

# APPENDIX D

**Heating Eff Upgrades**

Lafayette TMY3 Data

**Assumptions**

|  | Input |
|--|-------|
| Total Heating Bill - MMBTUs                  | 2699  |
| Summer Bill - June/July/Aug                  | 60    |
| Summer Usage (Y/N)                           | Y     |
| Heating Break Even Temp                      | 55    |
| Peak Winter Load - MBTU*                     | 450   |
| Low Bin Temp                                 | -12.5 |
| Summer Reheat Based Load - MBTU              | 81    |
| Exiting Fuel (Gas/Oil = 1, Electric = 2)     | 1     |
| Existing Burner Eff.                         | 79%   |
| Existing Skin Loss at Design Capacity        | 2%    |
| Existing Losses From Cycling % at Min Load   | 30%   |
| Existing Losses From Cycling % at Max Load   | 5%    |
| Proposed Fuel (Gas/Oil = 1, Electric = 2)    | 1     |
| Proposed Burner Eff. (at 180F if Condensing) | 88%   |
| Proposed Burner Eff. (at 120F if Condensing) | 92%   |
| Proposed Skin Loss at Design Capacity        | 1%    |
| Proposed Losses From Cycling % at Min Load   | 3%    |
| Proposed Losses From Cycling % at Max Load   | 1%    |

| 6am to 6pm<br>Bin Temp | Hours | Heating<br>Load | Existing Eff. |      |       | Proposed Eff. |        |      | MMBTU Hourly Usage |             | MMBTU Usage |       |        |       |
|------------------------|-------|-----------------|---------------|------|-------|---------------|--------|------|--------------------|-------------|-------------|-------|--------|-------|
|                        |       |                 | Burner        | Skin | Cycle | System Eff.   | Burner | Skin | Cycle              | System Eff. | Before      | After | Before | After |
| 102.5                  | 0     | -               | 0%            | 0%   | 0%    | 0%            | 0%     | 0%   | 0%                 | -           | -           | -     | -      | -     |
| 97.5                   | 4     | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 1     | 0      | 0     |
| 92.5                   | 24    | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 5     | 2      | 2.5   |
| 87.5                   | 124   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 25    | 12     | 13.0  |
| 82.5                   | 166   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 33    | 16     | 17.4  |
| 77.5                   | 321   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 64    | 30     | 33.7  |
| 72.5                   | 353   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 70    | 33     | 37.0  |
| 67.5                   | 366   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 73    | 34     | 38.4  |
| 62.5                   | 412   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 82    | 39     | 43.2  |
| 57.5                   | 330   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.20        | 0.09        | 66    | 31     | 34.6  |
| 52.5                   | 350   | 94              | 79%           | 7%   | 29%   | 43%           | 92%    | 2%   | 3%                 | 0.22        | 0.11        | 77    | 38     | 39.0  |
| 47.5                   | 310   | 122             | 79%           | 6%   | 27%   | 46%           | 92%    | 2%   | 3%                 | 0.26        | 0.14        | 82    | 43     | 38.2  |
| 42.5                   | 289   | 149             | 79%           | 5%   | 25%   | 49%           | 91%    | 2%   | 3%                 | 0.30        | 0.17        | 88    | 49     | 38.3  |
| 37.5                   | 164   | 176             | 79%           | 4%   | 24%   | 52%           | 91%    | 1%   | 2%                 | 0.34        | 0.20        | 56    | 33     | 22.8  |
| 32.5                   | 253   | 204             | 79%           | 3%   | 22%   | 54%           | 91%    | 1%   | 2%                 | 0.38        | 0.23        | 95    | 59     | 36.3  |
| 27.5                   | 228   | 231             | 79%           | 3%   | 20%   | 56%           | 90%    | 1%   | 2%                 | 0.41        | 0.27        | 94    | 60     | 33.2  |
| 22.5                   | 189   | 258             | 79%           | 3%   | 18%   | 58%           | 90%    | 1%   | 2%                 | 0.44        | 0.30        | 84    | 56     | 27.6  |
| 17.5                   | 193   | 286             | 79%           | 2%   | 16%   | 61%           | 90%    | 1%   | 2%                 | 0.47        | 0.33        | 91    | 63     | 27.8  |
| 12.5                   | 117   | 313             | 79%           | 2%   | 14%   | 63%           | 89%    | 1%   | 2%                 | 0.50        | 0.36        | 59    | 42     | 16.4  |
| 7.5                    | 75    | 341             | 79%           | 2%   | 12%   | 65%           | 89%    | 1%   | 2%                 | 0.53        | 0.39        | 40    | 29     | 10.2  |
| 2.5                    | 56    | 368             | 79%           | 2%   | 11%   | 67%           | 89%    | 1%   | 1%                 | 0.55        | 0.42        | 31    | 24     | 7.2   |
| -2.5                   | 33    | 395             | 79%           | 2%   | 9%    | 69%           | 89%    | 1%   | 1%                 | 0.58        | 0.46        | 19    | 15     | 4.0   |
| -7.5                   | 18    | 423             | 79%           | 2%   | 7%    | 71%           | 88%    | 1%   | 1%                 | 0.60        | 0.49        | 11    | 9      | 2.0   |
| -12.5                  | 5     | 450             | 79%           | 2%   | 5%    | 73%           | 88%    | 1%   | 1%                 | 0.62        | 0.52        | 3     | 3      | 0.5   |

4,536

1,245 721 524

| 6pm to 6am<br>Bin Temp | Hours | Heating<br>Load | Existing Eff. |      |       | Proposed Eff. |        |      | MMBTU Hourly Usage |             | MMBTU Usage |       |        |       |         |
|------------------------|-------|-----------------|---------------|------|-------|---------------|--------|------|--------------------|-------------|-------------|-------|--------|-------|---------|
|                        |       |                 | Burner        | Skin | Cycle | System Eff.   | Burner | Skin | Cycle              | System Eff. | Before      | After | Before | After | Savings |
| 92.5                   | 0     | -               | 0%            | 0%   | 0%    | 0%            | 0%     | 0%   | 0%                 | -           | -           | -     | -      | -     |         |
| 87.5                   | 28    | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 6     | 3      | 3     |         |
| 82.5                   | 60    | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 12    | 6      | 6     |         |
| 77.5                   | 147   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 29    | 14     | 15    |         |
| 72.5                   | 315   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 63    | 29     | 33    |         |
| 67.5                   | 457   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 91    | 43     | 48    |         |
| 62.5                   | 530   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 105   | 50     | 56    |         |
| 57.5                   | 381   | 81              | 79%           | 8%   | 30%   | 41%           | 92%    | 3%   | 3%                 | 0.2         | 0.1         | 76    | 36     | 40    |         |
| 52.5                   | 460   | 94              | 79%           | 7%   | 29%   | 43%           | 92%    | 2%   | 3%                 | 0.2         | 0.1         | 101   | 50     | 51    |         |
| 47.5                   | 354   | 122             | 79%           | 6%   | 27%   | 46%           | 92%    | 2%   | 3%                 | 0.3         | 0.1         | 93    | 50     | 44    |         |
| 42.5                   | 404   | 149             | 79%           | 5%   | 25%   | 49%           | 91%    | 2%   | 3%                 | 0.3         | 0.2         | 123   | 69     | 54    |         |
| 37.5                   | 248   | 176             | 79%           | 4%   | 24%   | 52%           | 91%    | 1%   | 2%                 | 0.3         | 0.2         | 85    | 50     | 35    |         |
| 32.5                   | 271   | 204             | 79%           | 3%   | 22%   | 54%           | 91%    | 1%   | 2%                 | 0.4         | 0.2         | 102   | 63     | 39    |         |
| 27.5                   | 270   | 231             | 79%           | 3%   | 20%   | 56%           | 90%    | 1%   | 2%                 | 0.4         | 0.3         | 111   | 72     | 39    |         |
| 22.5                   | 244   | 258             | 79%           | 3%   | 18%   | 58%           | 90%    | 1%   | 2%                 | 0.4         | 0.3         | 108   | 72     | 36    |         |
| 17.5                   | 192   | 286             | 79%           | 2%   | 16%   | 61%           | 90%    | 1%   | 2%                 | 0.5         | 0.3         | 91    | 63     | 28    |         |
| 12.5                   | 130   | 313             | 79%           | 2%   | 14%   | 63%           | 89%    | 1%   | 2%                 | 0.5         | 0.4         | 65    | 47     | 18    |         |
| 7.5                    | 93    | 341             | 79%           | 2%   | 12%   | 65%           | 89%    | 1%   | 2%                 | 0.5         | 0.4         | 49    | 36     | 13    |         |
| 2.5                    | 81    | 368             | 79%           | 2%   | 11%   | 67%           | 89%    | 1%   | 1%                 | 0.6         | 0.4         | 45    | 34     | 10    |         |
| -2.5                   | 53    | 395             | 79%           | 2%   | 9%    | 69%           | 89%    | 1%   | 1%                 | 0.6         | 0.5         | 31    | 24     | 6     |         |
| -7.5                   | 21    | 423             | 79%           | 2%   | 7%    | 71%           | 88%    | 1%   | 1%                 | 0.6         | 0.5         | 13    | 10     | 2     |         |
| -12.5                  | 4     | 450             | 79%           | 2%   | 5%    | 73%           | 88%    | 1%   | 1%                 | 0.6         | 0.5         | 2     | 2      | 0     |         |
| 4,375                  |       |                 |               |      |       |               |        |      |                    |             |             |       | 1,399  | 823   | 576     |

Total MMBTU Usage  
% of Bill

Before After Savings  
2,644 1,544 1,100  
98% 57% 41%

**Formulas:**

Heating Load = if Hrs = 0, 0, if OA > Breakeven Temp, if Summer Usage, Summer Reheat Load, 0, ( Summer RH Load + ( Peak Load - Summer Reheat Load) x (Breakeven Temp - OA Temp) / (Breakeven Temp - Low Bin Temp)

Burn Eff. = if Load = 0, 0, Avg. Burner Eff.

Skin Loss = if Load = 0, 0, Skin Loss x Peak Load / Building Load

Cycle Loss = if Load = 0, 0, if OA > Breakeven Temp, Cycle Loss at Min Load, Cycle Loss at Min Load - ( Cycle Loss at Min Load - Cycle Loss at Peak Load) x (Breakeven Temp - OA Temp) / (Breakeven Temp - Low Bin Temp)

System Eff. = Burner Eff. - Skin Losses - Cycle Losses

MMBTU Usage = if Load = 0, 0, Heating Load x Hrs / System Eff.

MMBTU Hourly Usage = if Load = 0, 0, MMBTU Usage / Hrs

Monthly KW = MMBTU Peak Load x 1,000,000 / 3413