

US EPA ARCHIVE DOCUMENT

Independent Study of CO2 Sales of Waste CO2 Stream from Corpus Christi LNG Project

28-Mar-14

Retain Same Amine System, Triazine Sulfur Removal, Eliminate Thermal Oxidizers, Add CO2 Drying Compression

Corpus Christi LNG
Modeled After Freeport PSD Application
CO2 Pipeline/Injection Well Assumptions

Basis: Case 2-02A from DOE Baseline Report
Source: Cost and Performance of PC and IGCC Plants for a Range of Carbon Dioxide Capture
27-May-11 DOE/NETL-2011/1498

Pipeline Length , miles 160 (to Hastings Field)

Pipeline Diameter: 10 inches vs 16.8 in PSD Application

Number of Injection Wells - NA

Depth of Well 1,000 meters (Assume EOR)

Electricity for Compression (DOE Study)

Electricity TEG Drying (rough guess)

Electricity for Inlet Blower

Total Power Requirements

CSS Cost Breakdown

Key Assumptions:

- 1 CO2 Compr/Drying extracted from DOE capex
- 2 Costs for add'l utilities contols, electrical, etc scaled to CO2/TIC
- 3 Escalated per HIS CERA Downstream O/G Index 2006/7 to 2013 +5% to 2014
- 4 Overnight Cost 2014 no escalation for construction or operating periods
- 5 Estimating contingency of 15% added to total estimate
- 6 Use of existing Amine Design uses existing Triazine scavenger, integrating TEG dryer in the Compression System

5,326

920

0

6,246

Economics Method is from ATKINS 044167600 Report CO2 BACT Study

Cost Type	Units	Cost	
Pipeline Costs ¹			
Pipeline Materials	Scaled from similar CO2 lines	Private Sources	\$36,222,163
Pipeline Labor			\$103,569,242
Pipeline Miscellaneous, commissioning, freight			\$0
Pipeline Right of Way, Surveys			\$35,214,941
Construction Management			\$1,500,000
Permits and Licenses			\$1,000,000
Total Pipeline Cost	per mile cost	\$1,109,414.67	\$177,506,347
Other Capital ²			
Inlet Compression / Control			\$0
CO2 Compression and Drying Equipment			\$19,800,000
Add TEG Dehydration			
CO2 Surge Tank		\$0	\$0
Pipeline Control System		\$340,000	\$0
Total Compression/Drying Cost			\$19,800,000
Engineering			Included above
Savings from Eliminating Thermal Oxidizers			\$-25,241,250
Net Plant Cost Additions, excluding Pipeline			\$14,358,750
Total Capex			\$191,865,097
O&M - Pipeline ³			
Fixed O&M		\$8,632	\$319,384
O&M - Compress and Dry			
Fixed O&M	% of installed cost	2.5%	\$495,000
Natural Gas for Amine Regeneration		\$3,000	\$0
Electricity for Compression		\$0.060	\$3,282,890
Water Disposal			\$34,400
Electricity for Inlet Blower		\$0.060	\$0
Amine Replacement		Engineering Estimate	\$0
Credit for Shutting Down RTOs			
Annual O&M Costs (Compression, Drying, Pipeline)			\$4,140,309
Geologic Storage Costs ³			
Site Screening and Evaluation		\$0	\$0
Injection Wells	\$/inj	\$240,714 x e	\$0
Injection Equipment	\$/inj	\$94,029 x	\$0
Liability Bond		\$7389/yr	\$0
Declining Capital Funds			
Pore Space Acquisition	\$/short ton	0.334/s	\$0
Total Capital Cost			
O&M - Geologic			
Normal Daily Expenses (Fixed O&M)	\$/injection well	\$11,566	\$0
Consumables (Variable O&M)	\$/yr/short ton	\$2,995	\$0
Surface Maintenance (Fixed O&M)	see formula	\$23,478 x	\$0
Subsurface Maintenance (Fixed O&M)	\$/ft-de	\$7	\$0

Amortized CCS Cost

1.National Energy Technology Laboratory, "Carbon Dioxide Transport and Storage Costs in NETL Studies," DOE/NETL-2013/1614, March 2013.

2.Costs are based on Revised Estimates based on Published DOE Studies

Total Capital Investment (TCI)

Capital Recovery Factor (CRF) = $i(1+i)^n / ((1+i)^n - 1)$

i = interest rate

n= equipment life, years

Amortized Installation Costs = CRF * TCI

Annual O&M Costs

\$191,865,097

8.255%

8.000%

30

\$15,838,036

\$4,140,309

Total CCS Annualized Cost

\$19,978,345

Tons CO2 per Year Removed (AGR)

552,522 TPA

Use Atkins annual volumes

Average Annual Cost per Ton CO2 Removed

\$36.16 per ton

(assume 100% of captured CO2 is compressed and sold to EOR operator)

ATKINS 044167600 Revised November 7, 2013

ATKINS 07/20/2012 Response to EPA

Pipeline Capacity is smaller and 10" diam vs 16.8"

use square root scaling factor

0.772

Labor and ROW scales to distance

4.71

From Freeport Atkins Estimates

Corpus Christi

	\$ 9,976,724	\$ 36,222,163
	\$ 22,008,464	\$ 103,569,242
	\$ 7,483,175	\$ 35,214,941
	??	\$ 1,500,000
		\$ 1,000,000
\$1,160,834.21	\$ 39,468,363	\$ 177,506,347

This estimate is very close to the Trinity PSD Report

Not Needed

from scaled DOE Studies of similar equipment

TEG cost unknown, in DOE Compress/Dry estimate

Not Needed

Included in estimate above

based on vendor quotations including install, commissioning costs

Round Up

Use 160 mi to Hastings Denbury, use Freeport Cost data

Typical Compression FOM is 2-3%, including operating labor

Steam or fuel to operate Solvent AGR will be less than Amine System, not estimated, assume zero is safe

14,820 kw for Atkins. This is much higher than the DOE estimate +1500kw for intercooler TEG drying should be easily handled in PT Plant system, include in our estimate to be consistent

Solvent based AGR produces CO2 at elevated pressure, no blower is needed per DOE report

make up of solvent will be the same whether or not CO2 is compressed and sold to EOR

No credit is taken for savings in fuel, power, O&M cost of RTOs

Not needed if CO2 is sold to Denbury at NG processing site or pipeline terminal

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