Randy Hamilton

From: Latha Kambham <LKambham@trinityconsultants.com>
Sent: Monday, May 19, 2014 12:37 PM
To: Randy Hamilton
Cc: Carlson, Larry
Subject: Tenaska Brownsville - CCS Cost Analysis
Attachments: Tenaska_Brownsville_Pipeline Transfer Cost 2014-0516.pdf; Tenaska_Brownsville_CCS Cost Estimate 2014-0519.pdf

Randy,

Per our discussions last week (via voicemails) and your discussion with Larry, please find attached the CCS Cost evaluation based on capital cost for the proposed project and CCS.

The capital cost for the pipeline transfer was obtained from previously submitted cost analysis (excluded O&M costs). For your reference, we are including the pipeline transfer costs submitted to EPA Region 6.

Please let us know if you have any questions or comments regarding this.

Thanks,
Latha

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Table C-1. Cost Estimation for Transfer of CO_2 via Pipeline to Existing CO_2 Well

CO_2 Pipeline and Emissions Data

Parameter	Value	Units
Minimum Length of Pipeline	106	miles
Average Diameter of Pipeline	8	inches
CO_2 emissions from combustion turbines (both CCCTs)	3,140,799	Short tons/yr
CO_2 Capture Efficiency	90%	
Captured CO_2	2,826,719	Short tons/yr

CO_2 Transfer Cost Estimation [1]

Cost Type	Units	Cost Equation	Cost ($)
Pipeline Costs			
Materials	$ Diameter (inches), Length (miles)	$64,632 + $1.85 x L x (330.5 x D^2 + 686.7 x D + 26,960)	$10,576,690.16
Labor	$ Diameter (inches), Length (miles)	$341,627 + $1.85 x L x (343.2 x D2 + 2,074 x D + 170,013)	$41,242,164.78
Miscellaneous	$ Diameter (inches), Length (miles)	$150,166 + $1.58 x L x (8,417 x D + 7,234)	$12,639,149.60
Right of Way	$ Diameter (inches), Length (miles)	$48,037 + $1.20 x L x (577 x D +29,788)	$4,424,225.80
Other Capital			
CO_2 Surge Tank	$	$1,150,636	$1,150,636.00
Pipeline Control System	$	$110,632	$110,632.00
Operation & Maintenance (O&M)			
Fixed O&M	$/mile/yr	$8,632	$914,992.00
		Total Pipeline Cost	**$71,058,490.34**

Amortized Cost Calculation

Equipment Life [2]	20	years
Interest rate [3]	7%	
Capital Recovery Factor (CRF) [4]	0.09	
Total Pipeline Installation Cost (TCI)	$70,143,498	$ (Pipeline + Other Capital)
Amortized Installation Cost (TCI *CRF)	$6,621,050	$/yr
Amortized Installation + O&M Cost	$7,536,042	$/yr
CO_2 Transferred	2,826,719	Short tons/yr
Annuitized control cost per ton [5]	**3**	**$/ton-yr**

[1] Cost estimation guidelines obtained from "Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

[2] Pipeline life is assumed based on engineering judgment.

[3] Interest rate conservatively set at 7.00%, based on EPA's seven percent social interest rate from the OAQPS CCM Sixth Edition.

[4] Capital Recovery Fraction = Interest Rate (%) x (1+ Interest Rate (%)) ^ Pipeline Life) / ((1 + Interest Rate (%)) ^ Pipeline Life - 1)

[5] This cost estimation does not include capital and O&M costs associated with the compression equipment or processing equipment.

Tenaska Brownsville Partners, LLC
Brownsville Generating Station
Table 1. Carbon Capture and Sequestration (CCS) Cost Estimate

Plant Output (2X1)	800	MW
	800,000	kW
Cost of Compression and Storage		
Cost per NGCC Document (June 2011 basis)[1]	*624.00*	*$/kW*
Cost per NGCC Document (2014 basis)[2]	*657.66*	*$/kW*
Total Cost for Compression and Storage	$526,128,000	
Pipeline Transfer Cost[3]	$70,143,498	
Total Capital Cost for CCS	**$596,271,498**	
Total Capital Cost for the Proposed Brownsville Generating Station[4]	**$500,000,000**	$ (Equipment and control costs)
CCS Cost as a Percentage of Project Capital Cost	**119%**	

[1] Capital cost of compression and storage obtained from Exhibit 4-16 Case 14 in the final report of *Updated Costs (June 2011 Basis) for Selected Bituminous Baseline Cases,* dated August 2012.

[2] Capital costs adjusted using the U.S. BLS CPI Inflation Calculator from 2011 ($624/kW) to 2014 dollars ($657.66/kW) (http://www.bls.gov/data/inflation_calculator.htm).

[3] The pipeline transfer cost estimated based on-"Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs", DOE/NETL-2010/1447, dated March 2010.

[4] Total Capital Cost for the proposed Brownsville Generating Station obtained from Table 30 (Estimated Capital Cost and Fee Verification) submitted with the application.