VOCGEN CHP Level One Project Feasibility
Financial Summary

Expanded Foam Manufacturing Company
State of California DR/SS

Operational Costs	Air Pollution Control Equipment & Utility Supplied Energy	VOCGEN CHP Equipment
Natural Gas	($387,526)	($405,861)
Electricity	($94,610)	$0
Maintenance	($25,000)	($47,250)
Plant Natural Gas	($412,009)	
Plant Electricity	($477,314)	
	($1,396,459)	($453,111)
Annual Savings		**$943,348**
Capital Equipment		
Regenerative Thermal Oxidizer (RTO)	($2,275,000)	$2,275,000
VOCGEN CHP System	$0	($3,489,900)
	($2,275,000)	($1,214,900)
Simple Payback Period	None	**1.29-year payback**
Potential savings over 20-years		**$19,202,056**
Internal Rate of Return		**78%**
Net Present Value (NPV)		**$6,678,689**
Carbon Dioxide Emissions (MT)	7,180	4,568
Carbon Equivalent Emissions (MT)	1,958	1,246
Annual Carbon Reduction		**63.62%**

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Expanded Foam Manufacturing Company Example Level One (1) Cost Benefit Analysis

VOC loading Rate	120 lb/hr
Plant location	California
Natural Gas Price	$6.99 USD/MMBtu
Electricity Price	$0.123 USD/kWh

US Energy Information Agency - Energy Prices June - 2013..... Pentane - VOC Heat Content 19,500 Btu/tb

RTO - Regenerative Thermal Oxidizer Air Pollution Control Equipment & Utility Supplied Energy - Option 1

Equipment Selection

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (50) KCFM at 80°F	1	Unit(s)
Other Equipment	0	Unit(s)

Operating Hours

(RTO - Regenerative Thermal Oxidizer) Operating hours: **7,920 hr/yr**
(8hrs/shift, 3shifts/day, 330days/yr)

Air Flow

System airflow (CFM): **50,000 CFM**

Other:

1. Fuel

System operating hours (8hrs/shift, 3shifts/day, 330days/yr)	7,920	hrs/yr
Regenerative Thermal Oxidizer fuel requirement	7.00	MMBtu/hr
Other equipment fuel requirement	0.00	MMBtu/hr

Estimated Fuet Required

Annual Carbon Reduction

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (50) KCFM at 80°F	($387,526)	USD
Other Equipment	$0	USD
Total Natural Gas usage by Option 1	($387,526)	USD/yr

VOCGEN CHP Equipment Option 2

VOCGEN Equipment Selection

VOCGEN Genset -*0.560 MW — 1 Unit(s)
VOC Concentrator | HRSG — 1 Unit (s)
* Nominal rating

560 kW per gas turbine

VOCGEN Operating Hours

Genset(s) Operating hours: **8,712 hr/yr**
(8hrs/shift, 3shifts/day, 363days/yr)

VOCGEN Air Flow

VOCGEN Genset(s) - CFM ISO Cond.: 6,200 CFM/genset
6,200 CFM

Elevation: 250 Feet

1. VOCGEN Fuel

VOC Energy Contribution

Operating hours (VOC production) (8hrs/shift, 3shifts/day, 330days/yr)	7,920	hrs/yr
VOC load	120	lb/hr
Heat content	19,500	Btu/lb
	18,533	**MMBtu/yr**

Natural gas pilot fuel use is regulated by an automated system compensating for VOC heat content contribution.

Naturat Gas Fuel

VOCGEN Genset(s) 0.560 MW

Heat rate	15,700	Btu/kWh
	8.79	MMBtu/hr/genset
	8.79	MMBtu/yr
	76,596	MMBtu/yr

VOCGEN CHP Project Feasibility
Level 1

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Estimated Fuel Required

Natural Gas	55,440 MMBtu/yr
Total fuel	**($387,526) USD/yr**

2. Regenerative Thermal Oxidizer Electrical Cost

Estimated RTO Electricity Cost

Using total motor Hp of 97.5 & power draw of 0kW

772,329 kWh/yr

($94,610) USD/yr

3. Annual Maintenance

($25,000) USD/yr

4. Avoided Electrical Requirements of Facility

510 kW

3,896,442 kWh/yr

VOCGEN Cost Avoidance

($477,314) USD/yr

5. Avoided Natural Gas Requirements for Heating/Cooling

58,943 MMBtu/yr

VOCGEN Cost Avoidance

($412,009) USD/yr

Regenerative Thermal Oxidizer annual operating cost

(VOCGEN cost avoidance included in Regenerative Thermal Oxidizer annual operating cost below)

Operational Cost per Year **($1,396,459) USD/yr**

Estimated Fuel Required

VOC	18,533 MMBtu/yr		$129,544 USD/yr Savings
Natural Gas	58,063 MMBtu/yr		($405,861) USD/yr
Total fuel	**76,596 MMBtu/yr**	**Cost**	**($405,861) USD/yr**

2. VOCGEN Parasitic Loads

VOCGEN Genset(s) 0.560 MW

Chiller	0	kW/unit
	0	kW - parasitic load
NG Booster Compressor	50	kW/unit
	50	kW - parasitic load

Estimated Operation Electricity Use From Parasitic Load

50 kW

435,600 kWh/yr

3. Annual VOCGEN Maintenance

($3,938) USD/month

($47,250) USD/yr

4. VOCGEN Electrical Output Contribution (Less Parasitic Load)

(560kW - 50kW) 510 kW

3,896,442 kWh/yr

Altitude factor at 250ft is 0.993 of nominal output power

VOCGEN parasitic load deducted from total electrical output

5. VOCGEN Heat Output Contribution

VOCGEN Genset(s) 0.560 MW

8.79	MMBtu/hr Fuel
1.85	MMBtu/hr Electrical power
6.95	MMBtu/hr Heat
6.77	MMBtu/hr Heat w/radiated heat loss
58,943	**MMBtu/yr nominal heat**

VOCGEN Carbon Emissions Reductions - Potential

712 ton Carbon/year

Federal Proposed Value $0.00 USD/ton

$0 USD/yr

Not included in total savings

Operational Cost per Year **($453,111) USD/yr**

Estimated Annual Savings **$943,348 USD/yr**

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6. Capital Equipment Budget- First year

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (50) KCFM : ($1,750,000) USD
Other Equipment $0 USD

Two Additional 'RTO' unit(s) will be purchased during the 20-year evaluation period with installation costs included (factor: 1.30): ($2,275,000) USD

Estimated Equipment Costs ($1,750,000) USD/yr

Installation (est. 30% of equipment) ($525,000) USD

Estimated Capital Equipment Costs ($2,275,000) USD

Year Zero Avoided Costs $2,275,000 USD

6. VOCGEN Capital Equipment Budget- First year

Equipment Option 2

0.560MW VOCGEN Genset cost ($1,723,000) USD

Equipment Package Engineering and Designs w/Specifications and Operations Manual
Skid-mounted equipment enclosure
Natural Gas Booster Compressor and Receiver Tank (optional)
D.I. Water Purification System (optional)
Electric Chiller (300°F to 65°F)
Honeywell Catox Air Purification Catalyst (optional)

Functional Specification for 4160 VAC 560 kW Gas Turbine Designed by EPSI and Gas Technology Institute 1700 South Mount Prospect Road Des Plaines, Il 60018-1804

Estimated Equipment Cost ($1,723,000) USD

Estimated Project Costs
Installation (est. 30% of equipment) ($516,900) USD
Const. Mgmt., Subcontractors and Suppliers
Engineering, Civil, Mechanical, and Electrical
Heat utilization
VOC Concentrator | HRSG ($1,500,000) USD

Estimated Capital Equipment Costs ($3,489,900) USD
(Rebate of $250,000 subtracted from the cost)

Adjusted First Year Costs ($1,214,900) USD

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7. Cash Flow

	Equipment Option 1	VOCGEN Equip. Option 2	
	Each year	Each year	Difference
Year 0	($2,275,000)	($3,489,900)	($1,214,900)
Year 1	($1,396,459)	($453,111)	$943,348
Year 2	($1,396,459)	($453,111)	$943,348
Year 3	($1,396,459)	($453,111)	$943,348
Year 4	($1,396,459)	($453,111)	$943,348
Year 5	($1,396,459)	($453,111)	$943,348
Year 6	($1,396,459)	($453,111)	$943,348
Year 7	($1,396,459)	($453,111)	$943,348
Year 8	($3,671,459)	($1,953,111)	$1,718,348
Year 9	($1,396,459)	($453,111)	$943,348
Year 10	($1,396,459)	($453,111)	$943,348
Year 11	($1,396,459)	($453,111)	$943,348
Year 12	($1,396,459)	($453,111)	$943,348
Year 13	($1,396,459)	($453,111)	$943,348
Year 14	($1,396,459)	($453,111)	$943,348
Year 15	($1,396,459)	($453,111)	$943,348
Year 16	($3,671,459)	($1,953,111)	$1,718,348
Year 17	($1,396,459)	($453,111)	$943,348
Year 18	($1,396,459)	($453,111)	$943,348
Year 19	($1,396,459)	($453,111)	$943,348
Year 20	($1,396,459)	($453,111)	$943,348

Simple Payback	**1.29 years**
Potential savings over 20-years	**$ 19,202,056**
IRR	**78%**

Exampte

Discount Rate	**10%**	
Net Present Value	**$6,678,689**	**USD**

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Carbon Emissions Impact

Emissions from Natural Gas

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (50) KCFM :	1,040	MT CO_2 / year
Other Equipment		MT CO_2 / year
CO_2 emissions	1,040	MT CO_2 / year
	945,791	kg CO_2 / year
Carbon equivalent	284	MT Carbon/year
	257,943	kg Carbon/year

VOCGEN Natural Gas Emissions

Total usage	17,016,624	kWh/year
Carbon emissions from natural gas	0.185	kg CO_2/kW
CO_2 emissions	3,148,075	kg CO_2/year
Carbon equivalent	858,566	kg Carbon/year

VOCGEN VOC Emissions

Total usage	5,431,430	kWh/year
Carbon emissions from natural gas	0.185	kg CO_2/kW
CO_2 emissions	1,004,815	kg CO_2/year
Carbon equivalent	274,040	kg Carbon/year

Emissions Avoided by On-Site Energy Generation

Grid supplied electricity avoided	510	kW
	4,443,120	kWh/year
	4,443	MWh/year
Carbon emissions from grid electricity	0.537	kg CO_2 / kW
CO_2 emissions	2,385,955	kg CO_2 / year
Carbon equivalent	650,715	kg Carbon/year

VOCGEN Electricity Generated

Total electricity generated	510	kW
Parasitic load	50	kW
Theorectical - total electricity available	460	kW
Actual - total electrical available	456	kW
	3,976,418	kWh/year
	3,976	MWh/year

No carbon emissions (see natural gas above)

Emissions Avoided by On-Site Heat Generation

Natural gas usage avoided	17,274,380	kWh/year
Carbon emissions from natural gas	0.185	kg CO_2 / kW
CO_2 emissions	3,195,760	kg CO_2 / year
Carbon equivalent	871,571	kg Carbon/year

VOCGEN Heat Generated

17,274,380 kWh/year

No carbon emissions (see natural gas above)

Estimated CO_2 emissions (Metric Tons - MT)	**6,527,507**	**kg CO_2 / year**
	7,180	**MT CO_2 / year**
Estimated Carbon equivalent	**1,780,229**	**kg Carbon/year**
	1,958	**MT Carbon/year**

Estimated CO_2 emissions (Metric Tons - MT)	**4,152,890**	**kg CO_2 / year**
	4,568	**MT CO_2 / year**
Estimated Carbon equivalent	**1,132,606**	**kg Carbon/year**
	1,246	**MT Carbon/year**

Net Estimated Annual Savings	**2,612**	**MT CO_2 / year**
	712	**MT Carbon/year**

VOCGEN CHP Project Feasibility
Maintenance Schedule

Expanded Foam Manufacturing Company

Prices:	US Energy Information Agency - Energy Prices for June, 2013	
	Quarterly Service	$6,000.00
	Minor ASE8 engine rebuild	$70,000.00
	Major ASE8 engine rebuild	$85,000.00

		Total
Year 1	Quarterly Service	($24,000.00)
Year 2	Quarterly Service	($24,000.00)
Year 3	Quarterly Service and minor rebuild	($94,000.00)
Year 4	Quarterly Service	($24,000.00)
Year 5	Quarterly Service	($24,000.00)
Year 6	Quarterly Service and major rebuild	($109,000.00)
Year 7	Quarterly Service	($24,000.00)
Year 8	Quarterly Service	($24,000.00)
Year 9	Quarterly Service and minor rebuild	($94,000.00)
Year 10	Quarterly Service	($24,000.00)
Year 11	Quarterly Service	($24,000.00)
Year 12	Quarterly Service and major rebuild	($109,000.00)
Year 13	Quarterly Service	($24,000.00)
Year 14	Quarterly Service	($24,000.00)
Year 15	Quarterly Service and minor rebuild	($94,000.00)
Year 16	Quarterly Service	($24,000.00)
Year 17	Quarterly Service	($24,000.00)
Year 18	Quarterly Service and major rebuild	($109,000.00)
Year 19	Quarterly Service	($24,000.00)
Year 20	Quarterly Service	($24,000.00)

Total over 20-years	($945,000.00)
Yearly cost	($47,250.00)
Monthly cost	($3,937.50)

Assumptions and Notes

	Energy			Maintenance (k$)	Annual O&M ($k)	Capital (k$)	Annual CO2 Emissions (MT)	Annual Carbon Emissions (MT)
	Gas (k$)	Electric (k$)	Credit (k$)					
Thermal Oxidizer *(TO)*	($388)	($95)	$16	($25)	($602)	($2,275)	7,180	1,958
TO Heat Recovery *(HR)*								
VOCGEN Gas Turbine Oxidizer *(GTO)*	($406)	$0	$889	($47)	$436	($3,490)	4,568	1,246
GTO Heat Recovery *(HR)*								

Volatile Organic Compound: Pentane

Total	1,045,440 VOC lbs/year	50,000 CFM Airflow Total	
Drying Exhaust Pentane	10-100 lbs/hr	5,000 CFM voc laden air from production plant and voc concentrator	
		1,200 CFM ambient air flow	
Process air temp	75-100 deg F		
Destruct Removal Efficiency (DRE) Requirement		BACT	
VOCGEN Gas Turbine Oxidizer (GTO)	ASE 8 Gas Turbine VOC	6,200 cfm inlet air at 75°F	
GTO Recoverable Heat	60°F inlet air Temp	Exhaust Gas Heat Content ≈6.22 MMBtu/Hr	waste heat (<1000°F) for steam; fired to approx. 1300F
Natural Gas Fuel	20,100 Btu/lb Lower Heating Value		
Radiated heat:	"radiated, conducted and convected" from the engine at continuous duty - 180,000 Btu/hr		

The amount of natural gas required to run the gas turbine is dependent on two process variables: 1) the load placed on the gas engine (kW demand), and 2) the energy content supplied by the VOC laden air stream.

The system's main function is to convert the energy provided primarily from a natural gas supply (and to a lesser extent, the energy provided by a volatile organic compound laden air stream) to produce 525 kW of electrical power at 480 VAC, three-phase, 60 Hz, destroy VOC waste streams, as well as produce approximately 6 MMBTU" recoverable heat. Inlet air combined with a concentration of a volatile organic compound (at a level below 50 % LEL), will be drawn in, compressed and heated in a secondary combustion chamber, then introduced into a primary combustion chamber with natural gas to fuel a combustion process which operates the gas turbine at a speed of 41,730 rpm. The mechanical rotation of the gas turbine drives an AC generator at a rate of 1,800 rpm via a gearbox.

Maintenance Schedule: Service checkup including replacing belts, filters and other consumables is required quarterly. Minor rebuild of the ASE8 engine every 2.5 years and major rebuild of the engine every 3 years.