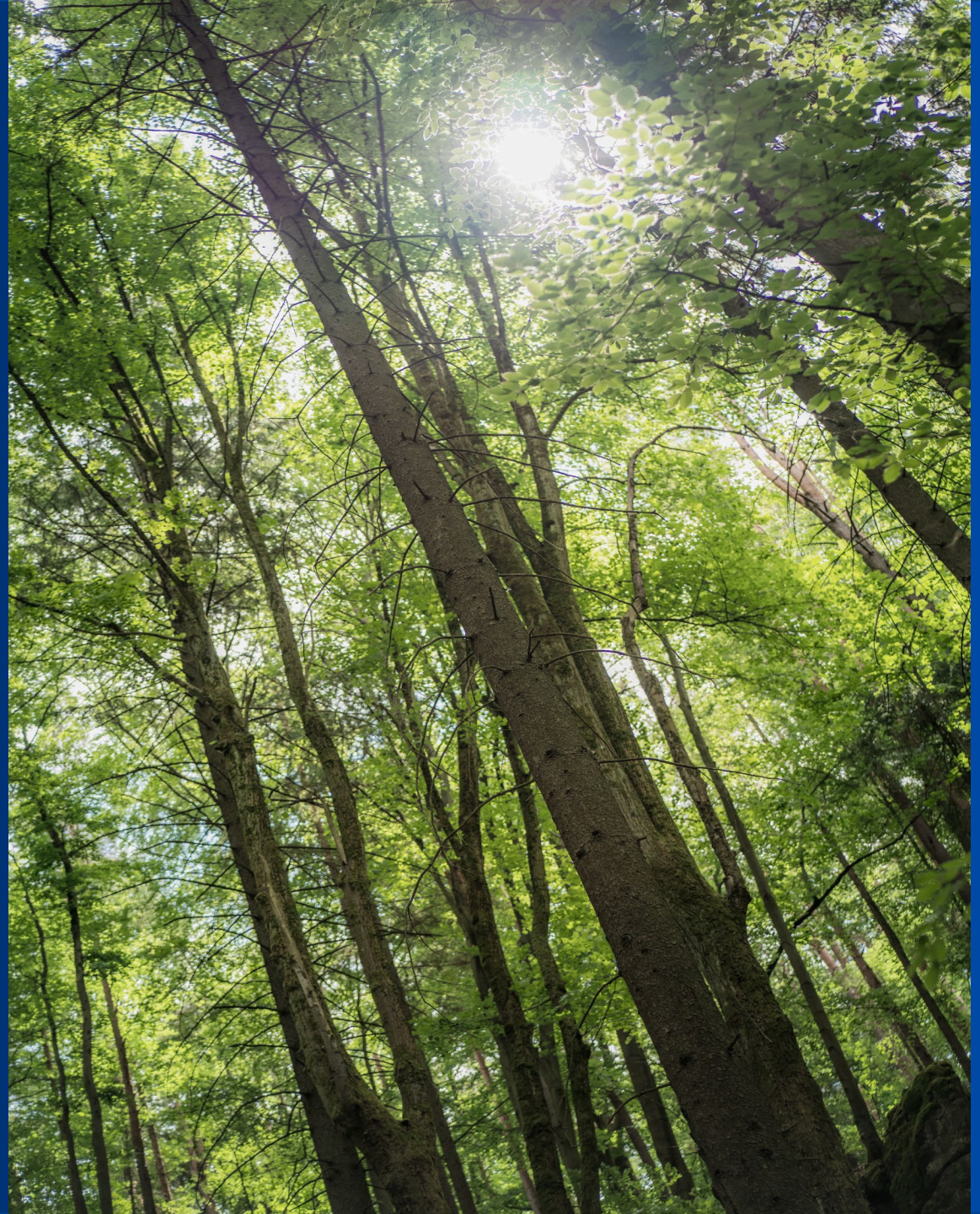
INDUSTRIAL INSULATION: SUSTAINABILITY WITHIN EASY REACH

- Scott Sinclair
- National Specification Manager
  Johns Manville Industrial
- NIA Certified Thermal Insulation Inspector
  and Insulation Energy Appraiser



AGENDA

- Sustainability – The Common Goal
- The Challenge
- High Tech Solutions – High Cost
- Real World Benefits of Mechanical Insulation
- Summary / Conclusion

The Goal

Due to public and government pressure, most companies have set goals for reducing energy consumption and GHG emissions.

- Short-term (2030, 2035) targets for reducing energy use and/or carbon emissions
- Long-term targets (2040, 2050) to achieve net-zero operations

The Path

Typical programs to achieve reductions in energy consumption and the associated GHG emissions most often involve transitioning to “green” energy technologies

- Solar and wind, possibly with battery back-up
- Geothermal
- Hydrogen / ammonia
- Carbon capture, utilization and sequestration (CCUS)
- Hydroelectric

The Challenge

- Lengthy design, approval and construction cycles
- Significant capital investment - $$$$
- Technologies still being developed.
- Some don’t provide 24/7/365 solutions.

High Tech Solutions – High Cost

Industrial Information Resources (IIR), a leading market research and analytics firm, is currently tracking 82 projects in North America scheduled to kickoff in 2023 that are related to carbon capture and sequestration, at a total investment value of $44.2B.* Average investment - $539 million.

Similarly, they are tracking 99 solar, wind and hydro power projects scheduled to start construction in 2023, with a total investment value of $3.2B.* Average investment - $32 million.

IIR is also tracking 104 hydrogen power projects (to produce or consume H2) scheduled to begin construction in 2023, with a total investment value of $36.3B (some may overlap with CCS projects).* Average investment - $349 million.

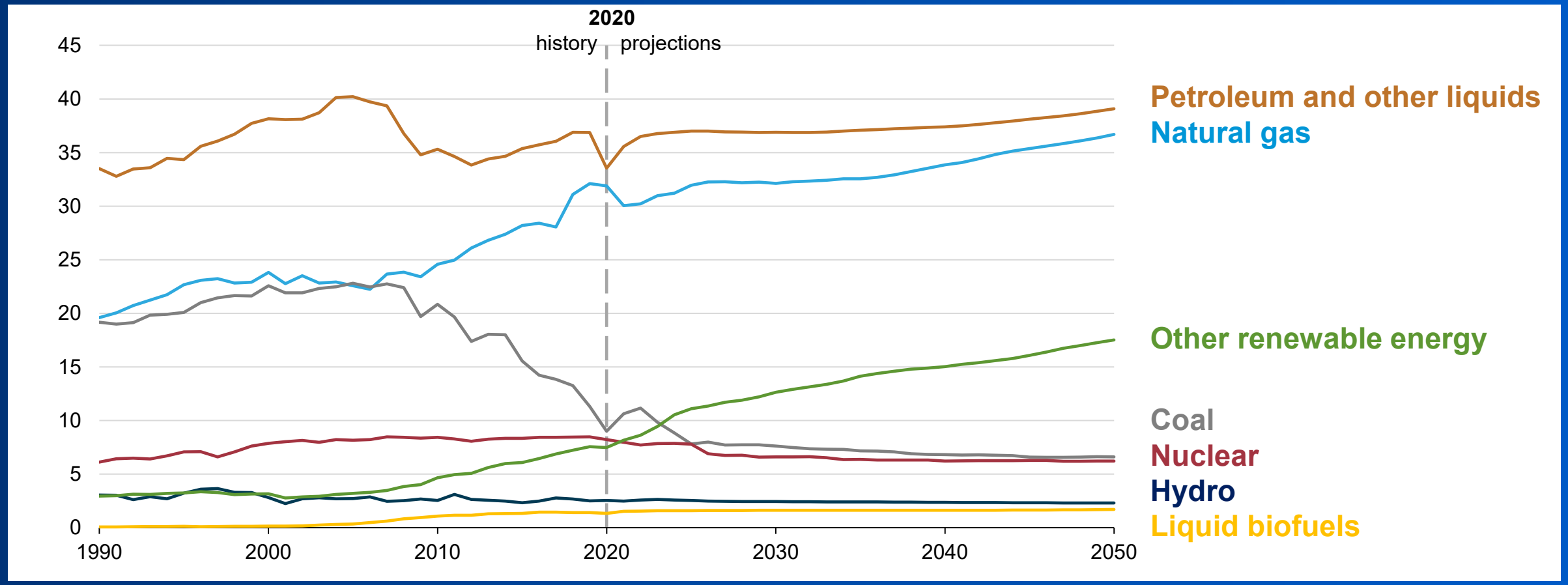
* As of 1-16-23

High Tech Solutions – High Cost

- CCUS costs \$20/tCO_2e for selected processes in the oil and gas sector but as much as \$100 to \$200/tCO_2e in other industries, such as cement. (1)
- A leading global manufacturer of hydrogen and nitrogen products, CF Industries recently announced a \$198.5 million plan to build a CO_2 dehydration and compression unit at its ammonia production plant in Donaldsonville. (2)

(1) McKinsey and Company, *The future is now: How oil and gas companies can decarbonize*, January 7, 2020
(2) Hydrocarbon Processing, 10/13/22

Energy Sources – Where Are We Going?



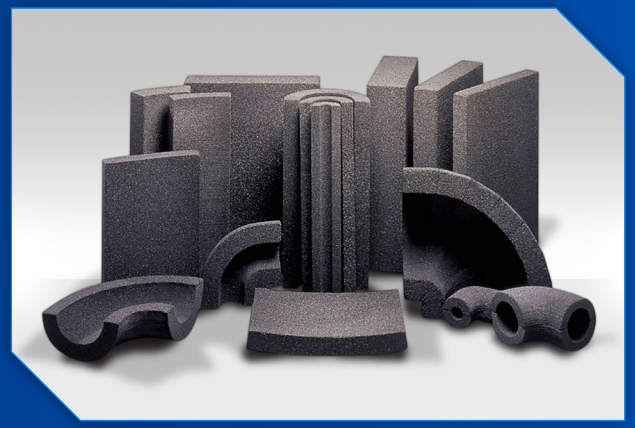
Source: U.S. Energy Information Administration, Annual Energy Outlook 2021(AEO2021) www.eia.gov/aeo

How Will You Get There?

Plans to reduce a facility's or company's carbon footprint and achieve "sustainability" targets must address how this will be accomplished:

1. Buying carbon offsets
2. Moving emissions from one operation to another or one location to another
3. Actually reducing the carbon emissions from the process area or facility

Real World Benefits of Mechanical Insulation




Real World Benefits of Mechanical Insulation

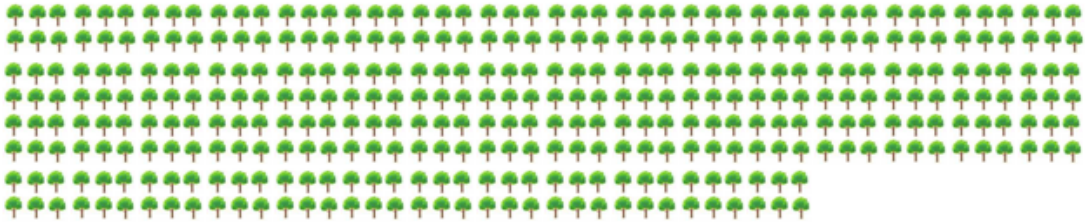
Real World Benefits of Mechanical Insulation

OFFSETTING CO2 EMISSIONS – MECHANICAL INSULATION IS AN OBVIOUS CHOICE!

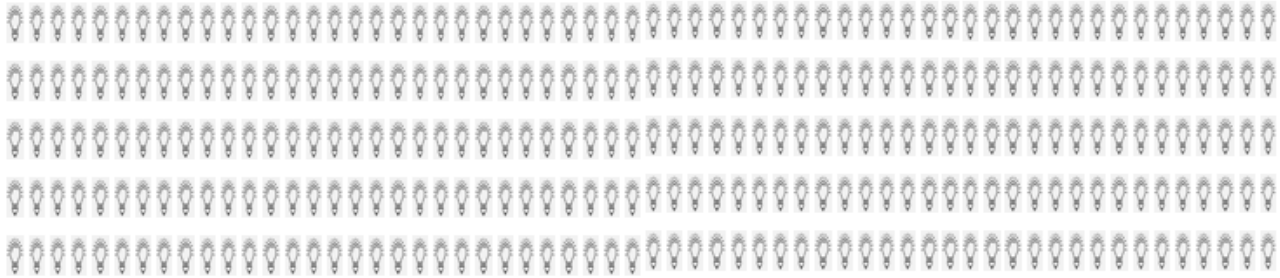
One full size pickup truck(1) that is driven 20,000 miles emits approximately 18,000 lbs of CO2.

How can we offset the emissions from one pickup truck?

We could plant 360 trees(2)



We could replace (310) 43-watt incandescent light bulbs with LED light bulbs(3)



Or we could insulate approximately 8' of bare 4" pipe operating @ 350F with 2" of insulation (4)

(1) 2021 Ford 150 2.7 L pick up emits 406 grams of carbon per mile; Source – EPA Fuel economy and greenhouse gas emissions sticker on truck
(2) http://www.tenmilliontrees.org/trees/ Typical tree on average saves 50 pounds/yr. of CO2
(2) EPA states medium growth coniferous or deciduous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 23.2 and 38.0 lbs. of carbon, respectively.
(3) https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Replace a 43W incandescent that operates 3 hours a day would reduce CO2 58 lbs. / year
(4) Crall, CP Insulation is Greener than trees. Insulation Outlook Jan 2009

Real World Benefits of Mechanical Insulation

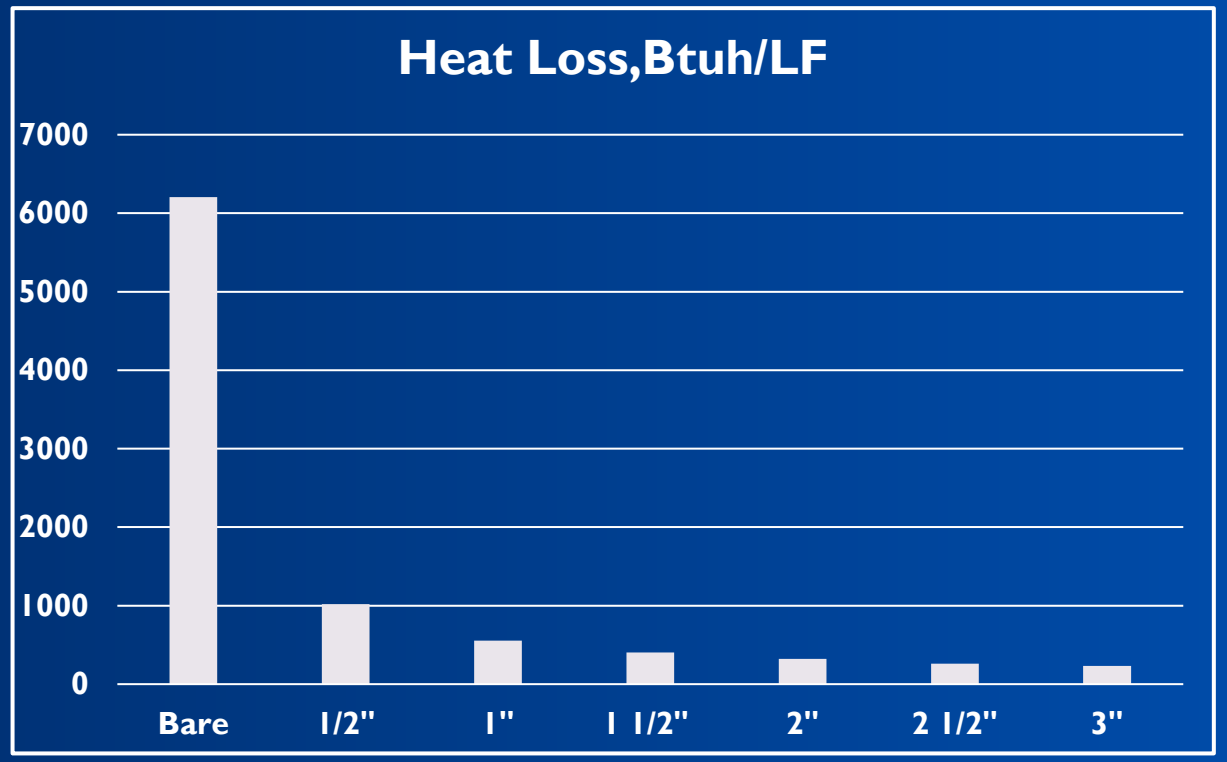
Oil Refinery Example

- Medium-sized oil refinery - 125,000 barrel per day capacity
- 1.87 million linear feet of piping

- 8” Nominal pipe size (NPS)
- 600°F operating temperature
- 60°F ambient temperature
- 5 mph wind
- 1 ½” mineral fiber pipe insulation (ASTM C547, Type I)

Source: Hart, Gordon H., “How Many Barrels of Oil Can Mechanical Insulation Save?”, *Insulation Outlook*, May 2005

Real World Benefits of Mechanical Insulation



Assumptions:

- 1% of the insulation is missing
- Reinsulate with 1½" of insulation
- 75% conversion efficiency (combustion)
- In operation 50 weeks per year
- Price of oil at $42/barrel ($1/gallon)

Annual Savings = $8.8 million/year

Source: Hart, Gordon H., "How Many Barrels of Oil Can Mechanical Insulation Save?", *Insulation Outlook*, May 2005

Real World Benefits of Mechanical Insulation

Shannon Global Energy Solutions from New York, documented savings on a 350°F steam system with only 48 fittings. By adding just 1.5” of removable/reusable insulation covers to areas such as valves, steam drums, flanges and strainers, Shannon showed a 10-month payback on a $31,000 installed job. Better yet, the CO2 savings from adding the insulation to those 48 areas was 444 tons a year – every year. (1)

(1) – BIC Magazine, January/February 2023

Real World Benefits of Mechanical Insulation

Working in conjunction with a major Houston-based midstream energy services company, an analysis was conducted to look at the optimal economic insulation systems for multiple high temperature process piping scenarios.

- Four pipe sizes were modeled – 3”, 8”, 16” and 30”
- Process temperatures from 200ºF to 1200ºF were analyzed
  - Ambient temperature of 90 ºF with 6mph wind speed for personnel protection (PP)
  - Ambient temperature of 55 ºF with 6mph wind speed for economic thickness
- Installed costs for calcium silicate insulation with aluminum jacket were averaged across several leading industrial insulation contractors

Real World Benefits of Mechanical Insulation

- Costs were based on an effective 100 feet of pipe - two elbows, one block valve, one 1” vent and one 1” drain and sufficient straight pipe to total 100 equivalent feet of pipe.
- Modeled on a natural gas fuel source at a cost of $4.50/MMBtu, an 80% heater efficiency and 8,000 hours per year operation
- Heat loss, fuel consumption reduction, energy cost savings and emissions reductions were calculated using the NAIMA 3E Plus tool

3” PIPE, 200F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	611.6		4,892,800	$ 27.52	$ -	$ -					
1	54.52	91.09	436,160	$ 2.45	$ 25.07	$ 2,507	$ 1,755	0.70	$ 1,755	$ 2,507	0.7
1.5	40.49	93.38	323,920	$ 1.82	$ 25.70	$ 2,570	$ 2,046	0.80	$ 291	$ 63	4.6
2	33.52	94.52	268,160	$ 1.51	$ 26.01	$ 2,601	$ 2,517	0.97	$ 471	$ 31	15.0
2.5	29.12	95.24	232,960	$ 1.31	$ 26.21	$ 2,621	$ 2,867	1.09	$ 350	$ 20	17.7
3	26.07	95.74	208,560	$ 1.17	$ 26.35	$ 2,635	$ 3,361	1.28	$ 494	$ 14	36.0
3.5	23.57	96.15	188,560	$ 1.06	$ 26.46	$ 2,646	$ 4,733	1.79	$ 1,372	$ 11	122.0
4	21.88	96.42	175,040	$ 0.98	$ 26.54	$ 2,654	$ 5,196	1.96	$ 463	$ 8	60.9
4.5	20.54	96.64	164,320	$ 0.92	$ 26.60	$ 2,660	$ -				
5	19.18	96.86	153,440	$ 0.86	$ 26.66	$ 2,666	$ 6,219	2.33	$ 1023	$ 12	84.20

PP and Heat Conservation Thickness

8” PIPE, 200F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	1152.61		9,220,880	$ 51.87	$ -	$ -					
1	113.32	90.17	906,560	$ 5.10	$ 46.77	$ 4,677	$ 2,387	0.51	2387.00	4676.81	0.51
1.5	82.79	92.82	662,320	$ 3.73	$ 48.14	$ 4,814	$ 2,795	0.58	408.00	137.39	2.97
2	66.34	94.24	530,720	$ 2.99	$ 48.88	$ 4,888	$ 3,472	0.71	677.00	74.02	5.13
2.5	54.04	95.31	432,320	$ 2.43	$ 49.44	$ 4,944	$ 3,933	0.80	461.00	55.35	8.33
3	47.53	95.88	380,240	$ 2.14	$ 49.73	$ 4,973	$ 4,630	0.93	697.00	29.30	23.79
3.5	42.71	96.29	341,680	$ 1.92	$ 49.95	$ 4,995	$ 6,076	1.22	1446.00	21.69	66.67
4	38.99	96.62	311,920	$ 1.75	$ 50.11	$ 5,011	$ 6,648	1.33	572.00	16.74	34.17
4.5	36.04	96.87	288,320	$ 1.62	$ 50.25	$ 5,025	$ 7,250	1.44	602.00	13.27	45.35
5	33.62	97.08	268,960	$ 1.51	$ 50.35	$ 5,035	$ 7,955	1.58	705.00	10.89	64.74

PP and Heat Conservation Thickness

16” PIPE, 200F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	1844.34		14,754,720	83.00	0.00	0.00					
1	206.07	88.83	1,648,560	9.27	73.72	7372.22	$ 4,714	0.64	4714.00	7372.22	0.64
1.5	146.29	92.07	1,170,320	6.58	76.41	7641.23	$ 5,327	0.70	613.00	269.01	2.28
2	112.34	93.91	898,720	5.06	77.94	7794.00	$ 6,301	0.81	974.00	152.78	6.38
2.5	95.12	94.84	760,960	4.28	78.71	7871.49	$ 6,940	0.88	639.00	77.49	8.25
3	81.8	95.56	654,400	3.68	79.31	7931.43	$ 7,955	1.00	1015.00	59.94	16.93
3.5	72.15	96.09	577,200	3.25	79.75	7974.86	$ 9,625	1.21	1670.00	43.42	38.46
4	64.82	96.49	518,560	2.92	80.08	8007.84	$ 10,541	1.32	916.00	32.99	27.77
4.5	59.06	96.8	472,480	2.66	80.34	8033.76	$ 11,485	1.43	944.00	25.92	36.42
5	54.42	97.05	435,360	2.45	80.55	8054.64	$ 12,457	1.55	972.00	20.88	46.55

PP and Heat Conservation Thickness

30” PIPE, 200F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	3071.99		24,575,920	$ 138.24	$ -	$ -					
1	364.23	88.14	2,913,840	$ 16.39	$ 121.85	$ 12,185	$ 8,340	0.68	$ 8,340	$ 12,185	0.68
1.5	257.93	91.6	2,063,440	$ 11.61	$ 126.63	$ 12,663	$ 9,290	0.73	$ 950	$ 478	1.99
2	197.06	93.59	1,576,480	$ 8.87	$ 129.37	$ 12,937	$ 10,495	0.81	$ 1,205	$ 274	4.40
2.5	165.45	94.61	1,323,600	$ 7.45	$ 130.79	$ 13,079	$ 11,310	0.86	$ 815	$ 142	5.73
3	141.2	95.4	1,129,600	$ 6.35	$ 131.89	$ 13,189	$ 12,707	0.96	$ 1,397	$ 109	12.80
3.5	123.57	95.98	988,560	$ 5.56	$ 132.68	$ 13,268	$ 14,327	1.08	$ 1,620	$ 79	20.42
4	110.18	96.41	881,440	$ 4.96	$ 133.28	$ 13,328	$ 15,768	1.18	$ 1,441	$ 60	23.92
4.5	99.66	96.76	797,280	$ 4.48	$ 133.75	$ 13,375	$ 17,234	1.29	$ 1,466	$ 47	30.97
5	91.17	97.03	729,360	$ 4.10	$ 134.14	$ 13,414	$ 18,726	1.40	$ 1,492	$ 38	39.05

PP and Heat Conservation Thickness

3” PIPE, 500F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	2350.7		18,805,600	$ 105.78	$ -	$ -					
1	201.8	91.42	1,614,400	$ 9.08	$ 96.70	$ 9,670	$ 1,755	0.18	$ 1,755	$ 9,670	0.18
1.5	150.05	93.62	1,200,400	$ 6.75	$ 99.03	$ 9,903	$ 2,046	0.21	$ 291	$ 233	1.25
2	124.27	94.71	994,160	$ 5.59	$ 100.19	$ 10,019	$ 2,517	0.25	$ 471	$ 116	4.06
2.5	107.97	95.41	863,760	$ 4.86	$ 100.92	$ 10,092	$ 2,867	0.28	$ 350	$ 73	4.77
3	96.67	95.89	773,360	$ 4.35	$ 101.43	$ 10,143	$ 3,361	0.33	$ 494	$ 51	9.71
3.5	87.4	96.28	699,200	$ 3.93	$ 101.85	$ 10,185	$ 4,733	0.46	$ 1,372	$ 42	32.89
4	81.16	96.55	649,280	$ 3.65	$ 102.13	$ 10,213	$ 5,196	0.51	$ 463	$ 28	16.49
4.5	76.17	96.76	609,360	$ 3.43	$ 102.35	$ 10,235	$ -				
5	71.15	96.97	569,200	$ 3.20	$ 102.58	$ 10,258	$ 6,219	0.61	$ 1,023	$ 45	22.71

PP and Heat Conservation Thickness

8” PIPE, 500F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	4724.75		37,798,000	$ 212.61	$ -	$ -					
1	418.76	91.14	3,350,080	$ 18.84	$ 193.77	$ 19,377	$ 2,387	0.12	$ 2,387	$ 19,377	0.12
1.5	306.52	93.51	2,452,160	$ 13.79	$ 198.82	$ 19,882	$ 2,795	0.14	$ 408	$ 505	0.81
2	245.82	94.8	1,966,560	$ 11.06	$ 201.55	$ 20,155	$ 3,472	0.17	$ 677	$ 273	2.48
2.5	200.31	95.76	1,602,480	$ 9.01	$ 203.60	$ 20,360	$ 3,933	0.19	$ 461	$ 205	2.25
3	176.21	96.27	1,409,680	$ 7.93	$ 204.68	$ 20,468	$ 4,630	0.23	$ 697	$ 108	6.43
3.5	158.37	96.65	1,266,960	$ 7.13	$ 205.49	$ 20,549	$ 6,076	0.30	$ 1,446	$ 80	18.01
4	144.61	96.94	1,156,880	$ 6.51	$ 206.11	$ 20,611	$ 6,648	0.32	$ 572	$ 62	9.24
4.5	133.65	97.17	1,069,200	$ 6.01	$ 206.60	$ 20,660	$ 7,250	0.35	$ 602	$ 49	12.21
5	124.7	97.36	997,600	$ 5.61	$ 207.00	$ 20,700	$ 7,955	0.38	$ 705	$ 40	17.50

PP and Heat Conservation Thickness

16” PIPE, 500F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	7910.25		63,282,000	$ 355.96	$ -	$ -					
1	759.94	90.39	6,079,520	$ 34.20	$ 321.76	$ 32,176	$ 4,714	0.15	$ 4,714	$ 32,176	0.15
1.5	541.11	93.16	4,328,880	$ 24.35	$ 331.61	$ 33,161	$ 5,327	0.16	$ 613	$ 985	0.62
2	416.03	94.74	3,328,240	$ 18.72	$ 337.24	$ 33,724	$ 6,301	0.19	$ 974	$ 563	1.73
2.5	352.45	95.54	2,819,600	$ 15.86	$ 340.10	$ 34,010	$ 6,940	0.20	$ 639	$ 286	2.23
3	303.21	96.17	2,425,680	$ 13.64	$ 342.32	$ 34,232	$ 7,955	0.23	$ 1,015	$ 222	4.58
3.5	267.47	96.62	2,139,760	$ 12.04	$ 343.93	$ 34,393	$ 9,625	0.28	$ 1,670	$ 161	10.38
4	240.33	96.96	1,922,640	$ 10.81	$ 345.15	$ 34,515	$ 10,541	0.31	$ 916	$ 122	7.50
4.5	219.01	97.23	1,752,080	$ 9.86	$ 346.11	$ 34,611	$ 11,485	0.33	$ 944	$ 96	9.84
5	201.8	97.45	1,614,400	$ 9.08	$ 346.88	$ 34,688	$ 12,457	0.36	$ 972	$ 77	12.55

PP Thickness

Heat Conservation Thickness

30” PIPE, 500F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	13780.8		110,246,400	$ 620.14	$ -	$ -					
1	1342.08	90.26	10,736,640	$ 60.39	$ 559.74	$ 55,974	$ 8,340	0.15	$ 8,340	$ 55,974	0.15
1.5	953.51	93.08	7,628,080	$ 42.91	$ 577.23	$ 57,723	$ 9,290	0.16	$ 950	$ 1,749	0.54
2	729.53	94.71	5,836,240	$ 32.83	$ 587.31	$ 58,731	$ 10,495	0.18	$ 1,205	$ 1,008	1.20
2.5	612.89	95.55	4,903,120	$ 27.58	$ 592.56	$ 59,256	$ 11,310	0.19	$ 815	$ 525	1.55
3	523.24	96.2	4,185,920	$ 23.55	$ 596.59	$ 59,659	$ 12,707	0.21	$ 1,397	$ 403	3.46
3.5	458.04	96.68	3,664,320	$ 20.61	$ 599.52	$ 59,952	$ 14,327	0.24	$ 1,620	$ 293	5.52
4	408.47	97.04	3,267,760	$ 18.38	$ 601.75	$ 60,175	$ 15,768	0.26	$ 1,441	$ 223	6.46
4.5	369.5	97.32	2,956,000	$ 16.63	$ 603.51	$ 60,351	$ 17,234	0.29	$ 1,466	$ 175	8.36
5	338.06	97.55	2,704,480	$ 15.21	$ 604.92	$ 60,492	$ 18,726	0.31	$ 1,492	$ 141	10.55

PP Thickness

Heat Conservation Thickness

3” PIPE, 900F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	6680.22		53,441,760	$ 300.61	$ -	$ -					
1	474.57	92.9	3,796,560	$ 21.36	$ 279.25	$ 27,925	$ 1,755	0.06	$ 1,755	$ 27,925	0.06
1.5	353.58	94.71	2,828,640	$ 15.91	$ 284.70	$ 28,470	$ 2,046	0.07	$ 291	$ 544	0.53
2	293.03	95.61	2,344,240	$ 13.19	$ 287.42	$ 28,742	$ 2,517	0.09	$ 471	$ 272	1.73
2.5	254.7	96.19	2,037,600	$ 11.46	$ 289.15	$ 28,915	$ 2,867	0.10	$ 350	$ 172	2.03
3	228.08	96.59	1,824,640	$ 10.26	$ 290.35	$ 29,035	$ 3,361	0.12	$ 494	$ 120	4.12
3.5	206.24	96.91	1,649,920	$ 9.28	$ 291.33	$ 29,133	$ 4,733	0.16	$ 1,372	$ 98	13.96
4	191.54	97.13	1,532,320	$ 8.62	$ 291.99	$ 29,199	$ 5,196	0.18	$ 463	$ 66	7.00
4.5	179.76	97.31	1,438,080	$ 8.09	$ 292.52	$ 29,252	$ -				
5	167.92	97.49	1,343,360	$ 7.56	$ 293.05	$ 29,305	$ 6,219	0.21	1023.00	106.29	9.62

PP Thickness

Heat Conservation Thickness

8” PIPE, 900F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	14430.92		115,447,360	$ 649.39	$ -	$ -					
1	982.06	93.19	7,856,480	$ 44.19	$ 605.20	$ 60,520	$ 2,387	0.04	$ 2,387	$ 60,520	0.04
1.5	721.2	95	5,769,600	$ 32.45	$ 616.94	$ 61,694	$ 2,795	0.05	$ 408	$ 1,174	0.35
2	579.16	95.99	4,633,280	$ 26.06	$ 623.33	$ 62,333	$ 3,472	0.06	$ 677	$ 639	1.06
2.5	472.3	96.73	3,778,400	$ 21.25	$ 628.14	$ 62,814	$ 3,933	0.06	$ 461	$ 481	0.96
3	415.61	97.12	3,324,880	$ 18.70	$ 630.69	$ 63,069	$ 4,630	0.07	$ 697	$ 255	2.73
3.5	373.61	97.41	2,988,880	$ 16.81	$ 632.58	$ 63,258	$ 6,076	0.10	$ 1,446	$ 189	7.65
4	341.19	97.64	2,729,520	$ 15.35	$ 634.04	$ 63,404	$ 6,648	0.10	$ 572	$ 146	3.92
4.5	315.36	97.81	2,522,880	$ 14.19	$ 635.20	$ 63,520	$ 7,250	0.11	$ 602	$ 116	5.18
5	294.28	97.96	2,354,240	$ 13.24	$ 636.15	$ 63,615	$ 7,955	0.13	$ 705	$ 95	7.43

PP Thickness

Heat Conservation Thickness

16” PIPE, 900F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	25189.37		201,514,960	$ 1,133.52	$ -	$ -					
1	1777.22	92.94	14,217,760	$ 79.97	$ 1,053.55	$ 105,355	$ 4,714	0.04	$ 4,714	$ 105,355	0.04
1.5	1271.34	94.95	10,170,720	$ 57.21	$ 1,076.31	$ 107,631	$ 5,327	0.05	$ 613	$ 2,276	0.27
2	979.43	96.11	7,835,440	$ 44.07	$ 1,089.45	$ 108,945	$ 6,301	0.06	$ 974	$ 1,314	0.74
2.5	830.44	96.7	6,643,520	$ 37.37	$ 1,096.15	$ 109,615	$ 6,940	0.06	$ 639	$ 670	0.95
3	714.81	97.16	5,718,480	$ 32.17	$ 1,101.36	$ 110,136	$ 7,955	0.07	$ 1,015	$ 520	1.95
3.5	630.77	97.5	5,046,160	$ 28.38	$ 1,105.14	$ 110,514	$ 9,625	0.09	$ 1,670	$ 378	4.42
4	566.9	97.75	4,535,200	$ 25.51	$ 1,108.01	$ 110,801	$ 10,541	0.10	$ 916	$ 287	3.19
4.5	516.68	97.95	4,133,440	$ 23.25	$ 1,110.27	$ 111,027	$ 11,485	0.10	$ 944	$ 226	4.18
5	476.13	98.11	3,809,040	$ 21.43	$ 1,112.10	$ 111,210	$ 12,457	0.11	$ 972	$ 182	5.33

PP Thickness

Heat Conservation Thickness

30” PIPE, 900F

Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/FT-YR	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	45435.51		363,484,080	$ 2,044.60	$ -	$ -					
1	3137.63	93.09	25,101,040	$ 141.19	$ 1,903.40	$ 190,340	$ 8,340	0.04	$ 8,340	$ 190,340	0.04
1.5	2239.25	95.07	17,914,000	$ 100.77	$ 1,943.83	$ 194,383	$ 9,290	0.05	$ 950	$ 4,043	0.23
2	1716.81	96.22	13,734,480	$ 77.26	$ 1,967.34	$ 196,734	$ 10,495	0.05	$ 1,205	$ 2,351	0.51
2.5	1443.65	96.82	11,549,200	$ 64.96	$ 1,979.63	$ 197,963	$ 11,310	0.06	$ 815	$ 1,229	0.66
3	1233.23	97.29	9,865,840	$ 55.50	$ 1,989.10	$ 198,910	$ 12,707	0.06	$ 1,397	$ 947	1.48
3.5	1079.97	97.62	8,639,760	$ 48.60	$ 1,996.00	$ 199,600	$ 14,327	0.07	$ 1,620	$ 690	2.35
4	963.35	97.88	7,706,800	$ 43.35	$ 2,001.25	$ 200,125	$ 15,768	0.08	$ 1,441	$ 525	2.75
4.5	871.61	98.08	6,972,880	$ 39.22	$ 2,005.38	$ 200,538	$ 17,234	0.09	$ 1,466	$ 413	3.55
5	797.55	98.24	6,380,400	$ 35.89	$ 2,008.71	$ 200,871	$ 18,726	0.09	$ 1,492	$ 333	4.48

PP Thickness

Heat Conservation Thickness

3” Pipe, Emissions Reduction

Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)
200	Bare	712.7	1.43	500	Bare	2739.3	5.49	900	Bare	7784.5	15.61
200	0.5	109.2	0.22	500	0.5	402.0	0.81	900	0.5	936.3	1.88
200	**1**	**63.5**	**0.13**	500	**1**	**235.2**	**0.47**	900	1	553.0	1.11
200	1.5	47.2	0.09	500	1.5	174.9	0.35	900	1.5	412.0	0.83
200	2	39.1	0.08	500	2	144.8	0.29	900	2	341.5	0.68
200	2.5	33.9	0.07	500	2.5	125.8	0.25	900	**2.5**	**296.8**	**0.6**
200	3	30.4	0.06	500	3	112.7	0.23	900	3	265.8	0.53
200	3.5	27.5	0.06	500	3.5	101.9	0.2	900	3.5	240.3	0.48
200	4	25.5	0.05	500	4	94.6	0.19	900	4	223.2	0.45
200	4.5	23.9	0.05	500	4.5	88.8	0.18	900	4.5	209.5	0.42
200	5	22.4	0.04	500	5	82.9	0.17	900	5	195.7	0.39
Reduction at PP thickness		**91%**				**91%**				**96%**	

PP Thickness

8” Pipe, Emissions Reduction

Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)
200	Bare	1343.1	2.69	500	Bare	5505.8	11.04	900	Bare	16816.4	7.63
200	0.5	244.1	0.49	500	0.5	892.7	1.79	900	0.5	2061.1	0.93
200	**1**	**132.1**	**0.26**	500	1	488.0	0.98	900	1	1144.4	0.52
200	1.5	96.5	0.19	500	**1.5**	**357.2**	**0.72**	900	1.5	840.4	0.38
200	2	77.3	0.16	500	2	286.5	0.57	900	**2**	**674.9**	**0.31**
200	2.5	63.0	0.13	500	2.5	233.4	0.47	900	2.5	550.4	0.25
200	3	55.4	0.11	500	3	205.3	0.41	900	3	484.3	0.22
200	3.5	49.8	0.1	500	3.5	184.6	0.37	900	3.5	435.4	0.2
200	4	45.4	0.09	500	4	168.5	0.34	900	4	397.6	0.18
200	4.5	42.0	0.08	500	4.5	155.7	0.31	900	4.5	367.5	0.17
200	5	39.2	0.08	500	5	145.3	0.2	900	5	342.9	0.16
Reduction at PP thickness		**90%**				**96%**				**97%**	

PP Thickness

16” Pipe, Emissions Reduction

Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)
200	Bare	2149.2	4.31	500	Bare	9217.8	18.49	900	Bare	29353.2	58.88
200	0.5	421.7	0.85	500	0.5	1536.5	3.08	900	0.5	3536.4	7.09
200	**1**	**240.1**	**0.48**	500	1	885.6	1.78	900	1	2071.0	4.15
200	1.5	170.5	0.34	500	1.5	630.6	1.26	900	1.5	1481.5	2.97
200	2	130.9	0.26	500	**2**	**484.8**	**0.97**	900	2	1141.3	2.29
200	2.5	110.8	0.22	500	2.5	410.7	0.82	900	2.5	967.7	1.94
200	3	95.3	0.19	500	3	353.3	0.71	900	3	833.0	1.67
200	3.5	84.1	0.17	500	3.5	311.7	0.63	900	3.5	735.0	1.47
200	4	75.5	0.15	500	4	280.1	0.56	900	**4**	**660.6**	**1.33**
200	4.5	68.8	0.14	500	4.5	255.2	0.51	900	4.5	602.1	1.21
200	5	63.4	0.13	500	5	235.2	0.47	900	5	554.8	1.11
Reduction at PP thickness		**89%**				**95%**				**98%**	

PP Thickness

30” Pipe, Emissions Reduction

Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO2 (lb/ft/yr)	NOx (lb/ft/yr)
200	Bare	3579.8	7.18	500	Bare	16058.8	32.21	900	Bare	52946.0	106.2
200	0.5	736.7	1.48	500	0.5	2682.6	5.38	900	0.5	6186.9	12.41
200	**1**	**424.4**	**0.85**	500	1	1563.9	3.14	900	1	3656.3	7.33
200	1.5	300.6	0.6	500	1.5	1111.1	2.23	900	1.5	2609.4	5.23
200	2	229.6	0.46	500	**2**	**850.1**	**1.71**	900	2	2000.6	4.01
200	2.5	192.8	0.39	500	2.5	714.2	1.43	900	2.5	1682.3	3.37
200	3	164.5	0.33	500	3	609.7	1.22	900	3	1437.1	2.88
200	3.5	144.0	0.29	500	3.5	533.8	1.07	900	3.5	1258.5	2.52
200	4	128.4	0.26	500	4	476.0	0.95	900	4	1122.6	2.25
200	4.5	116.1	0.23	500	4.5	430.6	0.86	900	4.5	1015.7	2.04
200	5	106.2	0.21	500	5	394.0	0.79	900	**5**	**929.4**	**1.86**
Reduction at PP thickness		**88%**				**95%**				**98%**	

PP Thickness

SUMMARY

Insulation projects are low cost.

Project execution is typically weeks to a few months.

Simple payback less than one year, often only one or two months.

All design thicknesses delivered reductions in CO2 and NOx emissions of 88 to 98 percent.

CONCLUSION

Even a relatively small investment in a proper insulation system will deliver major energy savings and carbon footprint reduction, with a simple payback of less than 1 year.

THANK YOU
ANY QUESTIONS

Scott Sinclair

scott.sinclair@jm.com

828-641-1544