VOCGEN CHP Level One Project Feasibility Financial Summary

Film Coating and Flexographic Production State of California

Operational Costs	Air Pollution Control Equipment & Utility Supplied Energy	VOCGEN CHP Equipment
Natural Gas	($450,538)	($473,175)
Electricity	($92,639)	$0
Maintenance	($50,000)	($45,000)
Plant Natural Gas	($389,611)	
Plant Electricity	($290,566)	
	($1,273,353)	($518,175)
Annual Savings		**$755,178**
Capital Equipment		
Regenerative Thermal Oxidizer (RTO)	($675,000)	$675,000
VOCGEN CHP System	$0	($2,559,250)
	($675,000)	($1,884,250)
Simple Payback Period	None	**2.5-year payback**
Potential savings over 20-years		**$11,568,267**
Internal Rate of Return		**39%**
Net Present Value (NPV)		**$3,605,751**
Carbon Dioxide Emissions (MT)	6,794	4,568
Carbon Equivalent Emissions (MT)	1,853	1,246
Annual Carbon Reduction		**32.76%**

Film Coating and Flexographic Production Example
Level One (1) Cost Benefit Analysis

VOC loading Rate	40 lb/hr
Plant location	California
Natural Gas Price	$6.61 USD/MMBtu
Electricity Price	$0.112 USD/kWh

US Energy Information Agency - Energy Prices October - 2013..... Ink/Coating Hap - VOC Heat Content 14,500 Btu/tb

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

Equipment Selection

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (25) KCFM at 60°F	1	Unit(s)
Other Equipment	0	Unit(s)

Operating Hours

(RTO - Regenerative Thermal Oxidizer) Operating hours	8,520 hr/yr
	(8hrs/shift, 3shifts/day, 355days/yr)

Air Flow

System airflow (CFM)	25,000 CFM
Other	

1. Fuel

System operating hours (8hrs/shift, 3shifts/day, 355days/yr)	8,520	hrs/yr
Regenerative Thermal Oxidizer fuel requirement	8.00	MMBtu/hr
Other equipment fuel requirement	0.00	MMBtu/hr

Estimated Fuet Required

Annual Carbon Reduction

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (25) KCFM at 60°F	($450,538)	USD
Other Equipment	$0	USD
Total Natural Gas usage by Option 1	($450,538)	USD/yr

VOCGEN CHP Equipment Option 2

VOCGEN Equipment Selection

VOCGEN Genset -*0.560 MW — 1 Unit(s)

VOC Concentrator — 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: 45 Feet

1. VOCGEN Fuel

VOC Energy Contribution

Operating hours (VOC production) (8hrs/shift, 3shifts/day, 360days/yr)	8,640	hrs/yr
VOC load	40	lb/hr
Heat content	14,500	Btu/lb
	5,011	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

Estimated Fuel Required

Natural Gas	68,160 MMBtu/yr
Total fuel	**($450,538) USD/yr**

Estimated Fuel Required

VOC	5,011	MMBtu/yr	$33,124 USD/yr Savings
Natural Gas	71,585	MMBtu/yr	($473,175) USD/yr
Total fuel	**76,596**	**MMBtu/yr**	**Cost ($473,175) USD/yr**

2. Regenerative Thermal Oxidizer Electrical Cost

Estimated RTO Electricity Cost
Using total motor Hp of 97.5 & power draw of 0kW

830,839 kWh/yr
($92,639) USD/yr

2. VOCGEN Parasitic Loads

VOCGEN Genset(s) 0.560 MW

Chiller	75	kW/unit
	75	kW - parasitic load
NG Booster Compressor	50	kW/unit
	50	kW - parasitic load

Estimated Operation Electricity Use From Parasitic Load

125 kW
1,089,000 kWh/yr

3. Annual Maintenance

($50,000) USD/yr

3. Annual VOCGEN Maintenance

($3,750) USD/month
($45,000) USD/yr

4. Avoided Electrical Requirements of Facility

435 kW
2,605,977 kWh/yr

VOCGEN Cost Avoidance
($290,566) USD/yr

4. VOCGEN Electrical Output Contribution (Less Parasitic Load)

(560kW - 125kW) 435 kW
2,605,977 kWh/yr

Altitude factor at 45ft is 0.999 of nominal output power
VOCGEN parasitic load deducted from total electrical output

5. Avoided Natural Gas Requirements for Heating/Cooling

58,943 MMBtu/yr

VOCGEN Cost Avoidance
($389,611) USD/yr

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**

Regenerative Thermal Oxidizer annual operating cost

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

VOCGEN Carbon Emissions Reductions - Potential

Federal Proposed Value
607 ton Carbon/year
$35.00 USD/ton

$21,249 USD/yr
Not included in total savings

Operational Cost per Year **($1,273,353) USD/yr**

Operational Cost per Year **($518,175) USD/yr**

Estimated Annual Savings **$755,178 USD/yr**

VOCGEN CHP Project Feasibility
Level 1

6. Capital Equipment Budget- First year

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (25) KCFM	($500,000) USD
Other Equipment	$0 USD

One Additional 'RTO' unit(s) will be purchased during the 20-year evaluation period with installation costs included (factor: 1.35): ($675,000) USD

Estimated Equipment Costs ($500,000) USD/yr

Installation (est. 35% of equipment) ($175,000) USD

Estimated Capital Equipment Costs **($675,000) USD**

Year Zero Avoided Costs **$675,000 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 480 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. 35% of equipment)	($603,050) USD
Const. Mgmt., Subcontractors and Suppliers	
Engineering, Civil, Mechanical, and Electrical	
Heat utilization	
VOC Concentrator | HRSG	($500,000) USD

Estimated Capital Equipment Costs **($2,559,250) USD**
(Rebate of $266,800 subtracted from the cost)

Adjusted First Year Costs **($1,884,250) USD**

7. Cash Flow

	Equipment Option 1	VOCGEN Equip. Option 2	
	Each year	Each year	Difference
Year 0	($675,000)	($2,559,250)	($1,884,250)
Year 1	($1,273,353)	($518,175)	$755,178
Year 2	($1,273,353)	($518,175)	$755,178
Year 3	($1,273,353)	($518,175)	$755,178
Year 4	($1,273,353)	($518,175)	$755,178
Year 5	($1,273,353)	($518,175)	$755,178
Year 6	($1,273,353)	($518,175)	$755,178
Year 7	($1,273,353)	($518,175)	$755,178
Year 8	($1,273,353)	($518,175)	$755,178
Year 9	($1,273,353)	($518,175)	$755,178
Year 10	($1,273,353)	($518,175)	$755,178
Year 11	($1,948,353)	($2,844,225)	($895,872)
Year 12	($1,273,353)	($518,175)	$755,178
Year 13	($1,273,353)	($518,175)	$755,178
Year 14	($1,273,353)	($518,175)	$755,178
Year 15	($1,273,353)	($518,175)	$755,178
Year 16	($1,273,353)	($518,175)	$755,178
Year 17	($1,273,353)	($518,175)	$755,178
Year 18	($1,273,353)	($518,175)	$755,178
Year 19	($1,273,353)	($518,175)	$755,178
Year 20	($1,273,353)	($518,175)	$755,178

Simple Payback	**2.50 years**
Potential savings over 20-years	**$ 11,568,267**
IRR	**39%**

Exampte

Discount Rate	**10%**	
Net Present Value	**$3,605,751**	**USD**

Carbon Emissions Impact

Emissions from Natural Gas

Equipment Option 1

RTO - Regenerative Thermal Oxidizer (25) 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	20,979,416	kWh/year
Carbon emissions from natural gas	0.185	kg CO_2/kW
CO_2 emissions	3,881,192	kg CO_2/year
Carbon equivalent	1,058,507	kg Carbon/year

VOCGEN VOC Emissions

Total usage	1,468,638	kWh/year
Carbon emissions from natural gas	0.185	kg CO_2/kW
CO_2 emissions	271,698	kg CO_2/year
Carbon equivalent	74,099	kg Carbon/year

Emissions Avoided by On-Site Energy Generation

Grid supplied electricity avoided	435	kW
	3,789,720	kWh/year
	3,790	MWh/year
Carbon emissions from grid electricity	0.537	kg CO_2 / kW
CO_2 emissions	2,035,080	kg CO_2 / year
Carbon equivalent	555,022	kg Carbon/year

VOCGEN Electricity Generated

Total electricity generated	435	kW
Parasitic load	125	kW
Theorectical - total electricity available	310	kW
Actual - total electrical available	310	kW
	2,696,930	kWh/year
	2,697	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)	**6,176,631**	**kg CO_2 / year**
	6,794	**MT CO_2 / year**
Estimated Carbon equivalent	**1,684,536**	**kg Carbon/year**
	1,853	**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 Annuat Savings	**2,226**	**MT CO_2 / year**
	607	**MT Carbon/year**

VOCGEN CHP Project Feasibility
Maintenance Schedule

Film Coating and Flexographic Production

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

		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	($94,000.00)
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	($94,000.00)
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	($94,000.00)
Year 19	Quarterly Service	($24,000.00)
Year 20	Quarterly Service	($24,000.00)

Total over 20-years	($900,000.00)
Yearly cost	($45,000.00)
Monthly cost	($3,750.00)

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)***	($451)	($93)	$15	($50)	($686)	($675)	6,794	1,853
TO Heat Recovery ***(HR)***								
VOCGEN Gas Turbine Oxidizer ***(GTO)***	($473)	$0	$680	($45)	$162	($2,559)	4,568	1,246
GTO Heat Recovery ***(HR)***								

Volatile Organic Compounds/HAP

Total	413,602 VOC lbs/year	12,921 ACFM Airflow Total
Topcoat Oven A	10-100 lbs/hr	10,500 ACFM Oven Air 2,400 ACFM Combustion Air
Destruct Removal Efficiency (DRE) Requirement		MACT

VOCGEN Gas Turbine Oxidizer (GTO)	ASE 8 Gas Turbine VOC	6,000 cfm inlet air at 60°F	
GTO Recoverable Heat	60°F inlet air Temp	Exhaust Gas Heat Content ≈6.22 MMBtu/Hr	high-grade (<900°F) waste heat
Natural Gas Fuel	20,100 Btu/lb Lower Heating Value		

Radiated heat: "radiated, conducted and convected" from the engine at continuous duty - 100,000 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.

	Natural Gas	Electricity
	($ / MMBtu)	($ / kWh)
State	**Oct-13**	**Oct-13**
Alabama	5.94	0.0604
Alaska	3.98	0.1208
Arizona	7.81	0.0613
Arkansas	7.49	0.0569
California	6.61	0.1115
Colorado	6.09	0.0631
Connecticut	10.40	0.1681
Delaware	15.70	0.0927
District of Columbia	--	0.0837
Florida	9.72	0.0937
Georgia	7.06	0.059
Hawaii	14.83	0.1585
Idaho	6.53	0.0515
Illinois	6.65	0.0745
Indiana	6.49	0.0584
Iowa	5.39	0.0497
Kansas	5.07	0.0642
Kentucky	7.95	0.105
Louisiana	5.24	0.0478
Maine	15.24	0.0966
Maryland	8.83	0.1035
Massachusetts	17.23	0.1006
Michigan	9.47	0.0717
Minnesota	4.99	0.0616
Mississippi	7.14	0.0659
Missouri	9.74	0.0498
Montana	9.25	0.0515
Nebraska	6.36	0.056
Nevada	11.34	0.072
New Hampshire	15.87	0.1477
New Jersey	7.77	0.109
New Mexico	4.68	0.0572
New York	8.00	0.065
North Carolina	8.31	0.0584
North Dakota	5.55	0.0561
Ohio	9.00	0.0685
Oklahoma	10.77	0.0499
Oregon	10.44	0.0465
Pennsylvania	9.32	0.0759
Rhode Island	11.64	0.1269
South Carolina	8.11	0.0574
South Dakota	5.63	0.0562
Tennessee	7.23	0.0674
Texas	6.04	0.0699
Utah	5.89	0.0476
Vermont	8.16	0.0925
Virginia	7.24	0.0687
Washington	12.64	0.051
West Virginia	5.19	0.054
Wisconsin	6.62	0.066
Wyoming	4.59	0.0463
Other (Site specific)	0.00	0