High-level Economic Analysis for CO2 Capture, Compression and Transportation

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In collaboration with

Kansas Geological Survey

Context

We outline a variety of scenarios for capture and transportation of large CO_2 volumes that are economic at **$70-100 oil**.

4.3 million tonne/yr could be captured and transported to Kansas oil fields for **$35-$42 per tonne** (~$2/mcf).

Proposed **45Q credits (ramp to $35/tonne** - $1.85/mcf) make the business proposition very attractive.

4.3 Mt/yr (221 mmcf/d) used for EOR could increase production in **Kansas by 28%** (10 million BO/yr).

Outline

Focus mainly on CO_2 capture from ethanol plants and transportation to EOR storage sites

1. Basis for capital and operating costs (CapX and OpX)
2. Describe financial modeling and assumptions
3. Economic analysis for multiple scenarios, small to very large
   - Summary of average costs
   - All the details for one scenario
   - Less detail for others
   - Transportation from larger industrial sources (power and refinery)
4. Summary and Discussion

Handy conversions, metrics and relationships

Conversions

- 6.624# CO_2 / gallon ethanol
- 1 tonne = 1.1 tons
- 1 tonne CO_2 = 19 mcf

Scales of CO_2 sources

• Small Ethanol (55 mgy)	8.6 mmcfd	0.17 million tonnes/yr
• Large Ethanol (313 mgy)	50 mmcfd	0.94 million tonnes/yr
• Coffeyville fertilizer plant	40 mmcfd	0.8 million tonnes/yr
• Jeffrey Energy Center	650 mmcfd	12.5 million tonnes/yr

Other

- Net Utilization (CO_2 stored EOR) ~ 8mcf/BO (0.42 tonne/BO)
  - ✓ *2.4 million BO recovered for million tonnes of CO_2*
- *Proposed* 45Q credits Ramps to \$35/tonne \$1.84/mcf \$0.116/gal eth
- *Possible* LCFS credits \$70/tonne \$3.68/mcf \$0.232/gal eth

Assumptions and methodology for simple financial model

- All financed in same manner: Ethanol plant capture, dehydration, and compression *and* pipeline construction
- All operations begin simultaneously: Capture facilities, pipeline, and sales points (oil fields)

- ✓ Twenty-two year project
- ✓ Two year construction phase
- ✓ 20-year operations and amortization
- ✓ Zero inflation
- ✓ ***Determine CO2 price required for CO2 to provide a specified ROR (NPV=0)***

Two Finance Scenarios

Weighted Average Return = 10.0%

Taxable Bond BBB- (50%@5%)

Regular LLC (50%@15%)

Weighted Average Return = 6.7%

Tax-Exempt PAB BBB (55%@4%)

Publicly Traded MLP (45%@10%)

Basis for CapX and OpX for Ethanol Plant Capture, Dehydration and Compression

Capital Expense

- ✓ Cost data for three plant sizes from DOE-funded project reports
- ✓ Compression drives most of the cost
- ✓ Regression analysis - equation related to volume in MGY

CapX ($million) = 9 + 0.146* MGY

(MGY is plant size in million gallons per year)

Operating Expense

- ✓ Cost data for two 55 MGY plants from DOE-funded project reports
- ✓ Report cost data $0.0732/kWh. Average Kansas industrial - $0.0709/kWh
- ✓ Assumes electrical costs are main OpX and are directly proportional to HP

OpX ($) = $8.58/tonne

Pipeline assumptions and cost model

FE/NETL CO2 Transport Cost Model

Grant & Morgan, 2014

- NETL model provides itemized costs for capital and O&M
- Added an input/output table to calculate pipeline network segment costs

FE/NETL CO_2 Transport Cost Model

Version:	1
Status:	Final
Date:	July 11, 2014
NETL document number:	DOE/NETL-2014/1667

This model estimates costs for transporting dense phase (liquid) CO2 in a pipeline from a source, such as a power plant, to either a CO2 saline storage site or a CO2 EOR site. This is a point to point transport model and does not account for possible cost reductions from using a larger diameter trunk pipe as part of a pipeline network. The model includes costs for constructing the pipeline, including booster pumps if desired. The model also includes costs for operating the pipeline.
To use the model, change any of the inputs, which are always orange cells, to the values appropriate for your project.

The use of this model requires macros to be enabled.

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FE/NETL CO2 Transport Cost Model: Main Interface and Financial Model

Solve for Break-even First Year Price for Transporting CO2 in $/tonne

A. First year price per tonne	2011$/tonne	2011$/tonne first yr of proj	2014$/tonne first yr of transp
Price to Transport CO2 by Pipeline	2.10	2.10	2.29
Number of pumps	1		
Length of pipeline	26.6 mi		
Key Outputs			
Calculated Minimum Inner Diameter for Pipe	5.15 in		
Pipeline Nominal Diameter	6 in		
Net Present Value (NPV) of Cash to Owners	-8,024,583	201	
Rate of Return on Weighted Debt and Equity	NA		
Summary of Costs	Real 2011$		
Capital Costs	21,980,185		
Operating Expenses	11,690,498		
Total Costs	33,670,682		
Weighted total tonnes of CO2 transp. (unweighted, escalated, escal. & discounted)	17,844,246		
Costs per tonne (using weighted total tonnes)	1.89		
Capital Costs per mile of pipeline	826,420		
Operating Expenses per mile of pipeline	439,544		
Operating Expenses per mile of pipeline per year of operation	14,651		
Total Costs per mile of pipeline	1,265,964		
Revenues	Real 2011$		
Revenue	37,472,917		
Revenue per tonne (using weighted total tonnes)	2.10		
Revenue per mile of pipeline	1,408,922		

Run

Segment ID (#)	Length (mi)	# of Pumps (#)	Annual CO2 (Mtonne/yr)	Capacity factor (Decimal Percent)	Input Pressure (psig)	Outlet Pressure (psig)	Change in Elevation (ft)	Minimum Pipeline Inner Diameter (in)	Pipeline Nominal Diameter (in)
DEFAULT	50	1	5	0.8	2200	1200	0	12.03	16.00
20	44.6	2	1.24	0.8	2200	1600	0	6.97	8.00
13	47.8	2	0.30	0.8	2200	1600	0	4.11	6.00
16	48.0	2	0.30	0.8	2200	1600	0	4.03	6.00
26	0.7	1	0.14	0.8	2200	1600	0	1.47	4.00
11	8.6	1	1.06	0.8	2200	1600	0	5.17	6.00
27	3.5	1	0.14	0.8	2200	1600	0	1.98	4.00
12	21.5	1	0.60	0.8	2200	1600	0	4.96	6.00
23	31.9	2	0.98	0.8	2200	1600	0	5.98	6.00
30	46.1	2	0.30	0.8	2200	1600	0	4.08	6.00
29	63.0	2	2.18	0.8	2200	1600	0	9.27	12.00
3	25.6	1	0.30	0.8	2200	1600	0	3.94	4.00
31	0.6	1	0.34	0.8	2200	1600	0	1.98	4.00
15	15.5	1	1.91	0.8	2200	1600	0	7.26	8.00
14	18.7	1	2.09	0.8	2200	1600	0	7.79	8.00
5	32.6	2	2.39	0.8	2200	1600	0	8.44	12.00
7	48.0	2	0.38	0.8	2200	1600	0	4.27	6.00
8	8.8	1	0.81	0.8	2200	1600	0	4.67	6.00
22	37.1	2	1.25	0.8	2200	1600	0	6.76	8.00
6	49.8	2	0.28	0.8	2200	1600	0	4.01	6.00
24	29.5	1	0.32	0.8	2200	1600	0	4.15	6.00
4	14.7	1	0.30	0.8	2200	1600	0	3.54	4.00
1	17.9	1	0.12	0.8	2200	1600	0	2.59	4.00
10	24.0	1	0.26	0.8	2200	1600	0	3.70	4.00
2	48.9	2	0.17	0.8	2200	1600	0	3.29	4.00
21	36.4	2	0.30	0.8	2200	1600	0	3.90	4.00
25	35.6	2	0.33	0.8	2200	1600	0	4.03	6.00
17	466.9	15	10.97	0.8	2200	1600	0	18.36	20.00
18	75.4	3	7.25	0.8	2200	1600	0	14.39	16.00
19	272.4	9	6.62	0.8	2200	1600	0	14.92	16.00
28	91.0	3	0.71	0.8	2200	1600	0	6.12	8.00
9	26.6	1	0.59	0.8	2200	1600	0	5.15	6.00
	1686								240

Capital Cost

Segment ID	Materials ($)	Labor ($)	ROW Damages ($)	Miscellaneous ($)	CO2 Surge Tanks ($)	Pipeline Control system ($)	Pumps ($)
DEFAULT	$13,884,459.77	$33,196,655.17	$11,437,733.93	$11,230,476.66	$1,244,743.66	$111,907.19	$2,695,877.77
20	$4,879,941.37	$19,083,196.43	$3,869,035.76	$5,346,122.29	$1,244,743.66	$111,907.19	$930,929.42
13	$4,198,644.03	$19,083,204.41	$3,148,778.44	$4,458,339.26	$1,244,743.66	$111,907.19	$352,543.05
16	$3,786,373.95	$17,214,607.99	$2,889,448.24	$4,027,912.52	$1,244,743.66	$111,907.19	$352,543.05
26	$122,136.51	$643,831.56	$88,110.47	$195,310.96	$1,244,743.66	$111,907.19	$125,291.96
11	$811,672.34	$3,731,900.99	$607,501.08	$922,203.07	$1,244,743.66	$111,907.19	$410,777.54
27	$317,507.60	$1,669,909.43	$227,051.02	$372,894.08	$1,244,743.66	$111,907.19	$125,291.96
12	$1,925,575.02	$8,700,616.93	$1,443,272.94	$2,085,162.76	$1,244,743.66	$111,907.19	$268,961.66
23	$2,827,384.24	$12,868,028.43	$2,119,909.06	$3,026,688.27	$1,244,743.66	$111,907.19	$773,356.18
30	$4,055,516.03	$18,434,482.87	$3,041,388.12	$4,308,907.80	$1,244,743.66	$111,907.19	$352,543.05
29	$10,563,609.89	$31,332,766.58	$9,175,636.06	$10,801,983.33	$1,244,743.66	$111,907.19	$1,514,877.23
3	$1,871,657.81	$9,832,217.83	$1,332,304.00	$1,785,543.40	$1,244,743.66	$111,907.19	$176,271.53
31	$110,062.25	$580,418.27	$79,528.72	$184,336.03	$1,244,743.66	$111,907.19	$188,321.22
15	$1,746,953.31	$6,894,594.14	$1,382,131.99	$1,960,193.68	$1,244,743.66	$111,907.19	$672,163.60
14	$2,083,985.28	$8,205,786.09	$1,649,661.28	$2,324,435.80	$1,244,743.66	$111,907.19	$727,777.75
5	$5,507,134.43	$16,413,427.98	$4,778,802.72	$5,668,171.37	$1,244,743.66	$111,907.19	$1,640,935.76
7	$4,216,982.95	$19,166,324.74	$3,162,538.30	$4,477,485.83	$1,244,743.66	$111,907.19	$371,081.07
8	$830,307.37	$3,816,363.45	$621,483.12	$941,658.79	$1,244,743.66	$111,907.19	$331,990.92
22	$4,068,803.27	$15,927,538.17	$3,225,170.43	$4,469,497.28	$1,244,743.66	$111,907.19	$940,198.43
6	$4,371,759.87	$19,867,844.48	$3,278,668.91	$4,639,079.23	$1,244,743.66	$111,907.19	$337,712.61
24	$2,618,064.50	$11,919,295.71	$1,962,854.45	$2,808,149.95	$1,244,743.66	$111,907.19	$182,759.81
4	$1,101,974.09	$5,789,882.77	$784,933.98	$1,085,937.16	$1,244,743.66	$111,907.19	$176,271.53
1	$1,333,075.48	$7,003,614.11	$949,284.57	$1,295,997.44	$1,244,743.66	$111,907.19	$120,657.45
10	$1,757,286.44	$9,231,545.95	$1,250,967.40	$1,681,585.22	$1,244,743.66	$111,907.19	$165,148.71
2	$3,510,426.95	$18,438,940.08	$2,497,734.77	$3,275,107.35	$1,244,743.66	$111,907.19	$269,121.93
21	$2,635,473.06	$13,843,732.08	$1,875,500.58	$2,479,815.49	$1,244,743.66	$111,907.19	$352,543.05
25	$3,152,081.77	$14,339,705.98	$2,363,532.73	$3,365,605.69	$1,244,743.66	$111,907.19	$371,081.07
17	$191,676,889.08	$386,832,526.85	$156,135,446.89	$128,159,474.44	$1,244,743.66	$111,907.19	$52,025,374.89
18	$20,893,335.74	$49,830,446.54	$17,218,425.57	$16,856,718.56	$1,244,743.66	$111,907.19	$6,963,362.89
19	$75,296,094.23	$179,011,706.47	$62,088,041.26	$60,527,496.87	$1,244,743.66	$111,907.19	$19,138,245.52
28	$9,878,215.66	$38,528,523.46	$7,836,566.74	$10,747,930.26	$1,244,743.66	$111,907.19	$909,770.90
9	$2,369,809.12	$10,794,088.89	$1,776,586.06	$2,548,961.24	$1,244,743.66	$111,907.19	$267,107.84
	$374,518,734	$979,119,070	$302,810,291	$296,828,785	$38,587,053	$3,469,123	$91,534,814

Annual O&M Cost

Segment ID	Total Capital ($)	Pipeline O&M ($)	Pipeline related equipment and pumps O&M ($)	Electricity costs for pumps ($)	Total annual operating expenses ($)
DEFAULT	$73,801,854.36	$423,845.47	$162,101.14	$1,413,050.29	$1,998,996.91
20	$35,465,876.12	$378,087.74	$91,503.21	$413,138.67	$882,729.63
13	$32,598,160.04	$404,778.52	$68,367.76	$100,276.38	$573,422.66
16	$29,577,536.60	$364,354.99	$68,367.76	$100,276.38	$532,999.13
26	$2,531,332.31	$6,229.86	$59,277.71	$22,562.19	$88,069.76
11	$7,840,705.87	$72,682.32	$70,697.14	$176,987.81	$320,367.27
27	$4,069,304.94	$29,756.54	$59,277.71	$22,562.19	$111,596.44
12	$15,860,240.16	$181,901.67	$65,024.50	$100,276.38	$347,202.55
23	$22,972,017.03	$270,325.03	$85,200.28	$327,903.74	$683,429.05
30	$31,549,408.72	$390,744.66	$68,367.76	$100,276.38	$559,388.80
29	$64,745,523.83	$534,093.95	$114,861.12	$729,009.27	$1,377,964.34
3	$16,354,645.41	$216,908.04	$61,316.90	$50,138.19	$328,363.13
31	$2,499,312.34	$4,775.87	$61,798.88	$56,656.15	$123,230.90
15	$14,012,687.64	$131,797.12	$81,162.58	$318,377.49	$531,327.19
14	$16,348,297.05	$158,291.89	$83,377.14	$348,460.40	$590,129.44
5	$35,365,123.10	$276,724.32	$119,903.46	$797,197.19	$1,193,824.97
7	$32,751,063.73	$406,576.67	$69,109.28	$110,304.02	$585,989.96
8	$7,898,454.50	$74,509.50	$67,545.67	$134,370.34	$276,425.52
22	$29,987,858.44	$314,322.51	$91,873.97	$418,152.49	$824,348.97
6	$33,851,715.94	$421,752.71	$67,774.54	$92,264.26	$581,781.51
24	$20,847,775.26	$249,801.00	$61,976.43	$53,647.85	$365,025.28
4	$10,295,650.39	$124,232.37	$61,316.90	$50,138.19	$235,677.45
1	$12,059,279.90	$152,051.70	$59,092.33	$20,055.28	$231,199.32
10	$15,443,184.57	$208,135.39	$60,871.98	$44,121.61	$308,128.98
2	$29,347,901.93	$414,249.40	$65,030.91	$55,152.01	$534,432.32
21	$22,543,715.11	$308,887.04	$68,367.76	$100,276.38	$477,531.18
25	$24,948,738.00	$302,161.97	$69,109.28	$110,304.02	$481,575.26
17	$916,186,163.01	$3,957,521.01	$2,135,273.03	$27,463,429.67	$33,556,223.71
18	$113,126,940.15	$639,024.70	$332,000.55	$3,631,007.53	$4,602,032.78
19	$397,418,235.21	$2,309,241.67	$819,795.85	$9,945,410.95	$13,074,448.47
28	$69,257,657.85	$771,012.35	$90,656.87	$356,482.48	$1,218,151.70
9	$19,113,204.00	$225,459.30	$64,990.35	$99,273.61	$389,683.26
	$2,086,867,869	$14,295,302	$5,343,640	$46,348,479	$65,987,501

Pipeline assumptions and cost model

FE/NETL CO2 Transport Cost Model

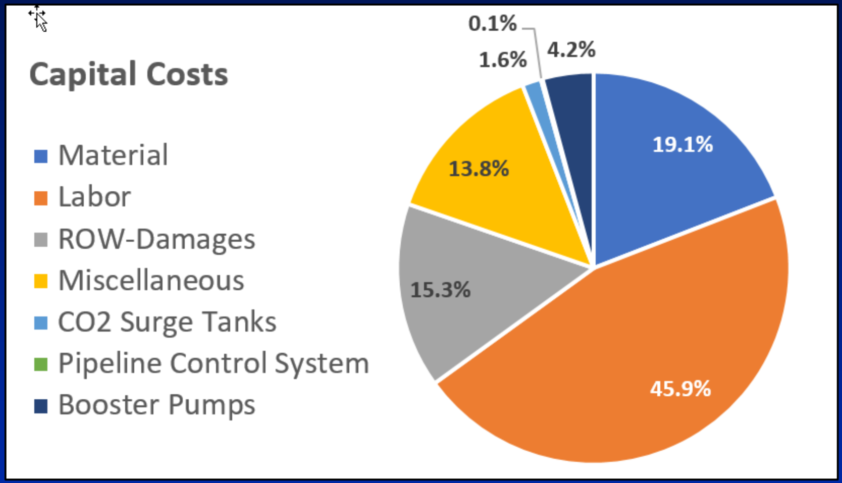
Grant & Morgan, 2014

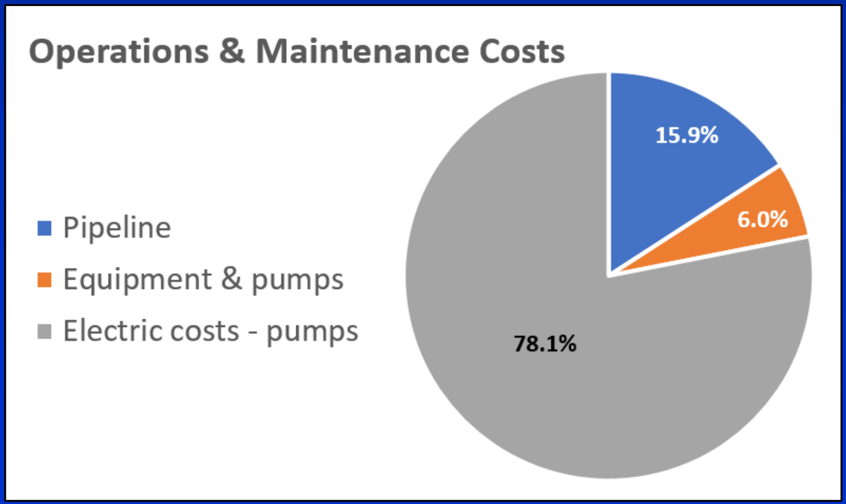
- NETL model provides itemized costs for capital and O&M
- Compared to $100k/inch-mile: Estimates ±10% for individual segments and ±3% for systems

Assumptions/Inputs

- 90% of plant rating for CO2 production (EIA 2016)
- 110% distance in miles
- 2000-1400 psi drops
- Booster stations
- Delivered to field at 1400 psi

CapX and OpX by expense category





Economic Analysis of Ethanol CO2 Capture and Transportation at Varying Scales

- Evaluated multiple scenarios - Four discussed today
- Range from simple, point-to-point (one source) to complex multi-source (up to 32 sources)
- Considered two Equity-Debt financing scenarios

Mean CO2 Price Required

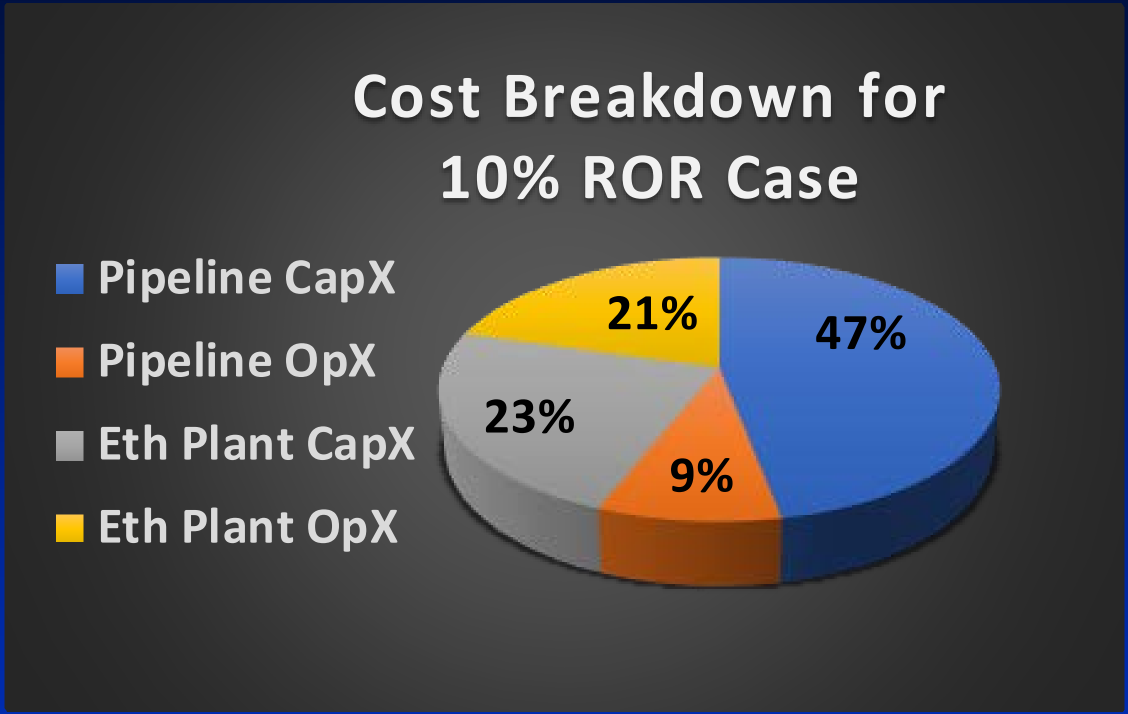
Required ROR	10%	6.7%
$/tonne	$42	$35
$/mcf	$2.20	$1.85
$/gal ethanol	$0.14	$0.12

(Scenarios 1A, 2, 3)

Average for scenarios 1A, 2, 3 at two ROR

CO2 price for required ROR (weighted average cost of capital)

Average cost allocation across three scenarios



For the 10% ROR Case

Ethanol plant (capture and compress) $18 /tonne, $0.85 /mcf, $0.061 /gal

Pipeline (transport) $23 /tonne, $1.23 /mcf, $0.078 /gal

More details on cost allocation

Perspective:

CO_2 for EOR in W TX sells for $1/mcf *(2% of WTI price - $50/BO)*

Three years ago WTI was $100/BO ($2/mcf CO_2)

Proposed 45Q tax credit ramps to $1.85/mcf ($35/tonne)

Cost Breakdown for 6.7% ROR case

		$/tonne	$/mcf	$/gal
Pipelines	**CapX**	$15.15	$0.80	$0.051
	OpX	$3.79	$0.20	$0.013
Ethanol Plants	**CapX**	$7.55	$0.40	$0.025
	OpX	$8.58	$0.45	$0.029
		$35	**$1.85**	**$0.117**

Cost Breakdown for 10% ROR case

		$/tonne	$/mcf	$/gal
Pipelines	**CapX**	$19.60	$1.03	$0.065
	OpX	$3.79	$0.20	$0.013
Ethanol Plants	**CapX**	$9.77	$0.51	$0.033
	OpX	$8.58	$0.45	$0.029
		$42	**$2.20**	**$0.139**

Average for three of the four scenarios at two ROR

Simple summary for the four scenarios

CO2 price for required ROR of 10% and 6.7% (weighted average cost of capital)

Scenario	Ethanol Plants	Pipeline Miles	CO2 (Mt/yr)	Required Price \$/tonne		Required Price \$/mcf	
				10%	6.70%	10%	6.70%
1A	2(1)	201	1.12	\$37	\$31	\$1.95	\$1.64
1B	1	16	0.15	\$33	\$28	\$1.75	\$1.47
2	15	737	4.26	\$42	\$35	\$2.19	\$1.84
3	34	1546	9.85	\$47	\$39	\$2.46	\$2.06

1A Point-to-point, two ADM plants (413 MGY) to Sleepy Hollow field, Nebraska

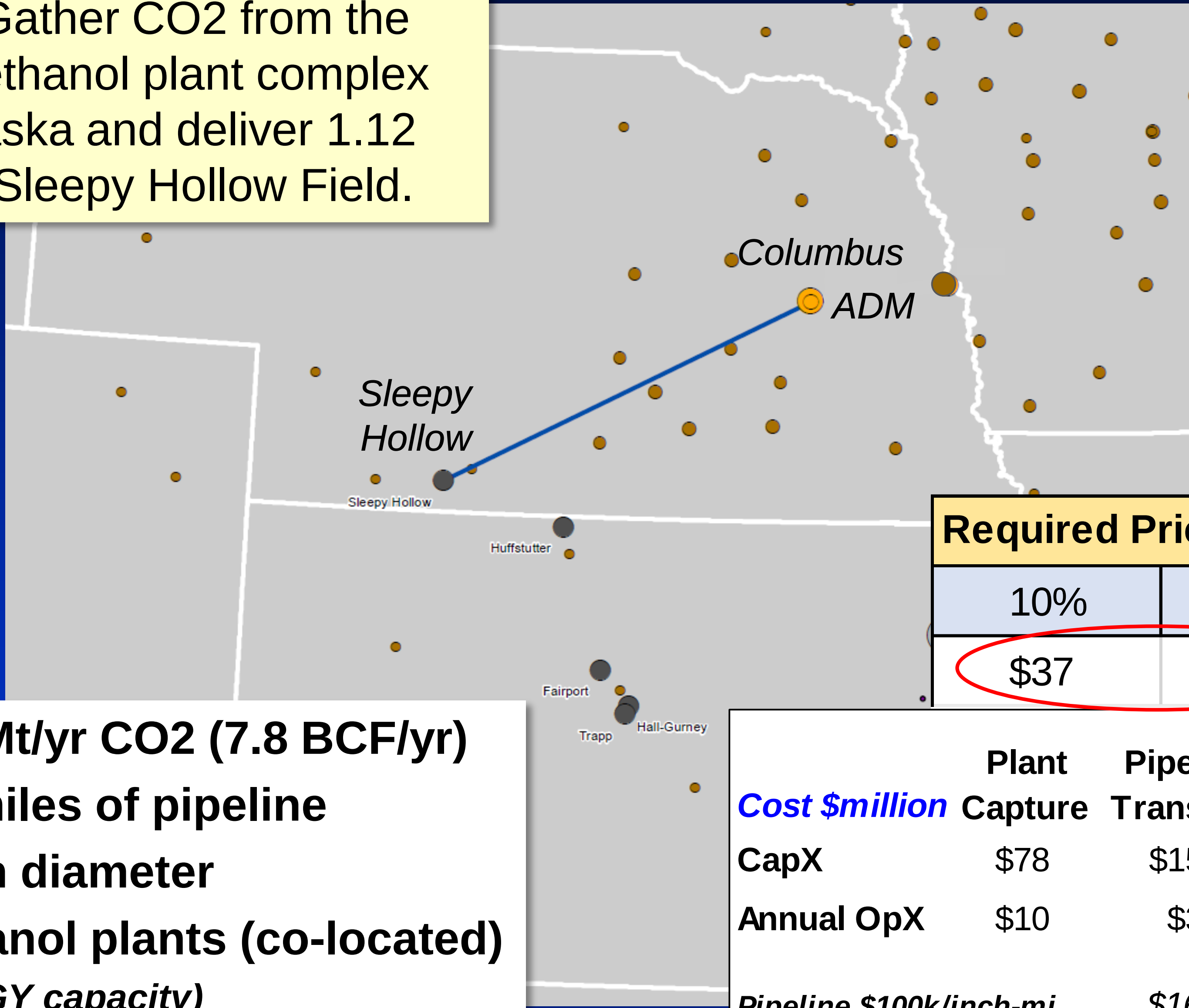
1B Generic Kansas point-to-point, 55 MGY plant to oil field within 16 miles

2 Fifteen plants (1575 MGY) to seven Kansas oil fields

3 Thirty-four plants (3643 MGY) through Kansas all the way to Permian Basin

Scenario 1A Large point-to-point

Logic: Gather CO2 from the largest ethanol plant complex in Nebraska and deliver 1.12 Mt/yr to Sleepy Hollow Field.



Required Price $/tonne	
10%	6.7%
$37	$31

- ✓ **1.12 Mt/yr CO2 (7.8 BCF/yr)**
- ✓ **201 miles of pipeline**
- ✓ **8 inch diameter**
- ✓ **2 ethanol plants (co-located)**
  (413 MGY capacity)

Cost $million	**Plant Capture**	**Pipeline Transport**	**Total**
CapX	$78	$154	$232
Annual OpX	$10	$3	$13
Pipeline $100k/inch-mi		*$161*	

Scenario 1B Small point-to-point

Kansas Examples:

Modeled: 148,000 tonnes/yr transported 16 miles

- ✓ Kansas Ethanol, Lyons (55MGY) to Geneseo Edwards Field
- ✓ USEP, Russell (55MGY) to Hall-Gurney
- ✓ Prairie Horizon, Phillipsburg (40MGY) to Huffstutter

*Could be attractive at **$75/BO***

45Q credits could make it attractive at today's prices

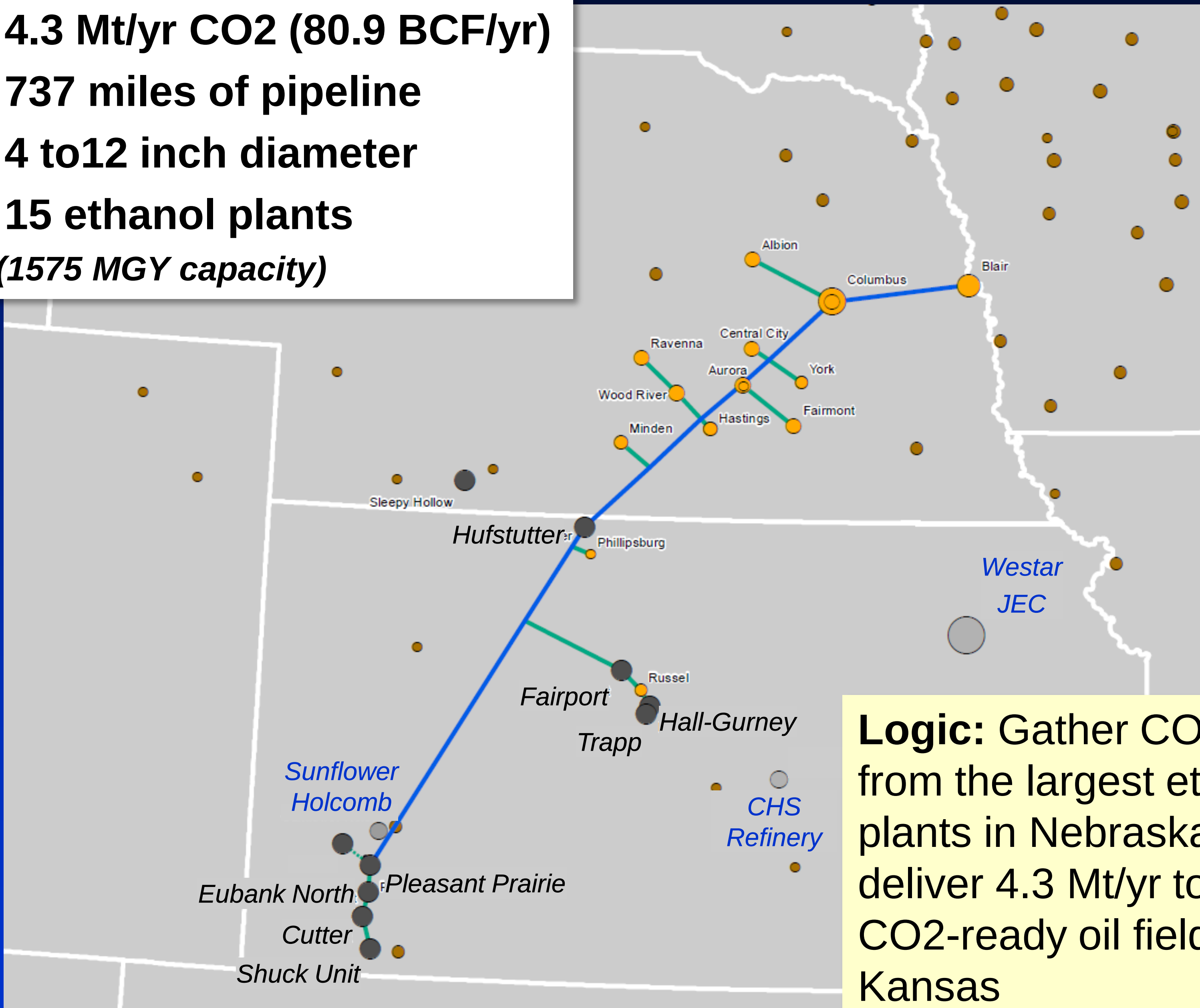
LCFS credits could make storage without EOR possible for ethanol plants

Cost Breakdown ($/tonne)

	Required ROR	10%	6.7%
Pipelines	**CapX**	$9.12	$7.05
	OpX	$1.48	$1.48
Ethanol Plants	**CapX**	$14.09	$10.89
	OpX	$8.58	$8.58
TOTAL	**$/tonne**	**$33**	**$28**
	$/mcf	**$1.75**	**$1.47**
	$/gallon	**$0.11**	**$0.09**

Scenario 2: Fifteen plants to Kansas oil fields

- ✓ **4.3 Mt/yr CO_2 (80.9 BCF/yr)**
- ✓ **737 miles of pipeline**
- ✓ **4 to12 inch diameter**
- ✓ **15 ethanol plants**
  (1575 MGY capacity)



Logic: Gather CO_2 from the largest ethanol plants in Nebraska and deliver 4.3 Mt/yr to CO_2-ready oil fields in Kansas

Scenario 2: Economics

Estimated Project Costs

Cost $million	Plant Capture	Pipeline Transport	Total
CapX	$364	$642	$1,006
Annual OpX	$37	$16	$53

*Note: Rule of thumb $100k/inch-mile yields **$613** million CapX for pipeline*

Cost breakdown ($/unit CO2) for two Cost of Capital cases

Cost of Capital = 10%

	Pipeline	Ethanol	Combined
CapX ($/tonne)	$18.60	$10.55	$29.15
OpX ($/tonne)	$3.80	$8.58	$12.39
Total ($/tonne)	$22	$19	**$42**
			$/tonne
CapX ($/mcf)	$0.98	$0.56	$1.53
OpX ($/mcf)	$0.20	$0.45	$0.65
Total ($/mcf)	$1.18	$1.01	**$2.19**
			$/mcf

Cost of Capital = 6.7%

	Pipeline	Ethanol	Combined
CapX ($/tonne)	$14.37	$8.15	$22.52
OpX ($/tonne)	$3.80	$8.58	$12.39
Total ($/tonne)	$18	$17	**$35**
			$/tonne
CapX ($/mcf)	$0.76	$0.43	$1.19
OpX ($/mcf)	$0.20	$0.45	$0.65
Total ($/mcf)	$0.96	$0.88	**$1.84**
			$/mcf

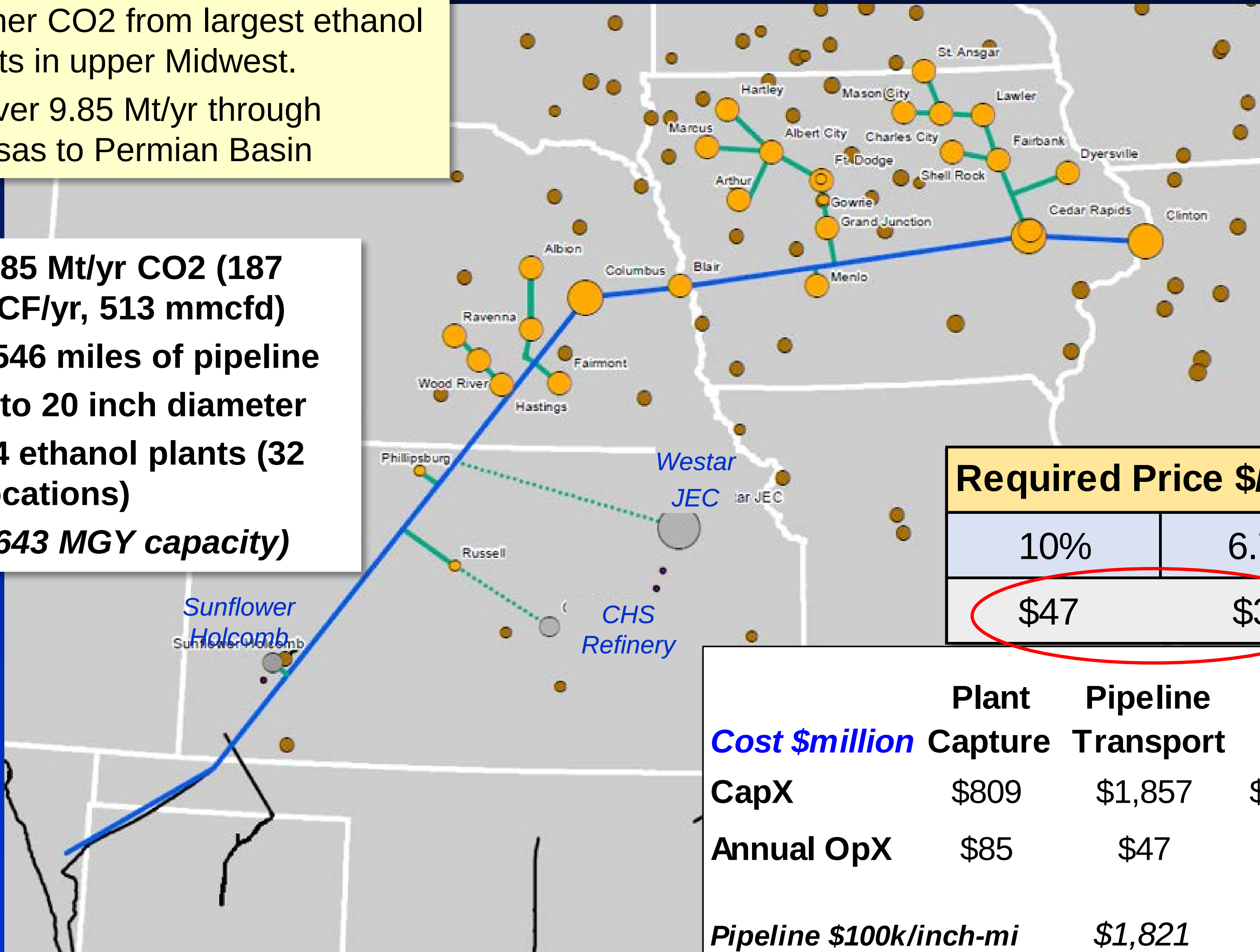
Scenario 3 Large-scale, 10 Mt/yr

Gather CO2 from largest ethanol plants in upper Midwest.

Deliver 9.85 Mt/yr through Kansas to Permian Basin

- ✓ **9.85 Mt/yr CO2 (187 BCF/yr, 513 mmcfd)**
- ✓ **1546 miles of pipeline**
- ✓ **4 to 20 inch diameter**
- ✓ **34 ethanol plants (32 locations)**

(3643 MGY capacity)

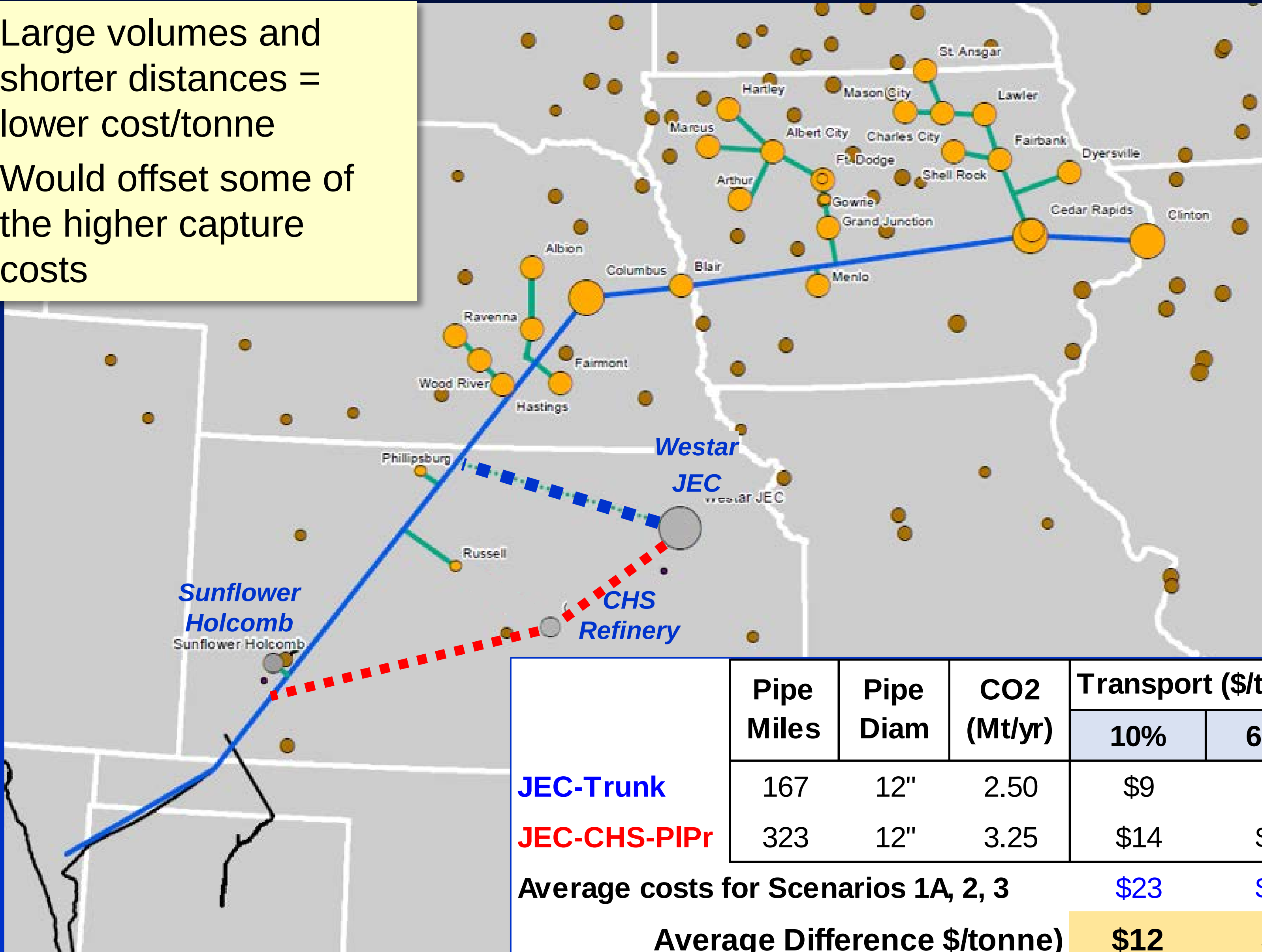


Required Price $/tonne	
10%	6.7%
$47	$39

Cost $million	**Plant Capture**	**Pipeline Transport**	**Total**
CapX	$809	$1,857	$2,667
Annual OpX	$85	$47	$131
Pipeline $100k/inch-mi		***$1,821***	

Westar and CHS would reduce overall transport cost

- ✓ Large volumes and shorter distances = lower cost/tonne
- ✓ Would offset some of the higher capture costs



	Pipe Miles	Pipe Diam	CO2 (Mt/yr)	Transport ($/tonne) 10%	Transport ($/tonne) 6.7%
JEC-Trunk	167	12"	2.50	$9	$7
JEC-CHS-PlPr	323	12"	3.25	$14	$12
Average costs for Scenarios 1A, 2, 3				$23	$19
Average Difference $/tonne)				$12	$9

Parting Comments

- 45Q passes – better move quickly
- If not, smaller scale projects possible
- Keep an eye on larger industrial source opportunities

Mean CO2 Price Required

Required ROR	10%	6.7%
$/tonne	$42	$35
$/mcf	$2.20	$1.85
$/gal ethanol	$0.14	$0.12

(Scenarios 1A, 2, 3)

Discussion

- Economic modeling?
- Potential for lowering costs?
- Kansas have the resource to support 4Mt?

Later today in open discussion

- Business model(s) to pull it all together
- How would credits be captured? And shared?
- Ins and outs of 45Q and LCFS credits?

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(Scenarios 1A, 2, 3)

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