

## Life Cycle Cost Analysis - Base Year 2018

### Final Assumptions

<b><i>Energy and Demand Rates</i></b>	
Essentia Natural Gas Rate (\$/MMBtu)	\$4.29
Fuel Oil (\$/gal)	\$2.35
District Heating Energy Charge (\$/MMBtu) STEAM	\$6.85
District Heating Energy Charge (\$/MMBtu) HOT WATER	\$4.79
District Heating Capacity Charge (\$/MMBtu)	\$6.75
Capacity Charge Factor	100%
<b><i>Water and Sewer Rates</i></b>	
Water Rate (\$/CCF)	\$1.91
Sewer Rate (\$/CCF)	\$7.96
<b><i>Escalation Rates</i></b>	
Inflation Rate	2.5%
Water and Sewage Acceleration	3.0%
Discount Rate	4.00%
Cost of Capital - Essentia	4.00%
Cost of Capital - DES	3.40%
Payment Periods	20
<b><i>Equipment Efficiency</i></b>	
Boiler Efficiency	85%
Steam Load Efficiency	90%
<b><i>Curtailement and Nat Gas Service Backup</i></b>	
Curtailement (hours)	42
Peak Load (85% diversity)	54
Percent of Peak Load Over Curtailement for Energy Calc.	60%
MMBtu	1,352
Gallons Fuel Oil Consumed	9,763
<b><i>Operation and Maintenance</i></b>	
<b><i>Central Plant Production Equipment</i></b>	
Balance of Plant O&M (% of Capital)	1.0%
Distribution O&M (% of Capital)	2.5%
HP Steam Plant (24/7 Operator Requirement)	
Annual Operator Hours (24/7)	8,760
Operator Workload Diversity	55%
Annual Operator Hours For Boiler Plant Operations	4,845
Annual Chief Engineer Hours	1,040
Operator Labor Rate (\$/hr)	\$43
Chief Engineer Labor Rate (\$/hr)	\$57
HP Steam Plant (With DES Connection)	
Essentia Dispatch Days	110
Administration Factor (% of O&M)	2.5%

## 20 Year Life Cycle Cost Analysis

### DES Base Case - Essentia Owned Equipment

<i>Heating (MMBtu)</i>	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Steam	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084
Hot Water	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818
DHW	0	0	0	0	0	0	0	0	0	0	0
<i>Production Equipment Install, Replace, and/or Repair (MMBtu/hr)</i>	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Boiler Plant Install/Replacement	76.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boiler Plant Repair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	76.0

#### Energy Rate Escalation

Year	1	2	3	4	5	6	7	8	9	10	11
Natural Gas	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Electricity	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
DES - Capacity	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
DES - Energy	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

#### Base Scenario - On-Site Production (n + 1)

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
<i>Years from Base Year</i>	2.75	3.75	4.75	5.75	6.75	7.75	8.75	9.75	10.75	11.75	12.75
<i>Analysis Period</i>	1	2	3	4	5	6	7	8	9	10	11
New Boiler Plant, Rebuild and Replace	\$ 4,250,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$76,394	\$364,427
Add steam interconnection pipe	\$300,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Debt Service Amortized Over 20 Years	\$326,631	\$326,631	\$326,631	\$326,631	\$326,631	\$326,631	\$326,631	\$326,631	\$326,631	\$332,115	\$358,276
Boiler Plant Operations	\$286,419	\$293,579	\$300,918	\$308,441	\$316,152	\$324,056	\$332,158	\$340,462	\$348,973	\$357,697	\$366,640
Balance of the Plant and Dist O&M	\$53,513	\$58,705	\$60,173	\$61,677	\$63,219	\$64,799	\$66,419	\$68,080	\$69,782	\$71,526	\$73,315
Administration	\$8,498	\$8,807	\$9,027	\$9,253	\$9,484	\$9,721	\$9,964	\$10,214	\$10,469	\$10,731	\$10,999
Water and Sewer	\$13,673	\$14,083	\$14,506	\$14,941	\$15,389	\$15,851	\$16,326	\$16,816	\$17,321	\$17,840	\$18,376
Fuel Oil Cost	\$29,277	\$30,155	\$31,060	\$31,991	\$32,951	\$33,940	\$34,958	\$36,007	\$37,087	\$38,199	\$39,345
Natural Gas Cost	\$667,903	\$687,941	\$708,579	\$729,836	\$751,731	\$774,283	\$797,512	\$821,437	\$846,080	\$871,463	\$897,606
<b>Total</b>	<b>\$1,385,914</b>	<b>\$1,419,901</b>	<b>\$1,450,894</b>	<b>\$1,482,771</b>	<b>\$1,515,558</b>	<b>\$1,549,282</b>	<b>\$1,583,969</b>	<b>\$1,619,646</b>	<b>\$1,656,343</b>	<b>\$1,699,572</b>	<b>\$1,764,557</b>

#### District Service - On-Site Production (n + 0)

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
<i>Years from Base Year</i>	2.75	3.75	4.75	5.75	6.75	7.75	8.75	9.75	10.75	11.75	12.75
<i>Analysis Period</i>	1	2	3	4	5	6	7	8	9	10	11
New Boiler Plant, Rebuild and Replace	\$3,000,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$273,320
Capacity Charge Reduction at DC3 & Miller Dwan Material Mgmt	(\$66,523)	(\$67,853)	(\$69,210)	(\$70,594)	(\$72,006)	(\$73,447)	(\$74,915)	(\$76,414)	(\$77,942)	(\$79,501)	(\$81,091)
Credit for Boiler Plant Labor	(\$92,383)	(\$94,692)	(\$97,060)	(\$99,486)	(\$101,973)	(\$104,523)	(\$107,136)	(\$109,814)	(\$112,560)	(\$115,374)	(\$118,258)
Credit for Boiler Plant Capital & Maintenance	(\$236,000)	(\$237,000)	(\$238,000)	(\$238,000)	(\$239,000)	(\$239,000)	(\$240,000)	(\$240,000)	(\$240,000)	(\$241,000)	(\$262,000)
Boiler Plant Debt Service Amortized Over 20 Years	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$220,745	\$240,857
Boiler Plant O&M, Water & Sewer	\$15,113	\$16,579	\$16,994	\$17,418	\$17,854	\$18,300	\$18,758	\$19,227	\$19,707	\$20,200	\$20,705
District Heating Energy Charge - Steam	\$354,800	\$361,896	\$369,134	\$376,516	\$384,047	\$391,728	\$399,562	\$407,553	\$415,704	\$424,019	\$432,499
District Heating Energy Charge - HW	\$348,207	\$355,171	\$362,274	\$369,520	\$376,910	\$384,449	\$392,138	\$399,980	\$407,980	\$416,140	\$424,462
District Heating Capacity Charge	\$851,805	\$873,100	\$894,928	\$917,301	\$940,234	\$963,739	\$987,833	\$1,012,529	\$1,037,842	\$1,063,788	\$1,090,383
<b>Total</b>	<b>\$1,395,764</b>	<b>\$1,427,946</b>	<b>\$1,459,805</b>	<b>\$1,493,421</b>	<b>\$1,526,810</b>	<b>\$1,561,992</b>	<b>\$1,596,984</b>	<b>\$1,633,807</b>	<b>\$1,671,477</b>	<b>\$1,709,016</b>	<b>\$1,747,557</b>
DES Connection Savings	(\$9,850)	(\$8,045)	(\$8,911)	(\$10,650)	(\$11,252)	(\$12,710)	(\$13,016)	(\$14,161)	(\$15,134)	(\$9,445)	\$17,000

	20 Year Cost	NPV
On-Site Generation	\$34,951,000	\$23,025,000
DES Service	\$34,863,000	\$23,008,000
Savings	\$88,000	\$17,000
Percent Savings	0.3%	0.1%

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### DES Base Case - Essentia Owned Equipment

<i>Heating (MMBtu)</i>	2032	2033	2034	2035	2036	2037	2038	2039	2040
Steam	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084	49,084
Hot Water	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818	68,818
DHW	0	0	0	0	0	0	0	0	0
<i>Production Equipment Install, Replace, and/or Repair (MMBtu/hr)</i>	2032	2033	2034	2035	2036	2037	2038	2039	2040
Boiler Plant Install/Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
Boiler Plant Repair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

<i>Energy Rate Escalation</i>	Year	12	13	14	15	16	17	18	19	20
Natural Gas		3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Electricity		2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
DES - Capacity		2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
DES - Energy		2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

<i>Base Scenario - On-Site Production (n + 1)</i>										
Year	2032	2033	2034	2035	2036	2037	2038	2039	2040	
<i>Years from Base Year</i>	13.75	14.75	15.75	16.75	17.75	18.75	19.75	20.75	21.75	Total
<i>Analysis Period</i>	12	13	14	15	16	17	18	19	20	Total
New Boiler Plant, Rebuild and Replace	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$4,690,821
Add steam interconnection pipe	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$300,000
Debt Service Amortized Over 20 Years	\$358,276	\$358,276	\$358,276	\$358,276	\$358,276	\$358,276	\$358,276	\$358,276	\$358,276	\$6,854,561
Boiler Plant Operations	\$375,806	\$385,201	\$394,831	\$404,702	\$414,819	\$425,190	\$435,820	\$446,715	\$457,883	\$7,316,463
Balance of the Plant and Dist O&M	\$75,147	\$77,026	\$78,952	\$80,925	\$82,949	\$85,022	\$87,148	\$89,327	\$91,560	\$1,459,264
Administration	\$11,274	\$11,556	\$11,845	\$12,141	\$12,444	\$12,755	\$13,074	\$13,401	\$13,736	\$219,393
Water and Sewer	\$18,927	\$19,495	\$20,080	\$20,682	\$21,302	\$21,941	\$22,600	\$23,278	\$23,976	\$367,403
Fuel Oil Cost	\$40,526	\$41,741	\$42,994	\$44,283	\$45,612	\$46,980	\$48,390	\$49,841	\$51,337	\$786,673
Natural Gas Cost	\$924,535	\$952,271	\$980,839	\$1,010,264	\$1,040,572	\$1,071,789	\$1,103,943	\$1,137,061	\$1,171,173	\$17,946,816
<b>Total</b>	<b>\$1,804,491</b>	<b>\$1,845,566</b>	<b>\$1,887,816</b>	<b>\$1,931,274</b>	<b>\$1,975,975</b>	<b>\$2,021,955</b>	<b>\$2,069,250</b>	<b>\$2,117,899</b>	<b>\$2,167,941</b>	

<i>District Service - On-Site Production (n + 0)</i>										
Year	2032	2033	2034	2035	2036	2037	2038	2039	2040	
<i>Years from Base Year</i>	13.75	14.75	15.75	16.75	17.75	18.75	19.75	20.75	21.75	Total
<i>Analysis Period</i>	12	13	14	15	16	17	18	19	20	Total
New Boiler Plant, Rebuild and Replace	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$3,273,320
Capacity Charge Reduction at DC3 & Miller Dwan Material Mgmt	(\$82,713)	(\$84,367)	(\$86,054)	(\$87,775)	(\$89,531)	(\$91,322)	(\$93,148)	(\$95,011)	(\$96,911)	(\$1,616,328)
Credit for Boiler Plant Labor	(\$121,214)	(\$124,245)	(\$127,351)	(\$130,535)	(\$133,798)	(\$137,143)	(\$140,571)	(\$144,086)	(\$147,688)	(\$2,359,890)
Credit for Boiler Plant Capital & Maintenance	(\$262,000)	(\$263,000)	(\$263,000)	(\$264,000)	(\$264,000)	(\$265,000)	(\$265,000)	(\$266,000)	(\$267,000)	(\$5,029,000)
Boiler Plant Debt Service Amortized Over 20 Years	\$240,857	\$240,857	\$240,857	\$240,857	\$240,857	\$240,857	\$240,857	\$240,857	\$240,857	\$4,616,019
Boiler Plant O&M, Water & Sewer	\$21,223	\$21,753	\$22,297	\$22,854	\$23,426	\$24,011	\$24,612	\$25,227	\$25,858	\$412,116
District Heating Energy Charge - Steam	\$441,149	\$449,972	\$458,971	\$468,151	\$477,514	\$487,064	\$496,805	\$506,741	\$516,876	\$8,620,701
District Heating Energy Charge - HW	\$432,952	\$441,611	\$450,443	\$459,452	\$468,641	\$478,013	\$487,574	\$497,325	\$507,272	\$8,460,512
District Heating Capacity Charge	\$1,117,642	\$1,145,583	\$1,174,223	\$1,203,578	\$1,233,668	\$1,264,510	\$1,296,122	\$1,328,525	\$1,361,739	\$21,759,073
<b>Total</b>	<b>\$1,787,895</b>	<b>\$1,828,164</b>	<b>\$1,870,385</b>	<b>\$1,912,582</b>	<b>\$1,956,776</b>	<b>\$2,000,991</b>	<b>\$2,047,251</b>	<b>\$2,093,579</b>	<b>\$2,141,002</b>	
DES Connection Savings	\$16,595	\$17,402	\$17,430	\$18,692	\$19,199	\$20,964	\$21,999	\$24,320	\$26,939	