

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	Basis:	Case 2-D2A from DOE Baseline Report
Modeled After Freeport PSD Application	Source:	
CO2 Pipeline/Injection Well Assumptions		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)	5,326	
Electricity TEG Drying (rough guess)	920	
Electricity for Inlet Blower	0	
Total Power Requirements	6,246	
CSS Cost Breakdown		

- 1 CO2 Comp/Drying extracted from DOE capex
- 2 Costs for add'l utilities controls, 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

Economics Method is from ATKINS 044167600 Report CO2 BACT Study

Cost Type	Units	Cost	
Pipeline Costs <sup>1</sup>			
Pipeline Materials	Scaled from similar CO2 lines	Private Sources	\$36,222,163
Pipeline Labor			\$103,569,242
Pipeline Miscellaneous, commissioning, freight			\$0
Permitting 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 <sup>2</sup>			
			\$0
			\$19,800,000
			\$0
			\$0
			\$340,000
Total			\$0
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 <sup>3</sup>			
Fixed O&M		\$8,632	\$319,384
O&M - Compress and Dry			
Fixed O&M	% of installed	2.5%	\$495,000
Natural Gas for Amine Regeneration			\$0
Electricity for Compression			\$0.060
Water Disposal			\$34,400
Electricity for Inlet Blower			\$0.060
Amine Replacement		Engineering Estimate	\$0
Credit for Shutting Down RTOs			
Annual O&M Costs (Compression, Drying, Pipeline)			\$4,140,309
Geologic Storage Costs <sup>3</sup>			
Capital			
Site Screening and Evaluation			\$0
Injection Wells	\$/in <sup>2</sup>	\$240,714 x e <sup>0.0008 x well depth</sup>	\$0
Injection Equipment	\$/inj ect	\$94,000 x <sup>7389/1</sup>	\$0
Liability Bond			\$5,000,000
Declining Capital Funds			
Pore Space Acquisition	\$/sh	0.334/s <sup>short ton</sup>	\$0
Total Capital Cost			\$191,865,097
O&M - Geologic			
Normal Daily Expenses (Fixed O&M)	\$/injection well	\$11,566	\$0
Consumables (Variable O&M)	\$/yr/short ton	\$2,995	\$0
Surveillance Maintenance (Fixed O&M)	see formula	\$23,478 x <sup>7389/1</sup>	\$0
Subsurface Maintenance (Fixed O&M)	\$/ft-de	\$7	\$0

Pipeline Capacity is smaller and 10" diam vs 16.8"

use square root scaling factor

Labor and ROW scales to distance

0.772

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&amp;M cost of RTOs

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

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## 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)		\$191,865,097	
Capital Recovery Factor (CRF) = $(1+i)^n / ((1+i)^n - 1)$		8.255%	
i = interest rate		8.000%	
n = equipment life, years		30	
Amortized Installation Costs = CRF * TCI		\$15,838,036	
Annual O&M Costs		\$4,140,309	

Total CCS Annualized Cost \$19,978,345

Akins reports 9% but formula says 8.26%

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