

CITCO - Waste Heat Recovery Sub-Application

March 25th – Additional information

Plant Basis of Production

Redacted

Scope 1 Emissions

- Refence Plant Emissions (BAU) **Redacted**
- Waste Heat Recovery Contribution : (11,000) metric ton CO2e/year
- Emissions with Waste Heat Recovery **Redacted**

Redacted

All Scope 1 emissions come from combustion of natural gas

- BAU Total Annual Natural Gas **Redacted**
- Heat Recovery Contribution : (209,000) MMBTU/year
- Total Annual Natural Gas with Heat Rec.: **Redacted**

BAU Scenario

Redacted **Redacted**

While hot air is exhausted, all fresh air coming into the building is heated using natural gas.

Heat Source vs Heat Sinks

Higher Temperature Source compared to Heat Sinks

Heat source : Redacted exhaust

- Temperature : Redacted
- Humidity : Redacted

First heat sink – Make-up water

- Temperature : 39°F to 77°F depending on season

Second heat Sink – Make-up air

- Temperature : 31°F to 77°F depending on season

Thermal Fluid

- The glycol is heated to a temperature between the source and sinks, up to Redacted
The glycol temperature is modulated to suit heat demand at the sinks.

Waste Heat Available

- Part of the heat available is used. Between 25% and 65% during the heating season.

Typical Flow Diagram – Similar Project in operation

Redacted

Greenhouse Gas Calculations – Heat Sinks

1) First Heat Sink

Fresh water heating

- 1800 l/min of fresh-water make-up.

Redacted

Redacted		Boiler efficiency 84%			
		Water temperature (°C)			
Month	Average Temperature (°C)	Days /Month	Heating requirement* (GJ)	Energy from boiler (84% eff) (GJ)	Gas avoidance (tonnes)
Jan	4	31	10 328	12 293	11 652
Feb	4	28	9 016	10 758	10 175
Mar	5	31	9 582	11 502	10 902
Apr	11	30	7 480	8 905	8 446
May	16	31	6 119	7 285	6 935
Jun	20	30	4 175	5 006	5 275
Jul	24	31	3 143	4 219	3 993
Aug	25	31	3 221	3 834	3 634
Sep	22	30	4 052	4 804	4 577
Oct	17	31	5 797	6 951	6 641
Nov	10	30	7 762	9 296	8 922
Dec	6	31	9 340	11 118	10 559
Total			91 026	99 459	91 426 tonnes
availability			95%		95%
Total			91 459		86 854 tonnes
GHG reduction				\$128	MTCO2e

Greenhouse Gas Calculations – Heat Sinks

2) Second Heat Sink :

Fresh air make-up to the building

- Considering 700 000 cfm of make-up air supplied to the buildings.

Redacted

Redacted				Air heating Efficiency 90%	
Month	Average Temperature (°F)	Average Temperature (°C)	Days/Month	Heating Requirement (GJ)	Heating Requirement (MMBtu)
Jan	31.9	-0.1	31	25,269	23,971
Feb	33.6	1.4	29	21,222	20,116
Mar	43.5	6.4	31	17,595	16,599
Apr	50.9	10.5	30	12,262	11,623
May	60.7	15.9	31	6,163	5,842
Jun	75.4	24.9	30	0	0
Jul	76.5	24.9	31	0	0
Aug	74.4	23.5	31	0	0
Sep	65.5	19.2	30	2,237	2,134
Oct	52.7	11.3	31	11,476	10,877
Nov	40.9	4.9	30	18,869	17,715
Dec	31.4	-0.3	31	25,621	24,293
Total				146,545	139,219
availability				90%	125,497
Total				133,517	126,926
GHG reduction				8,728	8,293

* 1000000 BTU per

Scope 1 and Scope 2 clarification

On the latest version of the
"Waste Heat Recovery_GHG
Avoidance Calculator_CITCO
855400 Checklist.xls"
submitted (see attached
document), **250 HP** of pumps
were deducted for the CHG
calculator.

CITCO GHG Avoidance Calculator				
Applicant Name: Falcon - Waste Heat Recovery		est - Metric Tonne		
Estimated Annual GHG avoidance - Scope 1 (net CO2e):		10 949, 10		
estBTU = One Million				
Project Information				
Measure Description	Estimated Equipment Cost	Natural Gas (Therms)	Coal (short tons)	Black Petroleum Co (mmBTU)
Glycol Heat Recovery System	\$ 8 668 710,00	1 259 760		
Glycol Heat Recovery System Additional Consumption		57 367		
Process Water Heat Recovery	\$ 910 000,00	868 757		

For this calculator we used a conversion rate of 1 therm = 100,000 BTU. For more information on the calculator's limitations, visit: [http://bit.ly/1111111](#)

Operation Narrative

- The operation team is in charge of the heat recovery system.
- The system is tied-in to the distributed control system (DCS) used for the process. All control loops are automated within the DCS, which is also provided with screen pages to monitor the performance.

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Redacted

Risk Identification

Risk Category	Description	Rate
Financial	Redacted	L
Technical	Technical risk mitigated with previous projects already executed and in operation.	L
Design	Project is based on existing industry standard designs but brings improvements which require unique engineering. However, equipment specifications are known from previous projects. Internal engineering and corporate energy engineers have experience with such installation.	L-M
Execution	Technically experienced internal and external professionals available for all aspects (piping, electrical, mech).	L-M
Achievement of Carbon Goal	Application design for process and for heat. Confidence of carbon KPI achievement based on similar projects previously achieved.	L
	Process equipment is integrated on the main DCS and fully part of the operation metrics followed continuously.	
	All Greenhouse projects within the corporation are monitored with metrics (actual vs objective) shared with upper management and operation teams.	
	Corporation has experience with Energy Management System and Energy Management Information Systems as per ISO 50 001.	

L = Low Risk
M = Medium Risk
H = High Risk

Pictures of Similar Installation

Redacted