REACHING SUSTAINABILITY GOALS: INSULATION FOR INDUSTRIAL FACILITIES

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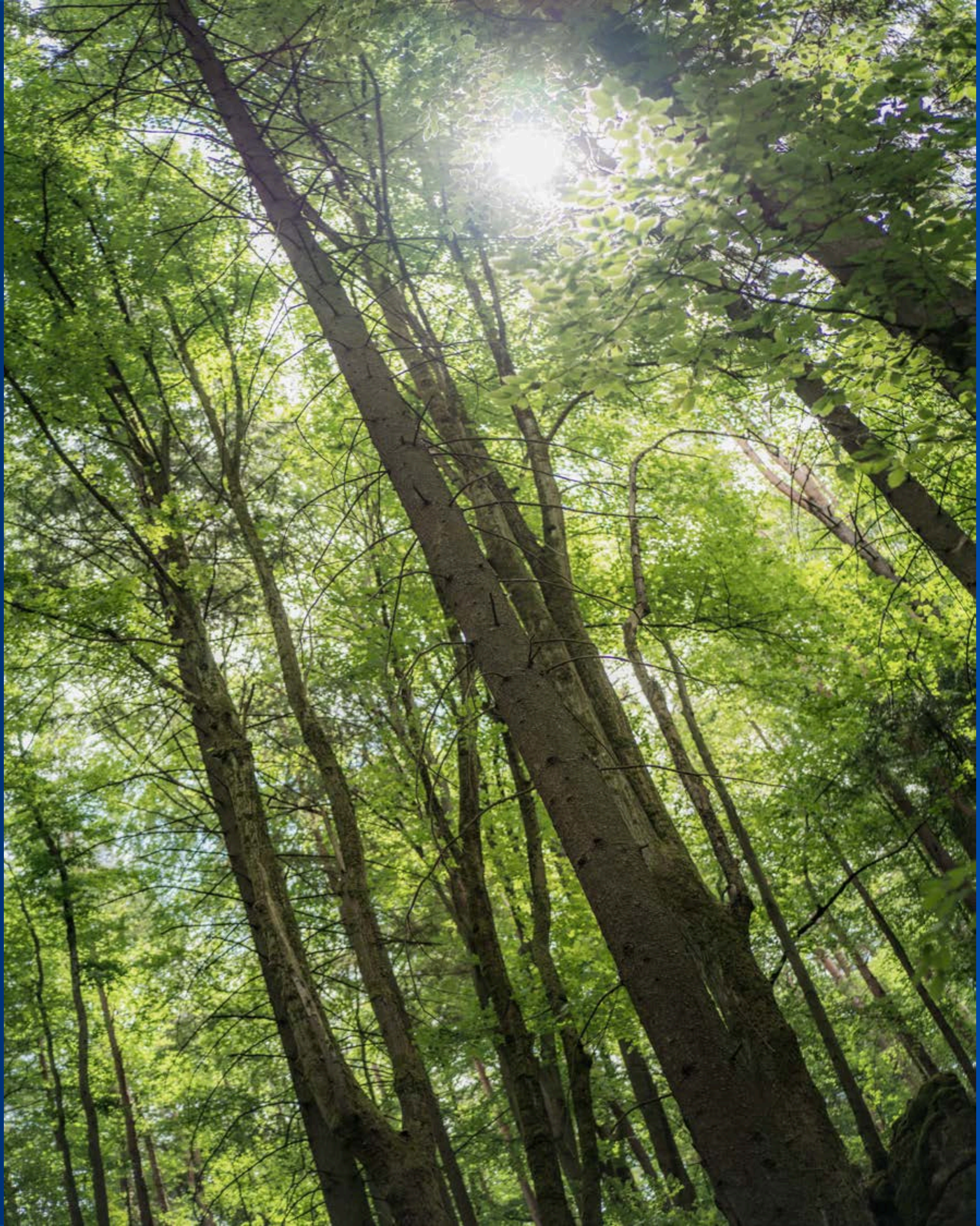


AGENDA

- The Goal / Path / Challenge
- UN 2030 Agenda for Sustainable Development
- Corporate / Government Sustainability Commitments
- High Tech Solutions—High Cost
- The Path to Sustainability / A Lower Carbon Footprint
- Real World Benefits of Mechanical Insulation
- Conclusion

The Goal

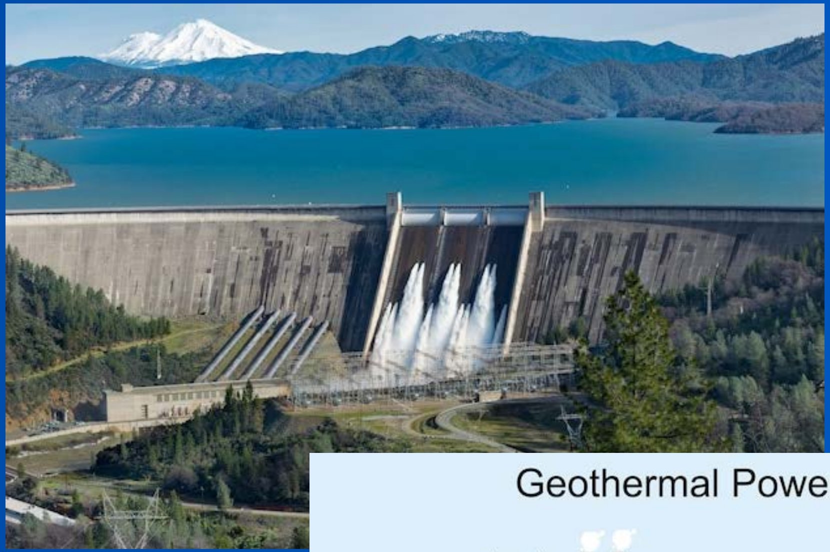
Due to public and government pressure, most companies have set goals for reducing energy consumption and greenhouse gas (GHG) emissions.

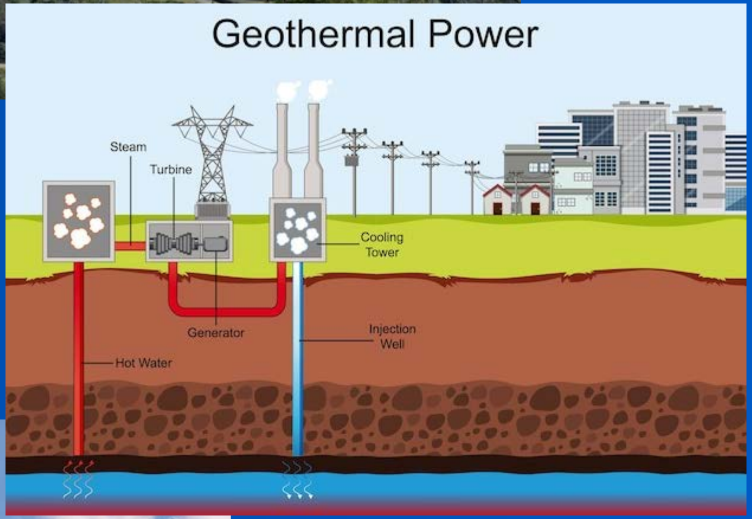
- Short-term (2030, 2035) targets for reducing energy use and/or carbon emissions
- Long-term targets (2040, 2050) to achieve net-zero operations

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

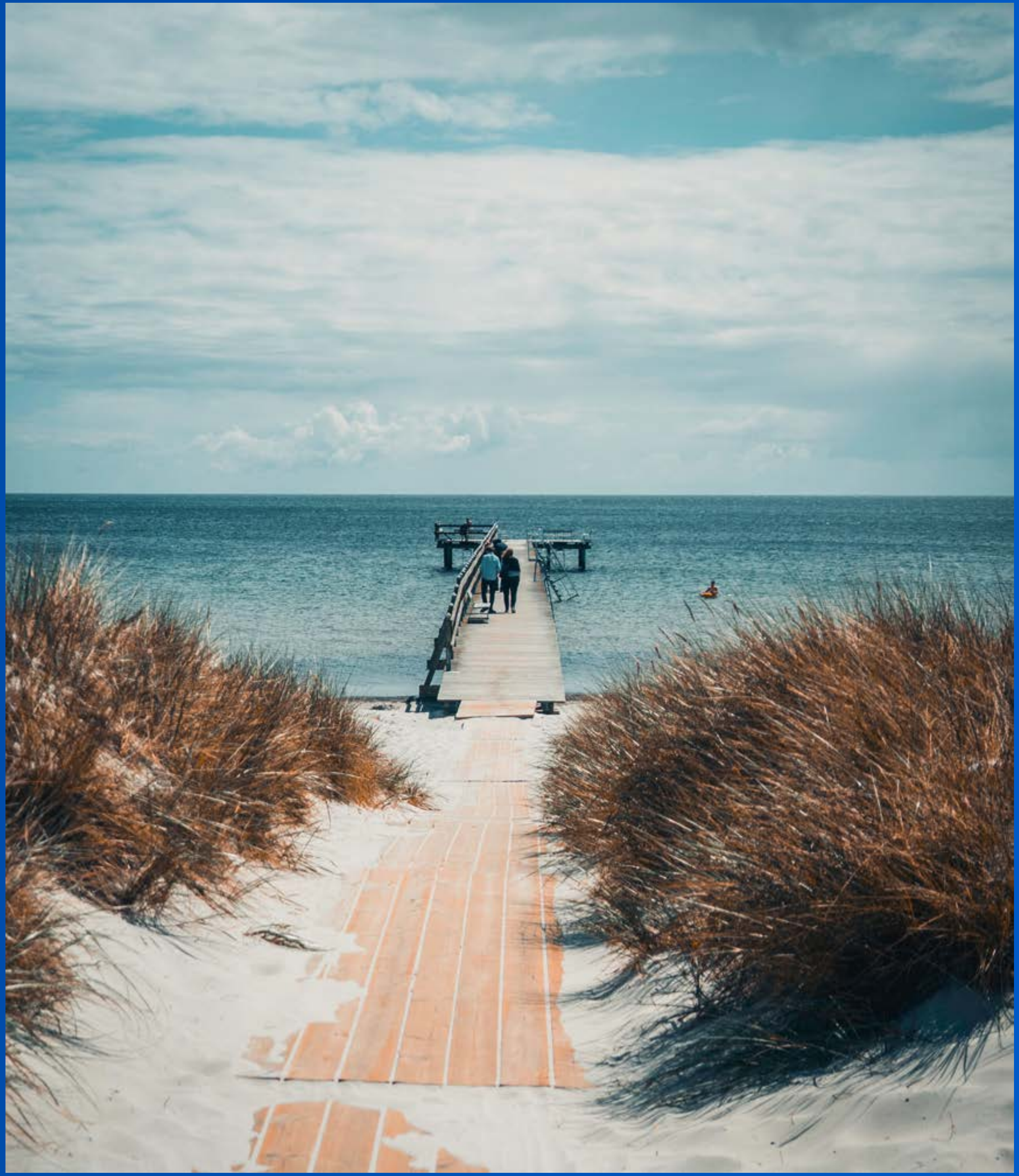
- Lengthy design, approval, and construction cycles
- Significant capital investment $$$$
- Technologies still being developed
- Some don’t provide 24/7/365 solutions

UN 2030 Agenda for Sustainable Development

On October 21, 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development

"All countries and all stakeholders, acting in collaborative partnership, will implement this plan... We are determined to take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path... "

Planet: We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.



UN 2030 Agenda for Sustainable Development

The agenda set 17 Sustainable Development Goals and 169 targets to be met by the member nations.

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

Goal 13: Take urgent action to combat climate change and its impacts.*

Goal 7. Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support

Corporate/Government Sustainability Commitments

The New York State Energy Research and Development Authority (NYSERDA), the New York State Department of Public Service and Governor Kathy Hochul announced a roadmap for deploying 6 gigawatts (GW) of energy storage across the state by 2030—double the 3-GW target under current legislation. The plan also features an interim goal of 1.5 GW by 2025 as the state aims to generate 70% of its electricity from renewable sources by 2030 and reach 100% emission-free generation by 2040. Industrial Info is tracking more than $7.5 billion worth of energy-storage projects in New York, nearly all of which is in the pre-construction stage. [1]

(1) Industrial Information Resources, January 5, 2023

Corporate/Government Sustainability Commitments

- **Apple calls on suppliers to decarbonize operations by 2030 (1)**
  - ➢ Apple said on October 25, 2022 that it is urging suppliers to vastly reduce greenhouse gas emissions as the tech giant works to make its entire supply chain carbon neutral by 2030.
  - ➢ The company is asking manufacturers to decarbonize Apple-related operations by taking steps such as running on 100% renewable electricity. Apple will track progress through yearly audits.
- **The Italian energy giant ENI has announced programs to plant 20 million acres (four times the size of Wales) of forest in Africa to serve as a carbon sink. (2)**

(1) Utility Dive, October 26, 2022
(2) McKinsey and Company, *The future is now: How oil and gas companies can decarbonize*, January 7, 2020

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 kick off 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.

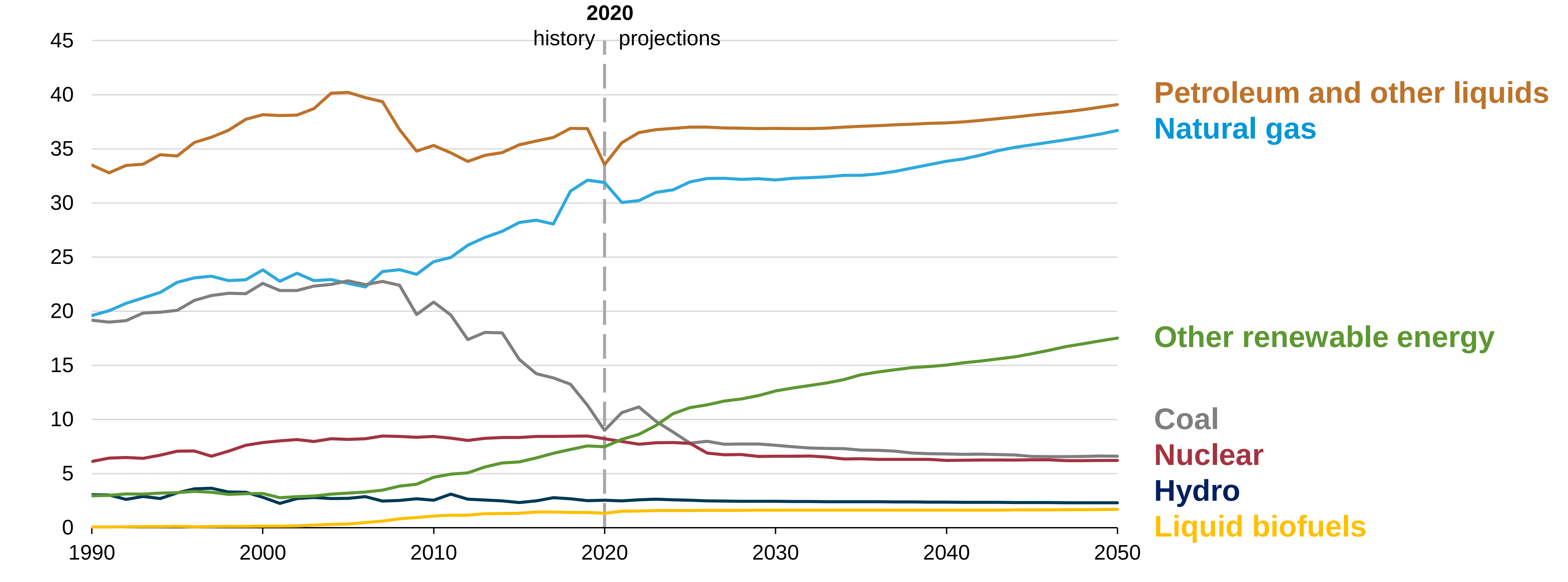
* As of 1-16-23

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?



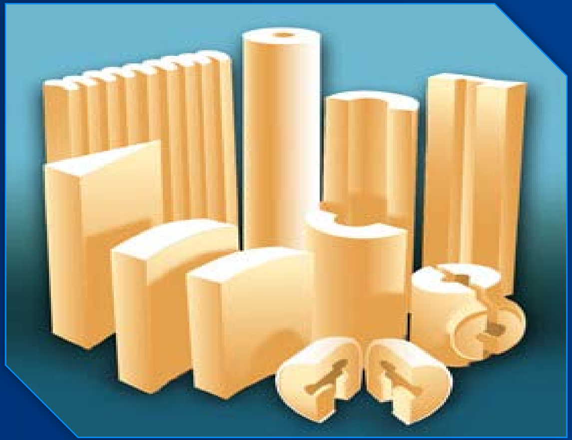
Source: U.S. Energy Information Administration, Annual Energy Outlook 2021(AEO2021), www.eia.gov/aeo

How Will You Get There?

Any 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



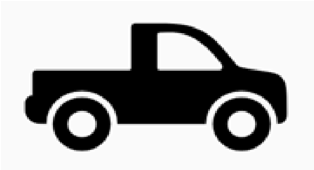




Real World Benefits of Mechanical Insulation

Real World Benefits of Mechanical Insulation

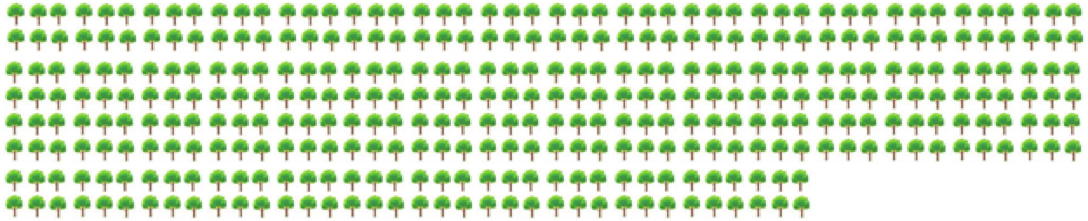
OFFSETTING CO2 EMISSIONS – MECHANICAL INSULATION IS AN OBVIOUS CHOICE!



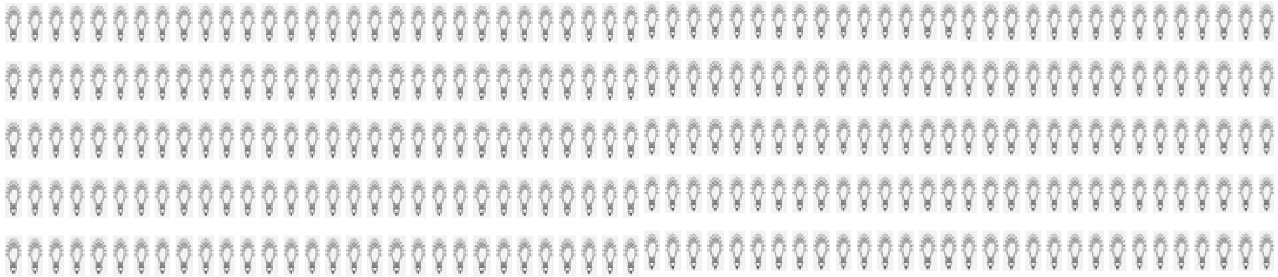
One full size pickup truck(1) that is driven 20,000 miles emits approximately 18,000 lbs of CO2.

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 C02 58 lbs. / year
(4) Crall, CP Insulation is Greener than trees. Insulation Outlook Jan 2009

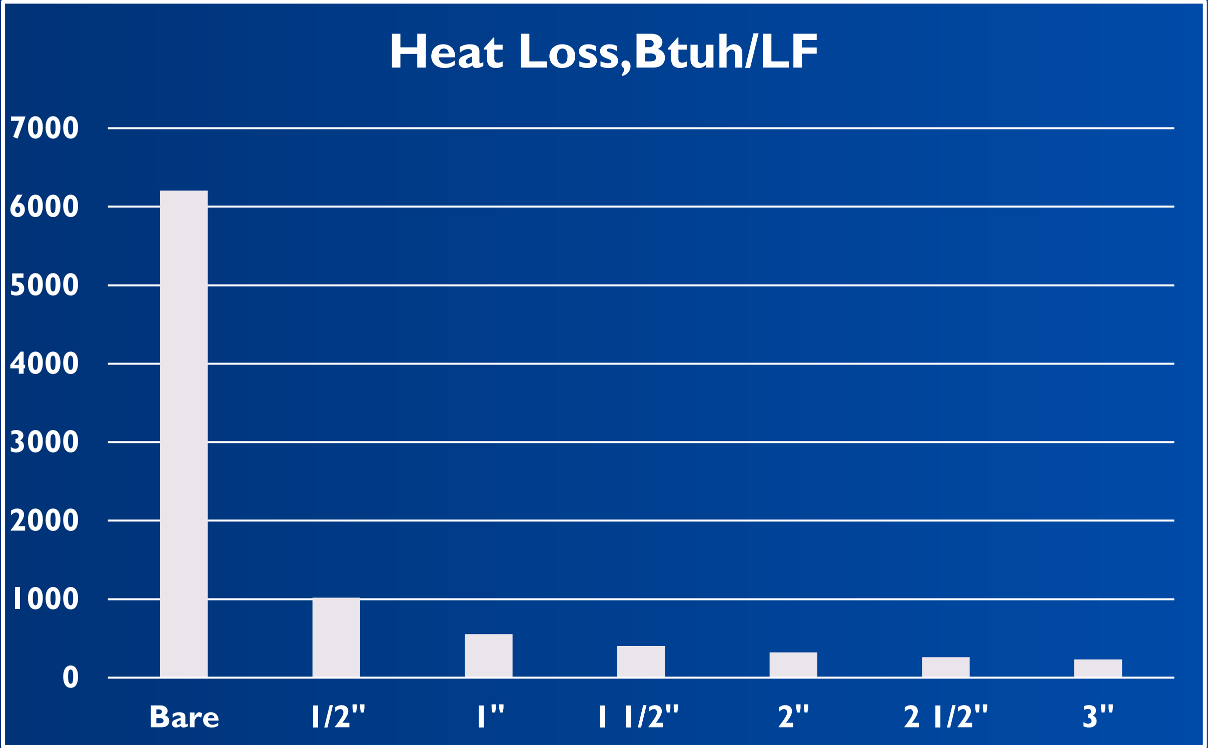
Real World Benefits of Mechanical Insulation

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 350ºF 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 CO_2 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 1,200ºF were analyzed
  - Ambient temperature of 90ºF with 6mph wind speed for personnel protection (PP)
  - Ambient temperature of 55ºF 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

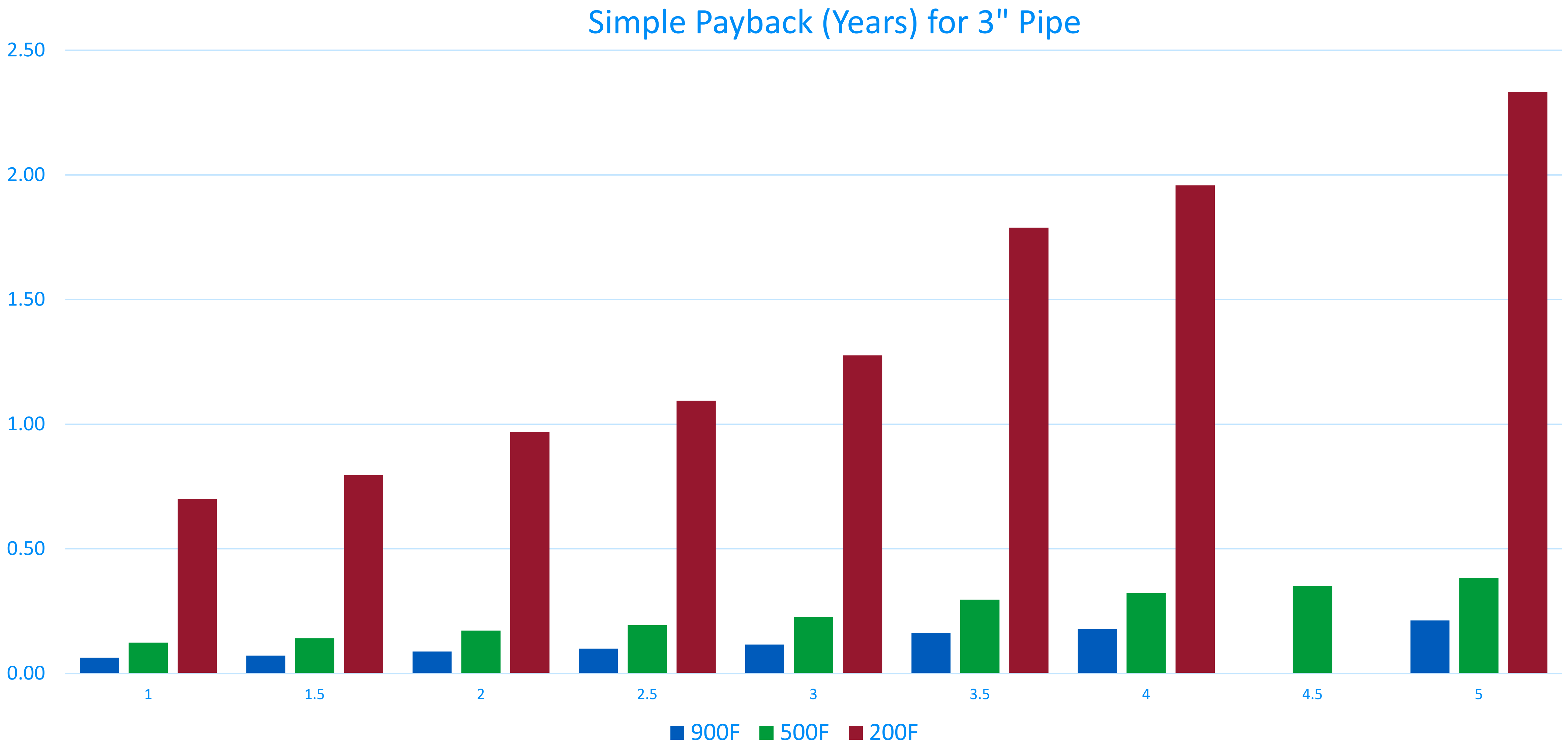
- Costs were based on an effective 100 feet of pipe—two elbows, one block valve, one 1” vent, one 1” drain, and sufficient straight pipe to total 100 equivalent feet of pipe.
- Modeled on a natural gas fuel source at a cost of \$4.50/MMBtu, an 80% heater efficiency, and 8,000 hours per year operation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

3” PIPE AT 200°F

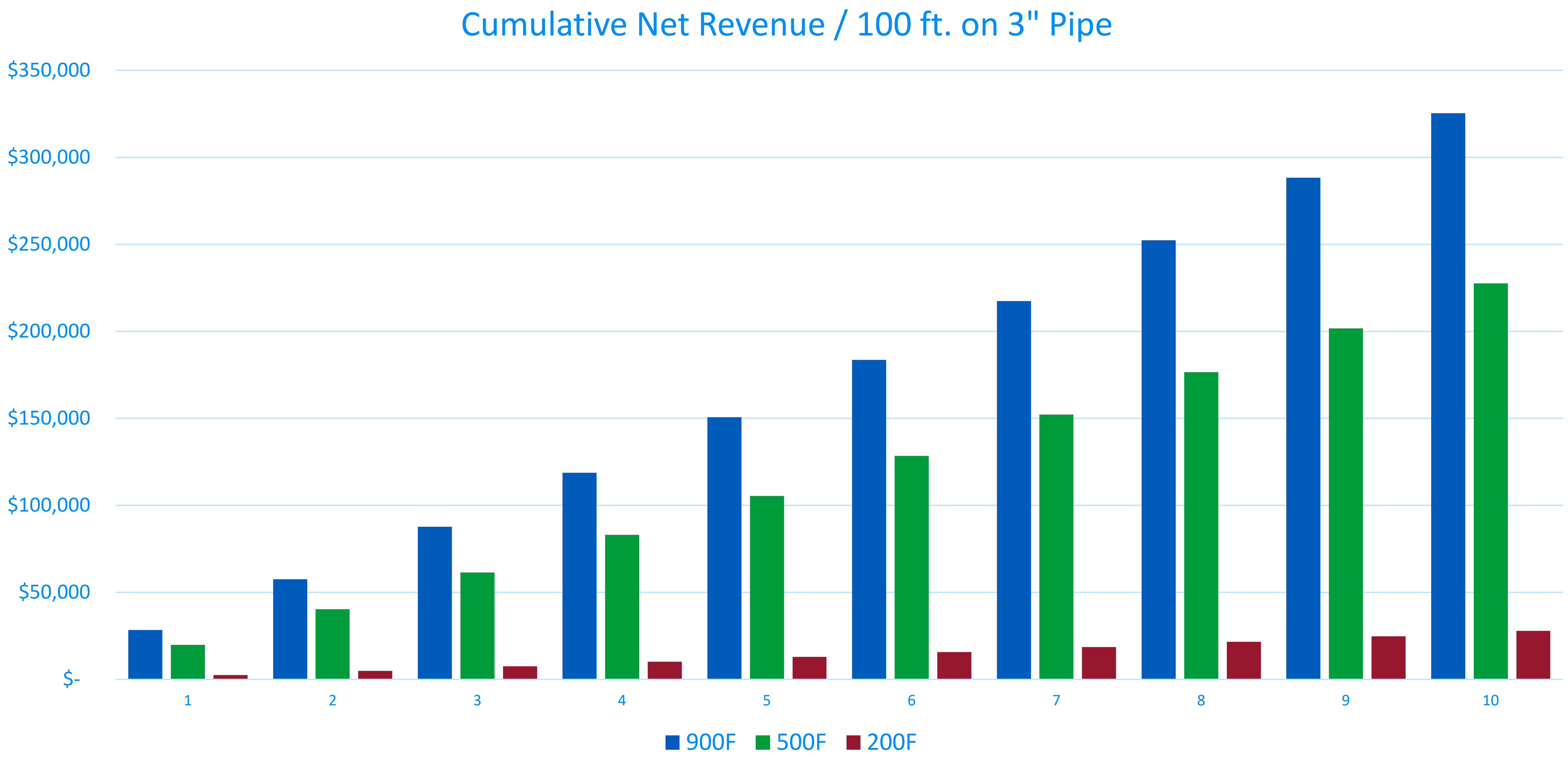
Thickness	Heat Loss	Efficiency	Heat Loss	Cost of Lost	Saving per	Saving per	Cost / 100'	Simple	Incremental	Incremental	Incremental
Inches	BTU/Hr-Ft	(%)	BTU/Ft-Yr	Energy/Ft	Ft per Yr	100 Ft / Yr	($)	Years	Cost	Revenue	Payback
0	611.6		4,892,800	$ 27.52	$ -	$ -					
1	54.52	91.09	436,160	$ 2.45	$ 25.07	$ 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
5	19.18	96.86	153,440	$ 0.86	$ 26.66	$ 2,666	$ 6,219	2.33	$ 1,023	$ 12	84.20

PP and Economic Thickness

3" PIPE

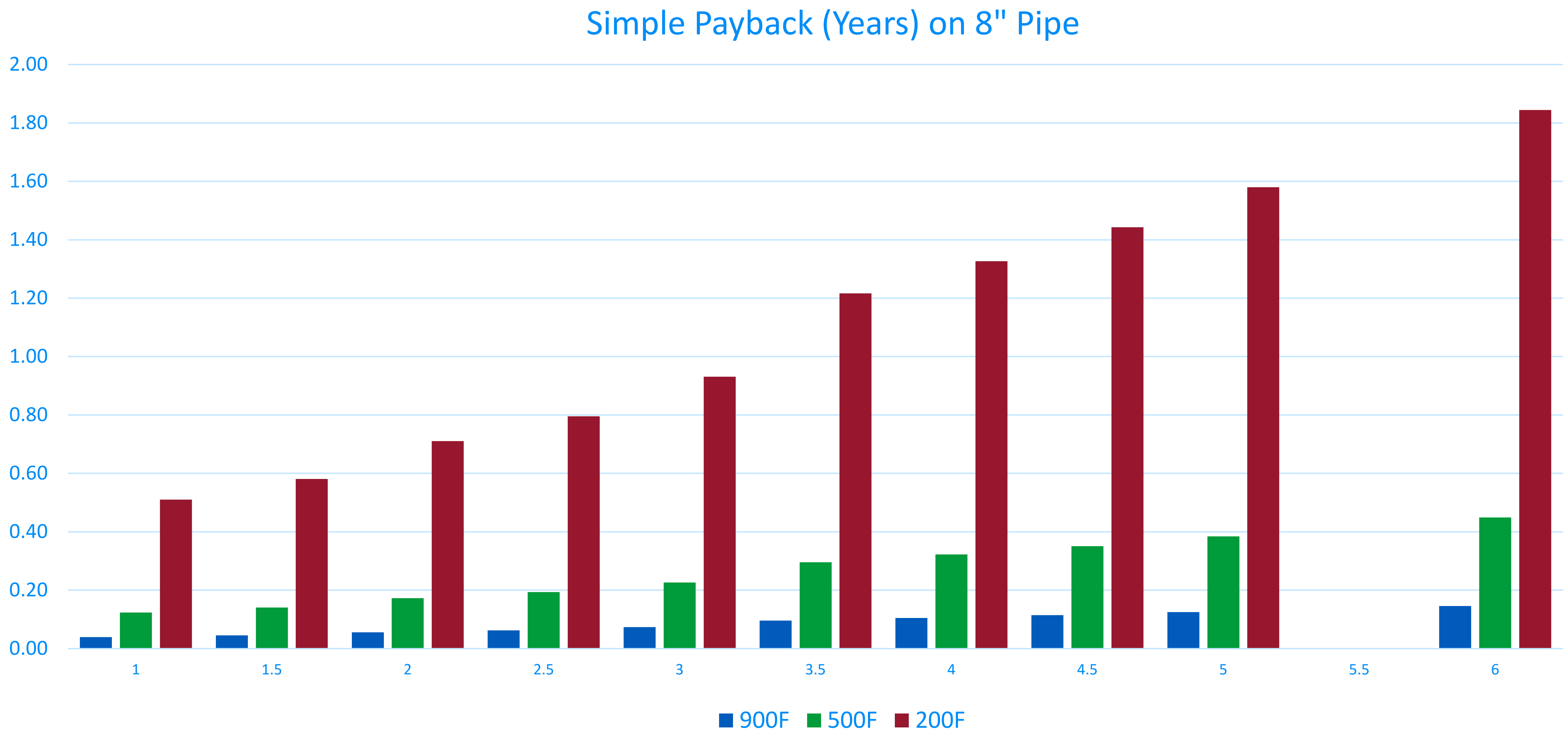

Simple Payback (Years) for 3" Pipe
2.50
2.00
1.50
1.00
0.50
0.00
1
1.5
2
2.5
3
3.5
4
4.5
5
900F
500F
200F

3” PIPE

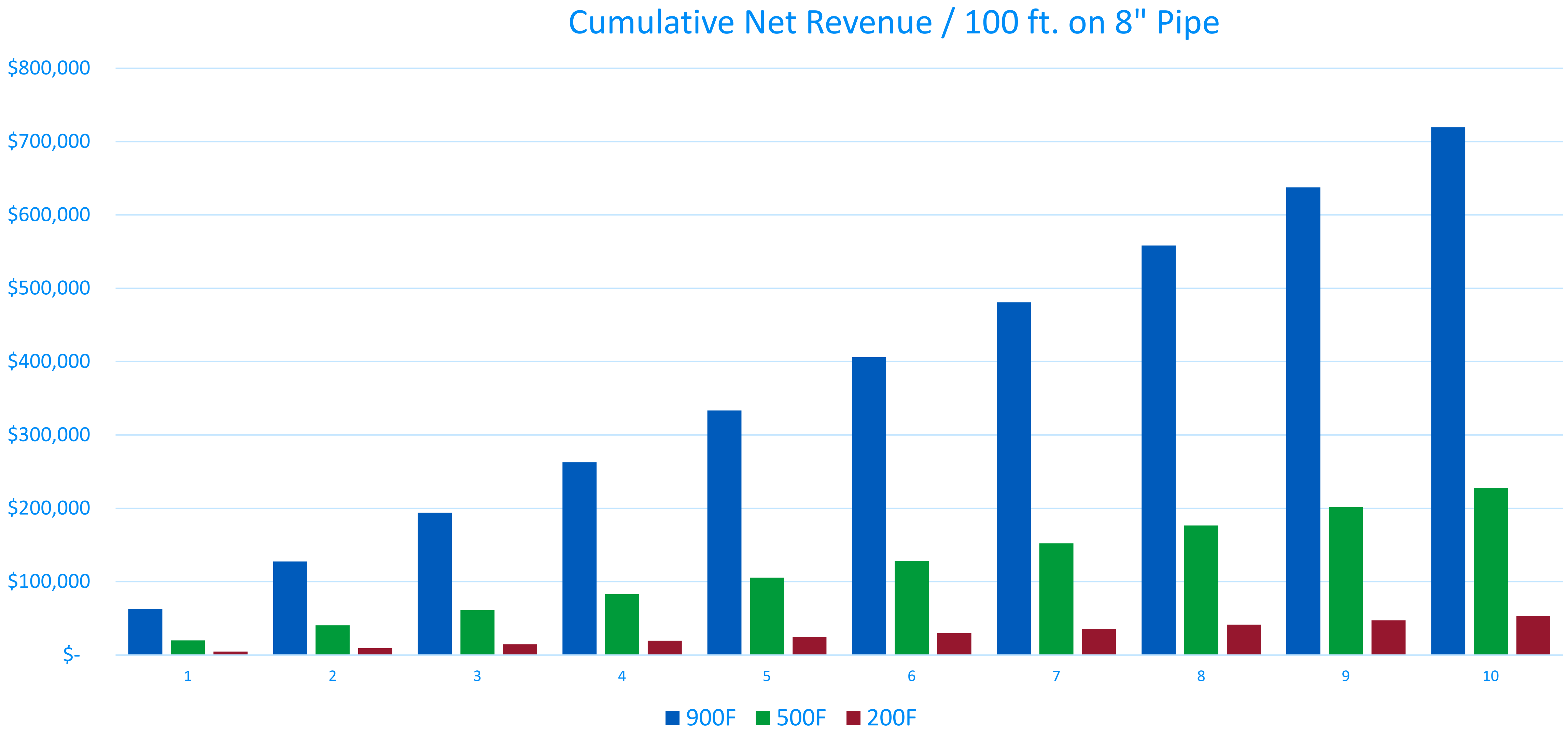


Cumulative Net Revenue / 100 ft. on 3" Pipe
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$-
1
2
3
4
5
6
7
8
9
10
900F
500F
200F

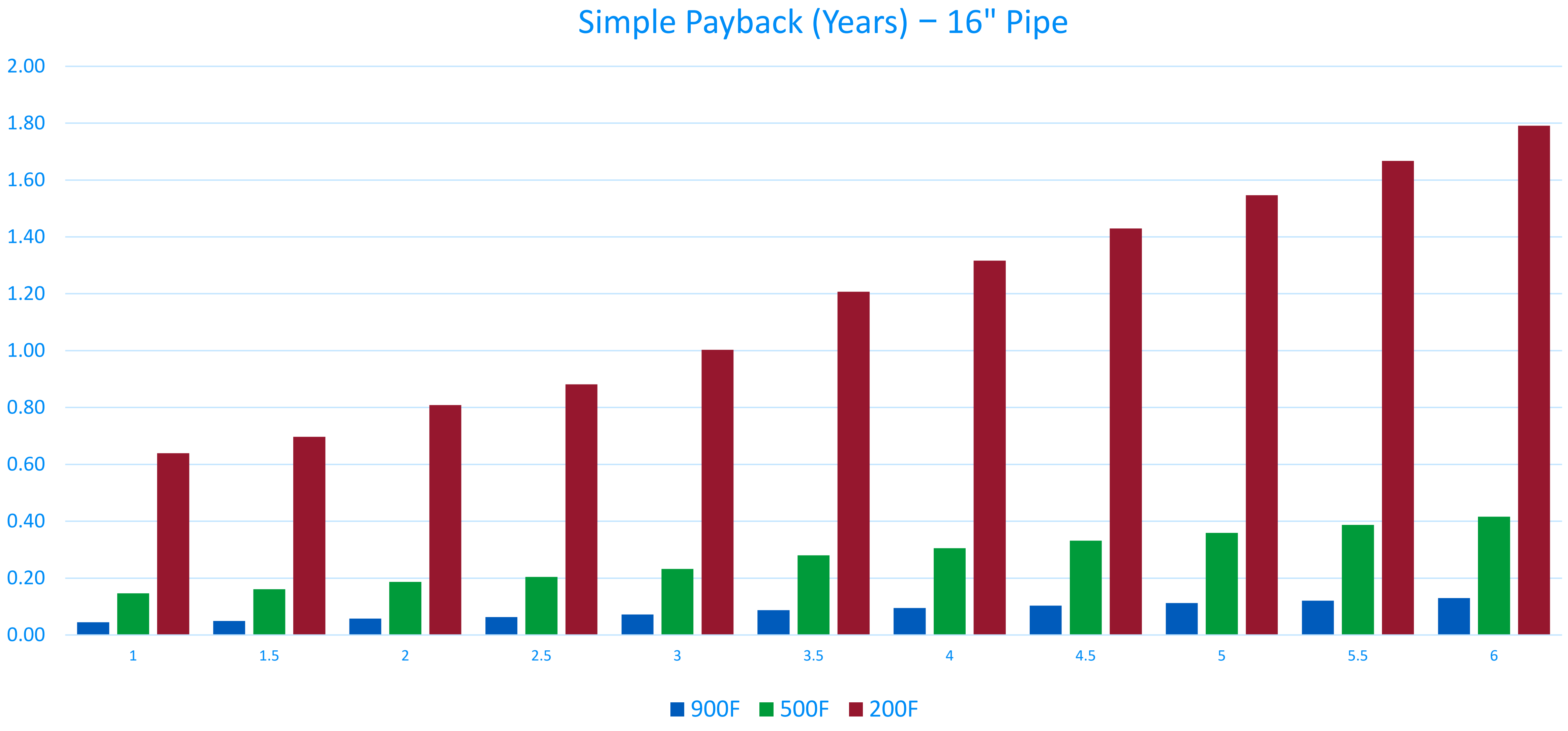
8” PIPE


Simple Payback (Years) on 8" Pipe
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
900F
500F
200F

8” PIPE

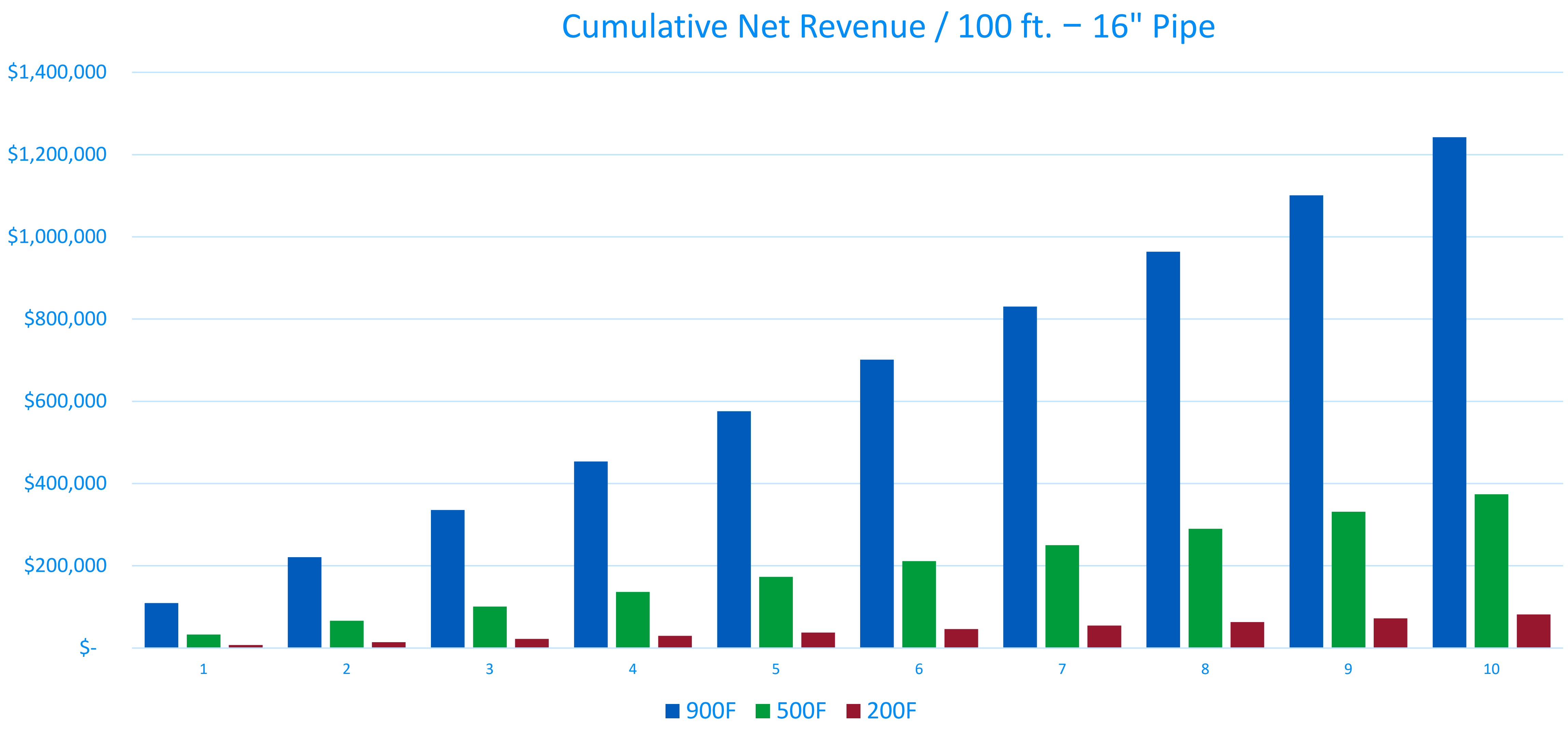

Cumulative Net Revenue / 100 ft. on 8" Pipe
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$-
1
2
3
4
5
6
7
8
9
10
900F
500F
200F

16” PIPE

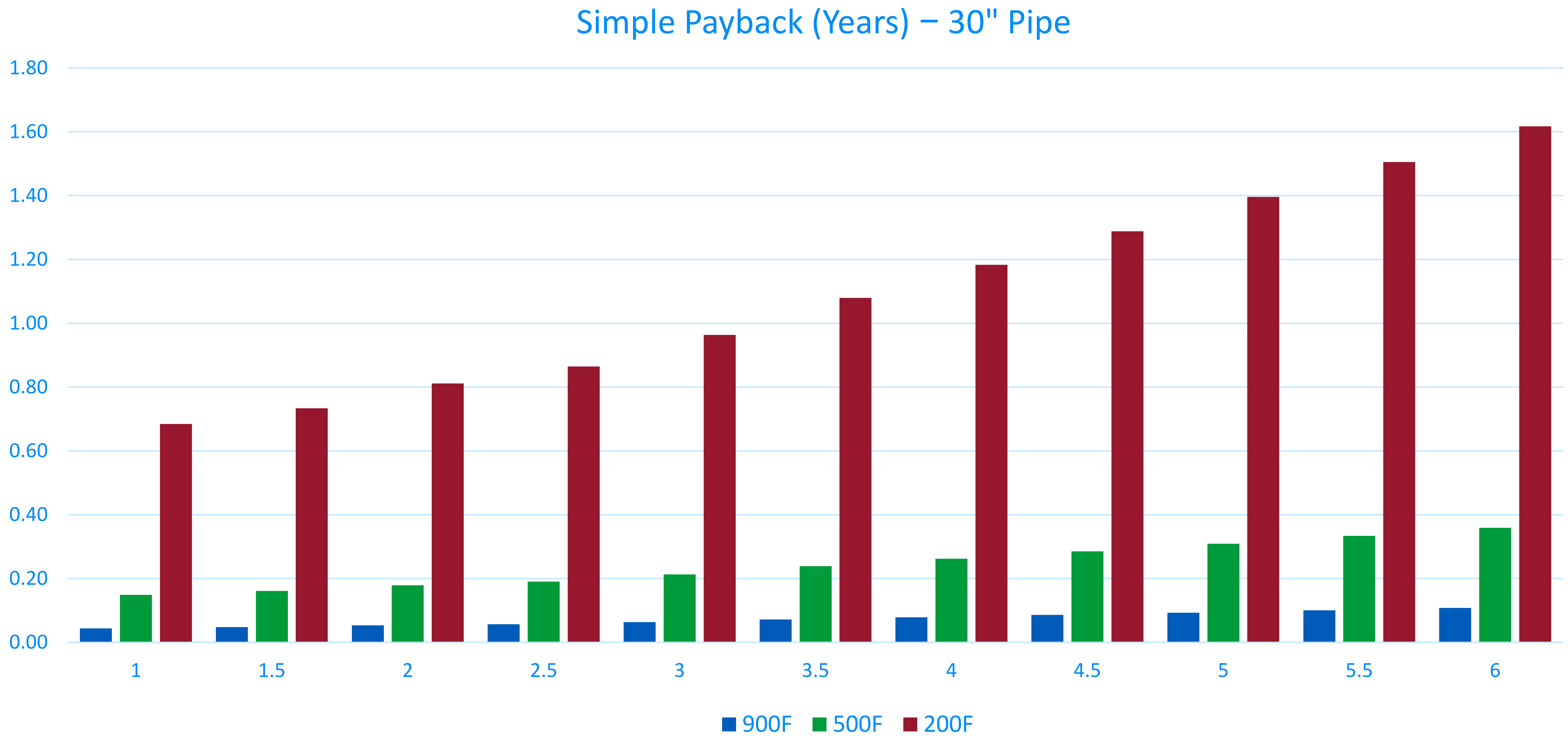


Simple Payback (Years) – 16" Pipe
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
900F
500F
200F

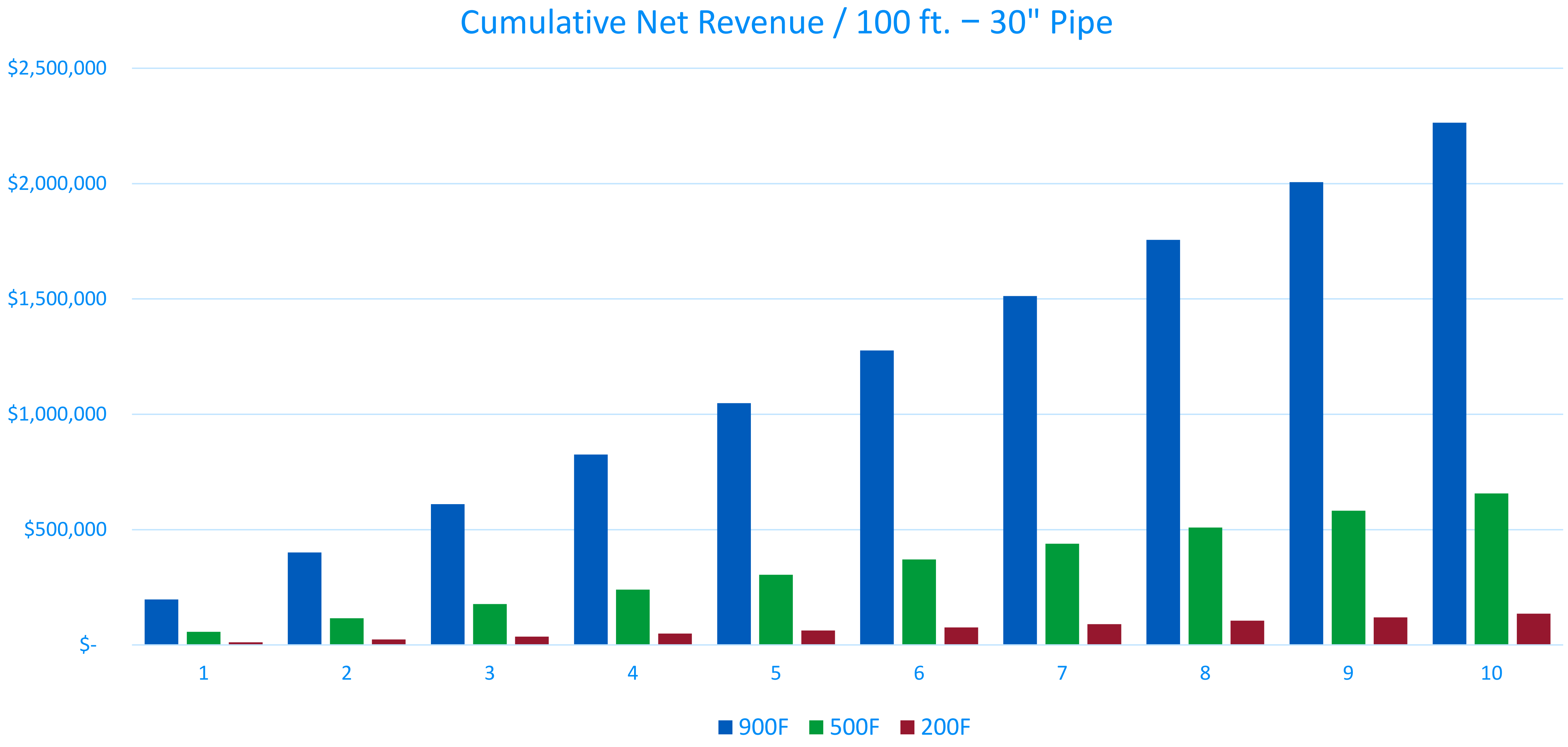
16” PIPE


Cumulative Net Revenue / 100 ft. – 16" Pipe
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$-
1
2
3
4
5
6
7
8
9
10
900F
500F
200F

30” PIPE


Simple Payback (Years) – 30" Pipe
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
900F
500F
200F

30" PIPE


Cumulative Net Revenue / 100 ft. – 30" Pipe
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$-
1
2
3
4
5
6
7
8
9
10
900F
500F
200F

3” Pipe, Emissions Reduction

Process Temp (°F)	Insulation Thickness (in)	CO_2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO_2 (lb/ft/yr)	NOx (lb/ft/yr)	Process Temp (°F)	Insulation Thickness (in)	CO_2 (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%**

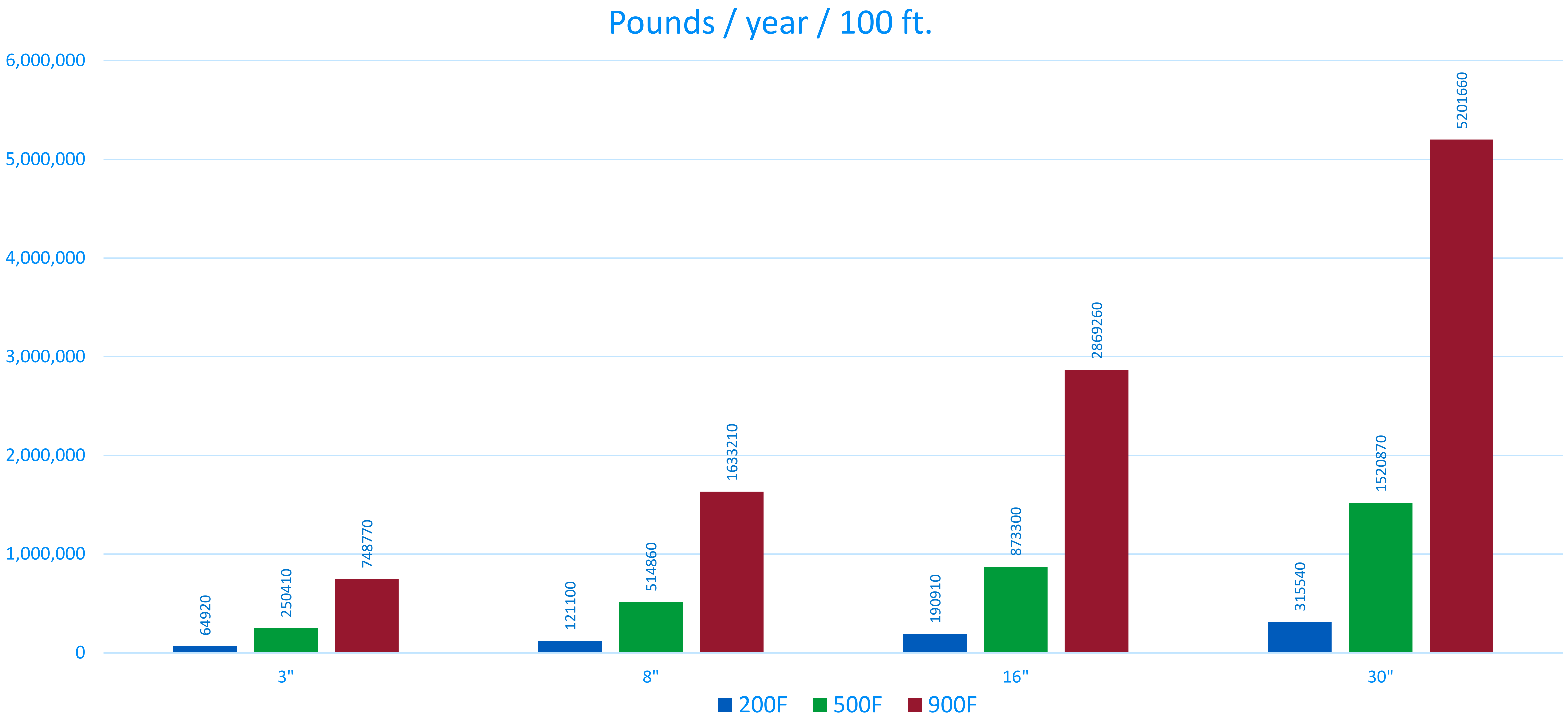
PP Thickness

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

CO_2 EMISSIONS REDUCTION



SUMMARY

Insulation projects are low cost.

Project execution is typically weeks to a few months.

Simple payback less than 1 year, often only 1 or 2 months.

All design thicknesses delivered reductions in CO_2 and NO_x emissions of 88 to 98%.

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

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