cogeneration equipment.
- Capital was defined as value. City wants overall protection on approach with respect to capital cost, equipment, and O&M.
- Gas holding refers to hours of capacity for dampening fluctuations caused by variations in production and use; gas storage refers to days. Recommended to have gas holding and possible separate from digester if available space.

The City requested that ballpark capital and O&M costs for each of the alternatives be included to aide the discussion and selection process (Attachment C). CDM used cursory estimates from experience including:

- $5,000/kW for reciprocating engines capital cost
- $6,000/kW for microturbines capital cost
- $0.03/kW for recip. engine O&M cost
- $0.025/kW for microturbine O&M cost

Based on the weighted comparison, the top two alternatives were:

- Alternative 3 - Modified Siemens NYSERDA (150 kW recip. engine)
- Alternative 5 - Modified Siemens NYSERDA (two 150 kW recip. engines)

Results of the weighted comparison are shown in Table 7-1.

Table 7-1
Weighted Comparison

	Weight	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5
Capital	27%	4	1	5	2	3
Risk	19%	4	2	4	2	3
Reliable	16%	5	3	3	2	5
Biosolids	16%	4	3	4	3	4
O&M	14%	3	5	4	5	5
Biogas	8%	1	5	4	4	5
Complexity	0%					
Weighting		3.8	2.7	4.1	2.7	3.9
Capital Cost		$500k	$1,500k	$750k	$1,000k	$1,000k

8. Recommendations

The team discussed the two alternatives that had the highest weightings and agreed that Alternative 5 gives the most flexibility for future gas production and use to offset electrical costs and heat demand required for the digesters and space heating. The recommended option also allows the City to take advantage of the full $1 Million NYSERDA grant as well as implement necessary plant upgrades. Therefore, Alternative 5 was selected as the recommended option by the team. A summary of the recommended plan is defined below.

Project Definition

- Two, 150 kW recip. engines
- Plant upgrades (boilers, sludge thickening, digestion, further belt filter press upgrades)
- Costs are anticipated $2.0 M (including $500,000 plant upgrades)
- Funding is assumed $1.0 M
- Annual O&M savings $112,000
- Simple payback 8.9 years
- Simple payback 4.5 years (deducting capital cost of plant upgrades)

At the conclusion of the final workshop, Siemens briefly discussed that the performance contract procurement method provides opportunity for savings to the City with the risk undertaken by the performance contractor (as in the previous Siemens project with the City). Furthermore, under NYS Article 9 the performance contractor must provide at a minimum a "revenue neutral" solution to the City.

Benefits of the performance contract procurement method include: potential for better financing, reduced project costs and implementation schedule through design/build approach, and reduced risk in that there are no change orders presented to City once Contract and terms are agreed upon. Based on the above, the City may wish to give this alternative project delivery method further consideration.

9. Conclusions

In conclusion, CDM led two, half-day workshops with the team and focused the options to a recommended one. It is apparent that a feasible project exists and that further work is required to better define assumptions, details and the overall implementation of the recommended plan.

CDM will circulate a draft of the meeting minutes and an executive summary to Siemens, Veolia Water and the City for review and comment. Upon agreement the City will then circulate the draft executive summary to the City Council. Upon acceptance by the City, CDM will finalize the executive summary and begin scoping the preliminary design for the project.

cc: Vincent Apa - CDM
Bruce Brown - Siemens Building Technologies
Farzin Kiani - Veolia Water North America
Paul LaFond - Veolia Water North America
Carl Olsen - City of Schenectady
Dave Parry - CDM
Bernie Sisson - City of Schenectady
Sandra Sullivan - Veolia Water North America

ATTACHMENT A

Business

A Capital cost

Capital costs include design, procurement, and construction costs. Capital costs will also include current building and safety codes, as well as projected costs for termination of existing contracts and projected revenues from the sale of purchased cogeneration engines if they are not required for the specific alternative.

B Operating cost and contract

Revenues include the projected sale or avoided purchases of energy due to the production and beneficial use of the digester gas. Operating costs include the energy, maintenance, and operational costs required to effectively use the digester gas.

C Maximize value of existing assets

This criterion will be used to analyze alternatives that leave existing the City of Schenectady assets stranded. The criterion will not be applied to aspects of an alternative where the value of the asset is already accounted for in the capital cost.

D Minimize/manage risk

Risk refers to situations with known frequencies. This criterion will be used to assess known risks. These risks may include bankruptcy of a City partner that is key to the implementation of a specific alternative.

Operability

E Adaptability to changes in solids handling processes

This criterion is used to assess how an alternative will respond to potential changes in solids handling processes, covers and gas storage. Changes that are considered most likely are the changes to process more primary sludge thru digestion, and not bypass to dewatering. These changes could also include handling of cheese whey from a local dairy or better thickening of primary and even waste activated sludge. The age of the existing composting system should also be evaluated and market for product. Possibility of City's WWTP becoming a regional facility with Rotterdam and Niskayuna.

F Adaptability to changing energy markets

This criterion will be used to asses how an alternative will respond to the changing costs of energy as well as the changing relative costs of energy sources. An alternative that is adaptable to these changing markets will be readily adjusted, through operational changes or through basic system improvements, to leverage the changing rates of different energy types.

G Complexity

This criterion will assess the amount of automation required to effectively implement the alternative.

H Proven and reliable system

Proven and reliable systems will have been successfully implemented and used in conjunction with digester gas or other equivalent biogas. Alternatives will further be considered reliable if daily repairs can be made quickly by local staff and do not require long delays for parts. Thus, reliability will not only include the frequency that a system may be down for repairs but also the projected length of time that the alternative may be out of service waiting for repairs.

I Provides standby power

The existing emergency backup system consists of an 800 kW 480V, three-phase Solar© turbine-generator and an Automatic Transfer Switch (ATS) located at the Plant Substation. The Emergency Power System (EPS) components where installed in the early 1970's; the system has become unreliable due to its age and replacement parts are becoming increasingly difficult to find. The City has hired another consultant to design a new emergency generator to be installed outdoors. The proposed unit is 1,000 kW and would run on propane. Standby power can be provided at different levels, e.g. power to run the entire plant independent of the grid or essential standby power which would run components of the City's WWTP for temporary periods of time while repairs are being made to the main electrical grid.

Social

J Minimize noise and odors

It is a given that all alternatives will be designed to mitigate noise and odor emissions in accordance with existing permits, agreements, and good neighbor policies. This criterion will apply to noise at the piece of equipment, along with potential odors and its impact on Veolia Water staff that would maintain and operate the equipment.

K Minimize view obstruction

This criterion asses the impacts of buildings, stacks, and other features of an alternative on views observed from the surrounding area.

Environmental

L Adaptability to changing regulations

Alternative will provide flexibility through operations or improvements to meet potential changing regulations. Regulations considered most important are priority pollutants such as NOx, CO, etc. Although, currently not regulated in the area, this criterion also recognizes that greenhouse gasses are becoming an increasing concern and could in the future be regulated. This criterion could also apply to regulations affecting wastewater treatment discharges, e.g. if an alternative dumps heat into the effluent regulations could be put into affect limiting this type of activity.

M Energy efficiency

Alternative will overall provide greatest energy efficiency through electrical and thermal recovery. For alternatives that are converted to fuels - including LNG, CNG, or other forms of natural gas - efficiency will be approximated based on typical equipment that consume these fuels, e.g. natural gas may be used in a home furnace at approximately 85% efficiency.

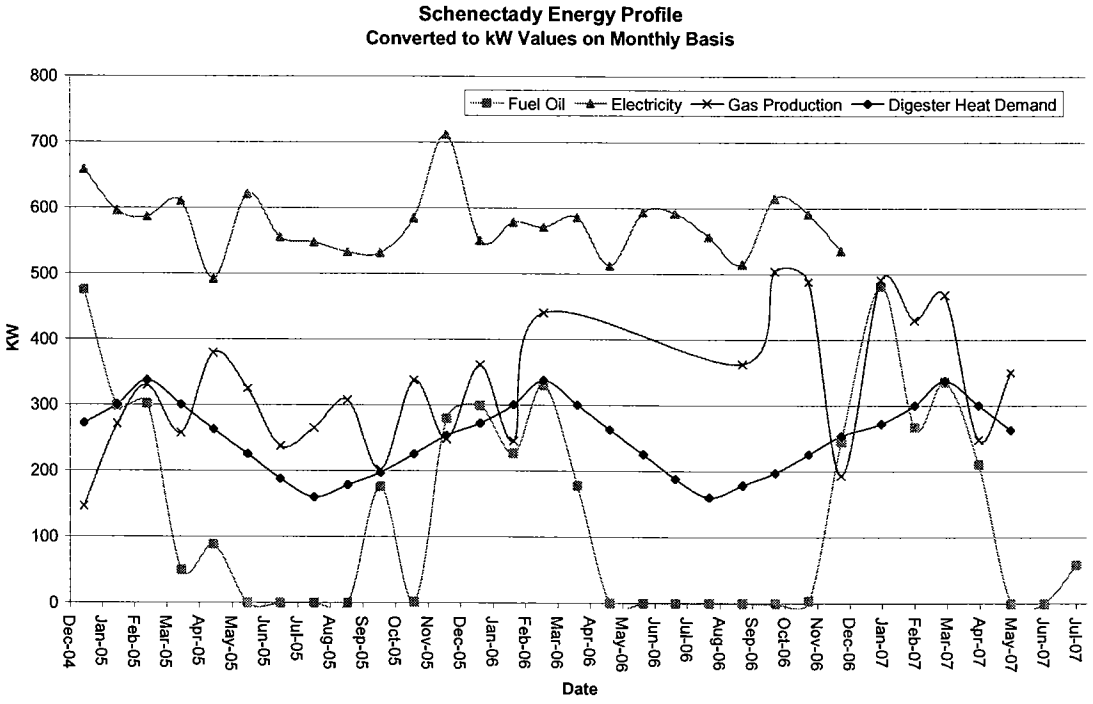
N Improved Emissions

It is a given that all alternatives will meet the emissions limits of local air permits. This criterion recognizes that different alternatives will improve emissions performance with respect to certain priority pollutants, greenhouse gases, and on-site odors. Alternatives that are not used on-site (LNG, CNG, natural gas) will be evaluated based on the typical technology that utilizes the produced fuel.

O Beneficial use of digester gas

It is a given that each alternative will beneficially use digester gas.

ATTACHMENT B



ATTACHMENT C

City of Schenectady
Best Use of Digester Gas
Expected Cost Analysis

Alternatives
1. Status Quo
2. Modified Siemens NYSERDA (400 kW engine)
3. Modified Siemens NYSERDA (150 kW engine)
4. Modified Siemens NYSERDA (250 kW Microturbine)
5. Modified Siemens NYSERDA (2, 150 kW engines)

kW rating/cogen unit	0	400	150	250	150
Assumed Values	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
No. of units (engines or microturbines)	0	1	1	1	2
Digester gas available (kW)	0	625	450	740	450
Equipment effic.	0.33	0.32	0.33	0.27	0.33
Gas available with effic. (kW)	0	200	150	200	150
Electrical rate ($/kW*hr)	0.10	0.10	0.10	0.10	0.13
CAPITAL					
Plant upgrades*	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000
Cogen unit cost per kW	$ -	$ 5,000	$ 5,000	$ 6,000	$ 5,000
Engine or microturbine	$ -	$ 2,000,000	$ 750,000	$ 1,500,000	$ 1,500,000
Total capital	$ 500,000	$ 2,500,000	$ 1,250,000	$ 2,000,000	$ 2,000,000
Funding (NYSERDA Grant)	$ -	$ 1,000,000	$ 500,000	$ 1,000,000	$ 1,000,000
Project Cost	$ 500,000	$ 1,500,000	$ 750,000	$ 1,000,000	$ 1,000,000
Project Term	10	10	10	10	10
Discount Rate	0.04	0.04	0.04	0.04	0.04
System Utilization	0.9	0.9	0.9	0.9	0.9
O&M					
Engine O&M ($/kW*hr)	0	0.02	0.025	0.015	0.025
Gas Treatment ($/kW*hr)	0	0.01	0.01	0.01	0.01
Total O&M Cost ($/kW*hr)	0	0.03	0.035	0.025	0.035
Annual Cost	$ -	$ 47,000	$ 41,000	$ 40,000	$ 41,000
ELECTRICAL					
Annual Savings	$ -	$ 158,000	$ 118,000	$ 158,000	$ 154,000
NET REVENUE	$ -	$ 110,000	$ 77,000	$ 118,000	$ 112,000
Simple Payback (years)	n/a	13.6	9.7	8.5	8.9

Notes:
1. 400 kWe engine generator is assumed to run at 50% capacity.
2. Option 5 assumes capital cost for 2 engines, but gas production is enough for 1 engine at this time. Option 5 is the only Option that provides year round demand benefit.
3. Simple payback based on total project costs including plant upgrades. Payback would be greater if based only on incremental capital cost for energy system.