APPENDICES

BUILDING OVERVIEW

MECHNICAL DEPTH

APPENDIX – BUILDING OVERVIEW

FCU	CLG mbh	HTG mbh
1	12.009	16.218
2	18.153	25.339
3	23.628	31.52
4	29.29	32.928
5	33.684	41.56
6	114.148	147.334

WSHP Systems

						cooling HAP equipment								heating HAP equipment				
						max load				gross capacity	comp calc			max load	gross capacity	comp calc		
MAU	FCUs scheduled	FCU nom ton	chosen FCU Fan FLA	#of FCUs	Zone #	total mbh	mbh/ht pump	total tons	tons/ht pump	scheduled mbH	Clg kW	Fan kW	Comp. Power kW	mbh	scheduled mbh	Htg kW	Fan kW	Comp. Power kW
MISC (no OA from MAU/direct vent)	1	1	0.8	7	1 - laundry	36.3	5.2	3.0	0.4	84.1	7.64	0.18	7.46	0	113.5	7.92	0.18	7.738
	2	1.5	1.1	1	2-mail	14.3	14.3	1.2	1.2	18.2	1.65	0.25	1.40	6.2	25.3	1.77	0.25	1.515
	6	10		1	3-gym	218.6	218.6	18.2	18.2	114.1	10.38	0.00	10.38	173.3	147.3	10.28	0.00	10.281
										216.4	19.67	0.44	**19.23**		**286.2**	19.97	0.44	**19.534**
MAU 1	4 (5 on 9th)	2.56	2.7	9	1-A	295.8	32.9	24.7	2.7	268.0	24.36	0.62	23.74	82.1	305.0	21.28	0.62	20.661
	2 (3 on 9th)	1.56	1.5	9	2-B	225.8	25.1	18.8	2.1	168.9	15.35	0.35	15.01	51.5	234.2	16.35	0.35	16.000
	2 (3 on 9th)	1.56	1.5	9	3-C	216.7	24.1	18.1	2.0	168.9	15.35	0.35	15.01	43.6	234.2	16.35	0.35	16.000
	2 (3 on 9th)	1.56	1.5	9	4-D	222.6	24.7	18.6	2.1	168.9	15.35	0.35	15.01	51.5	234.2	16.35	0.35	16.000
	4 (5 on 9th)	2.56	2.7	9	5-P	301.3	33.5	25.1	2.8	268.0	24.36	0.62	23.74	62.7	305.0	21.28	0.62	20.661
										1042.6	94.78	2.28	**92.50**		**1312.7**	91.60	2.28	**89.323**
MAU 2	2 (3 on 9th)	1.56	1.5	9	1-E	212.5	23.6	17.7	2.0	168.9	15.35	0.35	15.01	48.8	234.2	16.35	0.35	16.000
	2 (3 on 9th)	1.56	1.5	8	2-F	170.9	21.4	14.2	1.8	150.7	13.70	0.35	13.35	36	208.9	14.58	0.35	14.232
	3	2	2.7	6	3-G	189.9	31.7	15.8	2.6	141.8	12.89	0.62	12.27	54.2	189.1	13.20	0.62	12.576
										461.3	41.94	1.31	**40.63**		**632.2**	44.12	1.31	**42.808**
MAU 3	3	2	2.7	9	1-L	282.4	31.4	23.5	2.6	212.7	19.33	0.62	18.71	72.1	283.7	19.80	0.62	19.175
	2 (3 on 9th)	1.55	1.5	10	2-M	178.4	17.8	14.9	1.5	187.0	17.00	0.35	16.66	34.7	228.1	15.91	0.35	15.569
	4 (5 on 9th)	2.55	2.7	10	3-N	385.7	38.6	32.1	3.2	297.3	27.03	0.62	26.41	110.8	337.9	23.58	0.62	22.959
	3 (4 on 9th)	2.06	2.7	8	4-Q	258.9	32.4	21.6	2.7	218.3	19.85	0.62	19.23	34.1	285.1	19.89	0.62	19.273
										915.3	83.21	2.21	**81.00**		**1134.7**	79.18	2.21	**76.975**
MAU 4	3	2	2.7	6	1-H	204.5	34.1	17.0	2.8	141.8	12.89	0.62	12.27	50.1	189.1	13.20	0.62	12.576
	3	2	1.5	9	2-J	231.0	25.7	19.3	2.1	263.6	23.96	0.35	23.62	36	296.4	20.68	0.35	20.335
	3	2	2.7	10	3-K	312.5	31.3	26.0	2.6	336.8	30.62	0.62	30.00	77.2	415.6	29.00	0.62	28.380
	3 (4 on 9th)	2.06	2.7	8	4-R	240.4	30.1	20.0	2.5	194.7	17.70	0.62	17.08	27.8	253.6	17.69	0.62	17.073
										936.9	85.17	2.21	**82.97**		**1154.6**	80.57	2.21	**78.365**
				147		4198.5							EER 11	1052.7				COP 4.2

Annual Cost Summary

Table 1. Annual Costs

Component	TRY STREET TERMINAL BLDG ($)
Air System Fans	21,335
Cooling	187,220
Heating	71,185
Pumps	56,924
Cooling Tower Fans	3,201
HVAC Sub-Total	**339,865**
Lights	138,214
Electric Equipment	439,187
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**577,402**
Grand Total	**917,266**

Table 2. Annual Cost per Unit Floor Area

Component	TRY STREET TERMINAL BLDG ($/ft²)
Air System Fans	0.127
Cooling	1.115
Heating	0.424
Pumps	0.339
Cooling Tower Fans	0.019
HVAC Sub-Total	**2.024**
Lights	0.823
Electric Equipment	2.615
Misc. Electric	0.000
Misc. Fuel Use	0.000
Non-HVAC Sub-Total	**3.439**
Grand Total	**5.463**
Gross Floor Area (ft²)	167920.4
Conditioned Floor Area (ft²)	167920.4

Note: Values in this table are calculated using the Gross Floor Area.

Table 3. Component Cost as a Percentage of Total Cost

Component	TRY STREET TERMINAL BLDG (%)
Air System Fans	2.3
Cooling	20.4
Heating	7.8
Pumps	6.2
Cooling Tower Fans	0.3
HVAC Sub-Total	**37.1**
Lights	15.1
Electric Equipment	47.9
Misc. Electric	0.0
Misc. Fuel Use	0.0
Non-HVAC Sub-Total	**62.9**
Grand Total	**100.0**

Table 1. Annual Costs

Component	TRY STREET TERMINAL BLDG ($)
HVAC Components	
Electric	268,766
Natural Gas	71,097
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**339,863**
Non-HVAC Components	
Electric	577,381
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**577,381**
Grand Total	**917,243**

Table 2. Annual Energy Consumption

Component	TRY STREET TERMINAL BLDG
HVAC Components	
Electric (kWh)	3,089,258
Natural Gas (Therm)	44,603
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	6,636,561
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	9,725,819
Natural Gas (Therm)	44,603
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

Table 3. Annual Emissions

Component	TRY STREET TERMINAL BLDG
CO2 (lb)	0
SO2 (kg)	0
NOx (kg)	0

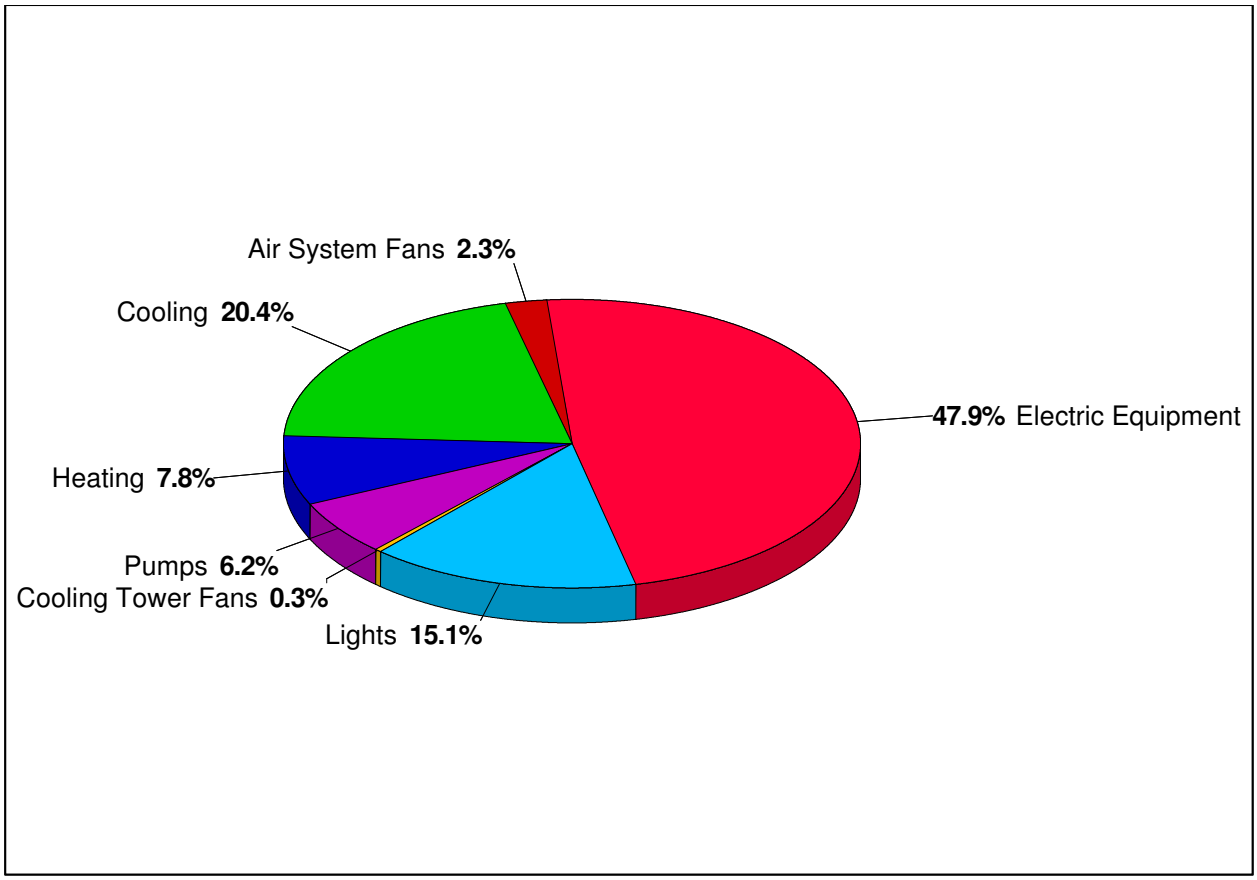
Table 4. Annual Cost per Unit Floor Area

Component	TRY STREET TERMINAL BLDG ($/ft²)
HVAC Components	
Electric	1.601
Natural Gas	0.423
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Remote CW	0.000
HVAC Sub-Total	**2.024**
Non-HVAC Components	
Electric	3.438
Natural Gas	0.000
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Non-HVAC Sub-Total	**3.438**
Grand Total	**5.462**
Gross Floor Area (ft²)	167920.4
Conditioned Floor Area (ft²)	167920.4

Note: Values in this table are calculated using the Gross Floor Area.

Table 5. Component Cost as a Percentage of Total Cost

Component	TRY STREET TERMINAL BLDG (%)
HVAC Components	
Electric	29.3
Natural Gas	7.8
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Remote CW	0.0
HVAC Sub-Total	**37.1**
Non-HVAC Components	
Electric	62.9
Natural Gas	0.0
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Non-HVAC Sub-Total	**62.9**
Grand Total	**100.0**



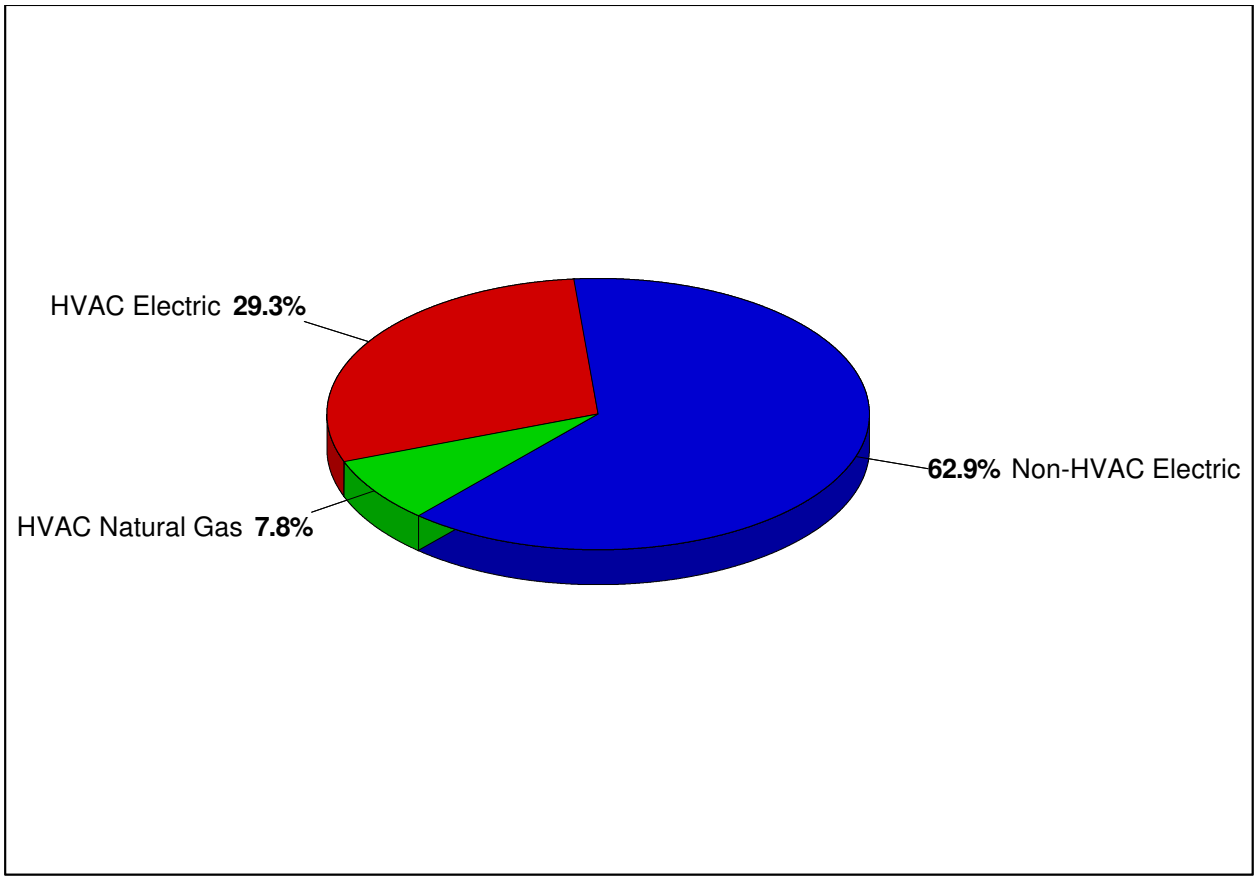
1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	21,335	0.127	2.3
Cooling	187,220	1.115	20.4
Heating	71,185	0.424	7.8
Pumps	56,924	0.339	6.2
Cooling Tower Fans	3,201	0.019	0.3
HVAC Sub-Total	**339,865**	**2.024**	**37.1**
Lights	138,214	0.823	15.1
Electric Equipment	439,187	2.615	47.9
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**577,402**	**3.439**	**62.9**
Grand Total	**917,266**	**5.463**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **167920.4** ft²
Conditioned Floor Area ..... **167920.4** ft²

Annual Energy Costs - TRY STREET TERMINAL BLDG



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	268,765	1.601	29.3
Natural Gas	71,097	0.423	7.8
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**339,863**	**2.024**	**37.1**
Non-HVAC Components			
Electric	577,381	3.438	62.9
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**577,381**	**3.438**	**62.9**
Grand Total	**917,243**	**5.462**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **167920.4** ft²
Conditioned Floor Area ..... **167920.4** ft²

Annual HVAC & Non-HVAC Cost Totals - TRY STREET TERMINAL BLDG

EXISTING BLDG_WSHP6 04/15/2007
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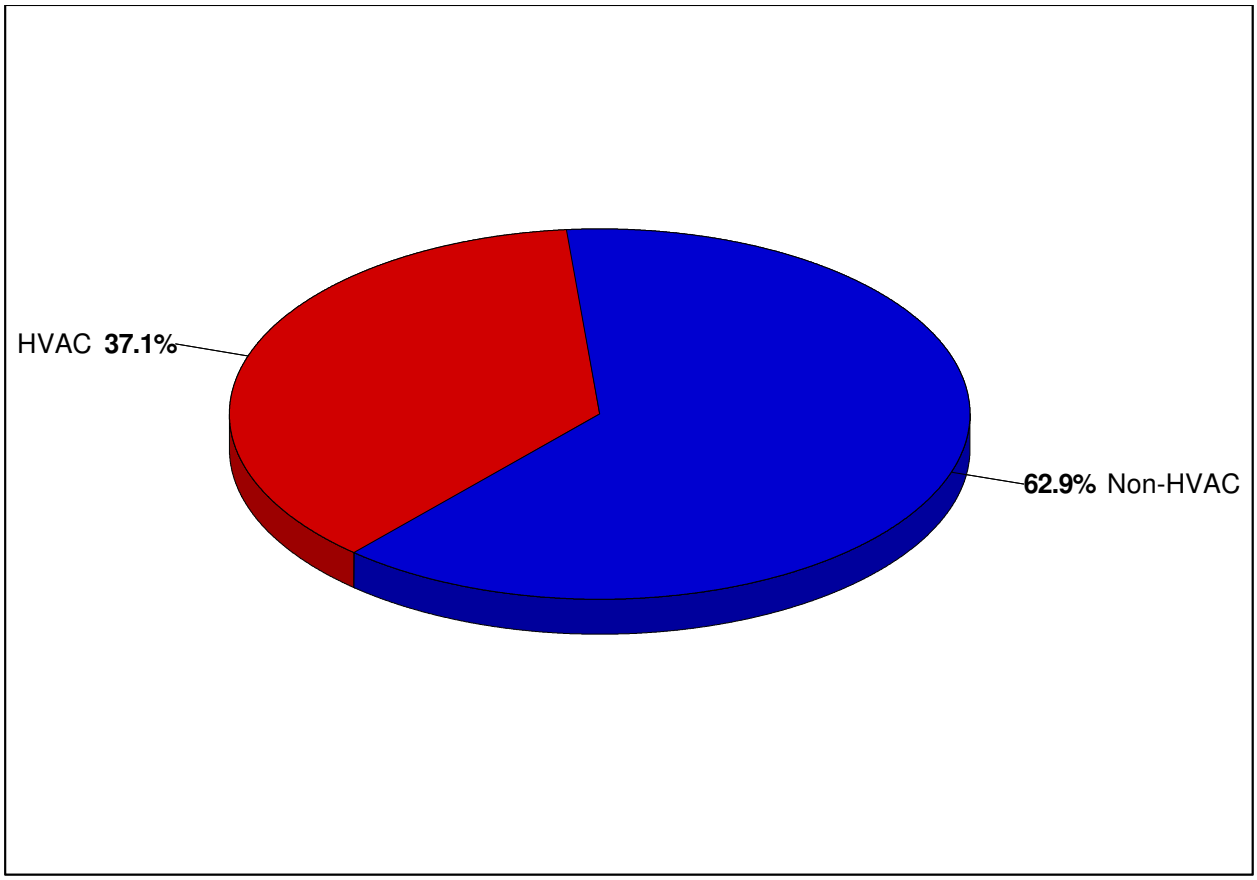

1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	339,865	2.024	37.1
Non-HVAC	577,402	3.439	62.9
Grand Total	**917,266**	**5.463**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **167920.4** ft²
Conditioned Floor Area ..... **167920.4** ft²

Energy Budget by System Component - TRY STREET TERMINAL BLDG

EXISTING BLDG_WSHP6 04/15/2007
Penn State 09:11AM

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	24,195,590	144.090
Heating Coil Loads	4,320,715	25.731
Grand Total	**28,516,303**	**169.820**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	836,725	4.983	836,725	4.983
Cooling	7,342,464	43.726	7,342,464	43.726
Heating	4,463,724	26.582	4,463,724	26.582
Pumps	2,232,486	13.295	2,232,486	13.295
Cooling Towers	125,523	0.748	125,523	0.748
HVAC Sub-Total	**15,000,921**	**89.334**	**15,000,921**	**89.334**
Lights	5,420,538	32.280	5,420,538	32.280
Electric Equipment	17,224,220	102.574	17,224,220	102.574
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**22,644,758**	**134.854**	**22,644,758**	**134.854**
Grand Total	**37,645,678**	**224.188**	**37,645,678**	**224.188**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (100.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **167920.4** ft²
   Conditioned Floor Area ..... **167920.4** ft²

Energy Budget by Energy Source - TRY STREET TERMINAL BLDG

EXISTING BLDG_WSHP6 04/15/2007
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1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	24,195,590	144.090
Heating Coil Loads	4,320,715	25.731
Grand Total	**28,516,303**	**169.820**

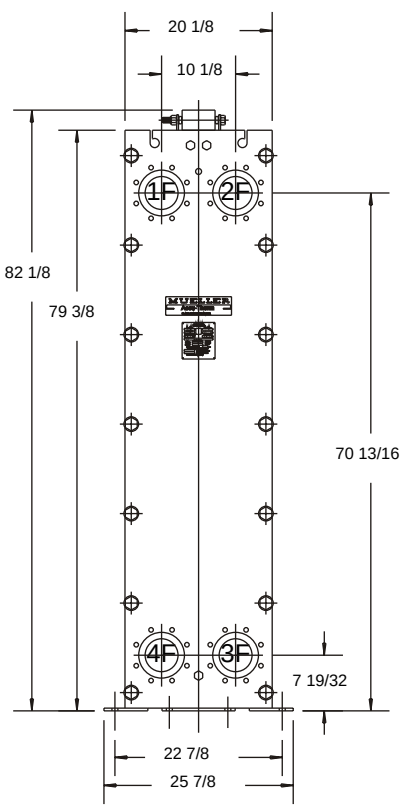
2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	10,540,548	62.771	10,540,548	62.771
Natural Gas	4,460,294	26.562	4,460,294	26.562
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**15,000,842**	**89.333**	**15,000,842**	**89.333**
Non-HVAC Components				
Electric	22,643,950	134.849	22,643,950	134.849
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**22,643,950**	**134.849**	**22,643,950**	**134.849**
Grand Total	**37,644,792**	**224.182**	**37,644,792**	**224.182**

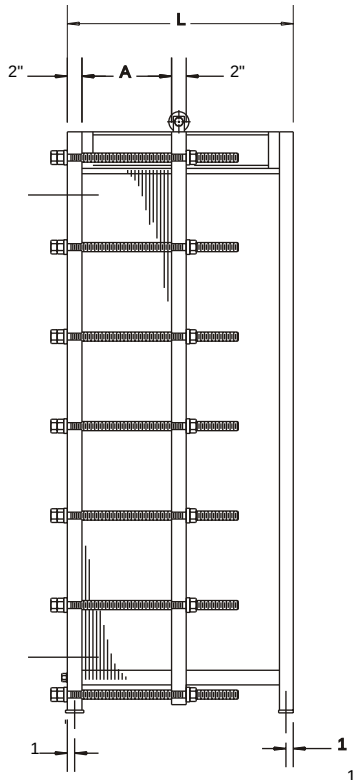
Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (100.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **167920.4** ft²
   Conditioned Floor Area ..... **167920.4** ft²

APPENDIX – MECHANICAL DEPTH

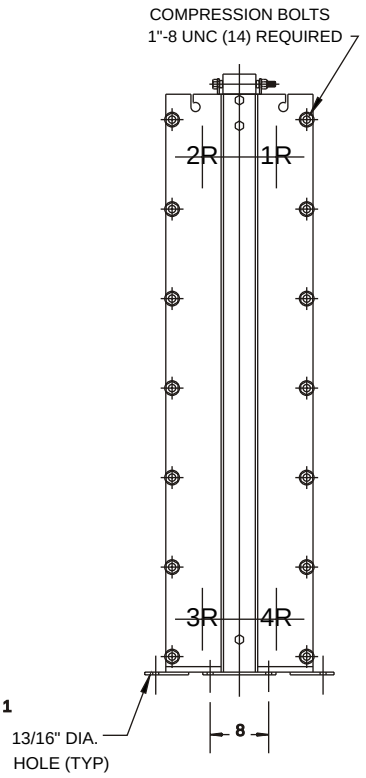
Accu-Therm®
Plate Heat Exchangers



FRONT VIEW

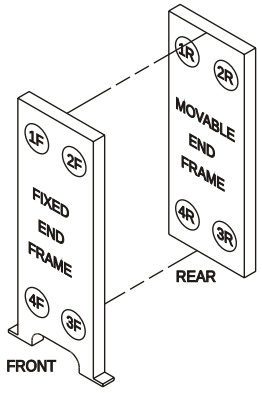


SIDE VIEW



REAR VIEW

PORT LOCATIONS

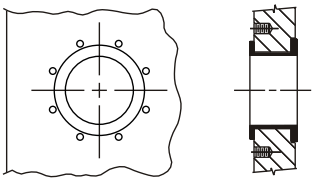


STANDARD MATERIALS OF CONSTRUCTION

END FRAMES. . . . . SA-515-70, SA-516-70 OR EQUIV
PLATE HANGER . . . . . TYPE 304 S/S
COMPRESSION BOLTS (ZINC PLATED) SA-193-B7
COMPRESSION NUTS (ZINC PLATED) SA-194-2H
CONNECTION STUDS (ZINC PLATED). SA-193-B7
CONNECTION NUTS (ZINC PLATED). SA-193-2H
SHROUD (OPTIONAL) . . . . . ALUMINUM
PAINT. . . . . CORROSION RESISTANT PAINT

DIMENSIONS ARE FOR REFERENCE USE ONLY.
ACTUAL PRODUCTION DIMENSIONS ARE SUBJECT TO CHANGE.

REFER TO COMPUTER PRINTOUT FOR VARIABLE DIMENSIONS AND COMPLETE PLATE, GASKET AND CONNECTION SPECIFICATIONS.



STANDARD CONNECTION
4" STUDDED PORT

MUELLER®

MODEL AT60
FRAME TYPE B-20

REV DATE 3/08/05

Annual Cost Summary

Table 1. Annual Costs

Component	TRY STREET TERMINAL BLDG ($)
Air System Fans	18,554
Cooling	129,843
Heating	30,234
Pumps	75,128
Cooling Tower Fans	0
HVAC Sub-Total	**253,758**
Lights	116,318
Electric Equipment	439,187
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**555,505**
Grand Total	**809,263**

Table 2. Annual Cost per Unit Floor Area

Component	TRY STREET TERMINAL BLDG ($/ft²)
Air System Fans	0.131
Cooling	0.919
Heating	0.214
Pumps	0.532
Cooling Tower Fans	0.000
HVAC Sub-Total	**1.796**
Lights	0.823
Electric Equipment	3.108
Misc. Electric	0.000
Misc. Fuel Use	0.000
Non-HVAC Sub-Total	**3.931**
Grand Total	**5.727**
Gross Floor Area (ft²)	141317.0
Conditioned Floor Area (ft²)	141317.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 3. Component Cost as a Percentage of Total Cost

Component	TRY STREET TERMINAL BLDG (%)
Air System Fans	2.3
Cooling	16.0
Heating	3.7
Pumps	9.3
Cooling Tower Fans	0.0
HVAC Sub-Total	**31.4**
Lights	14.4
Electric Equipment	54.3
Misc. Electric	0.0
Misc. Fuel Use	0.0
Non-HVAC Sub-Total	**68.6**
Grand Total	**100.0**

Table 1. Annual Costs

Component	TRY STREET TERMINAL BLDG ($)
HVAC Components	
Electric	223,635
Natural Gas	30,126
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**253,762**
Non-HVAC Components	
Electric	555,486
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**555,486**
Grand Total	**809,248**

Table 2. Annual Energy Consumption

Component	TRY STREET TERMINAL BLDG
HVAC Components	
Electric (kWh)	2,570,522
Natural Gas (Therm)	18,900
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	6,384,899
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	8,955,420
Natural Gas (Therm)	18,900
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

Table 3. Annual Emissions

Component	TRY STREET TERMINAL BLDG
CO2 (lb)	0
SO2 (kg)	0
NOx (kg)	0

Table 4. Annual Cost per Unit Floor Area

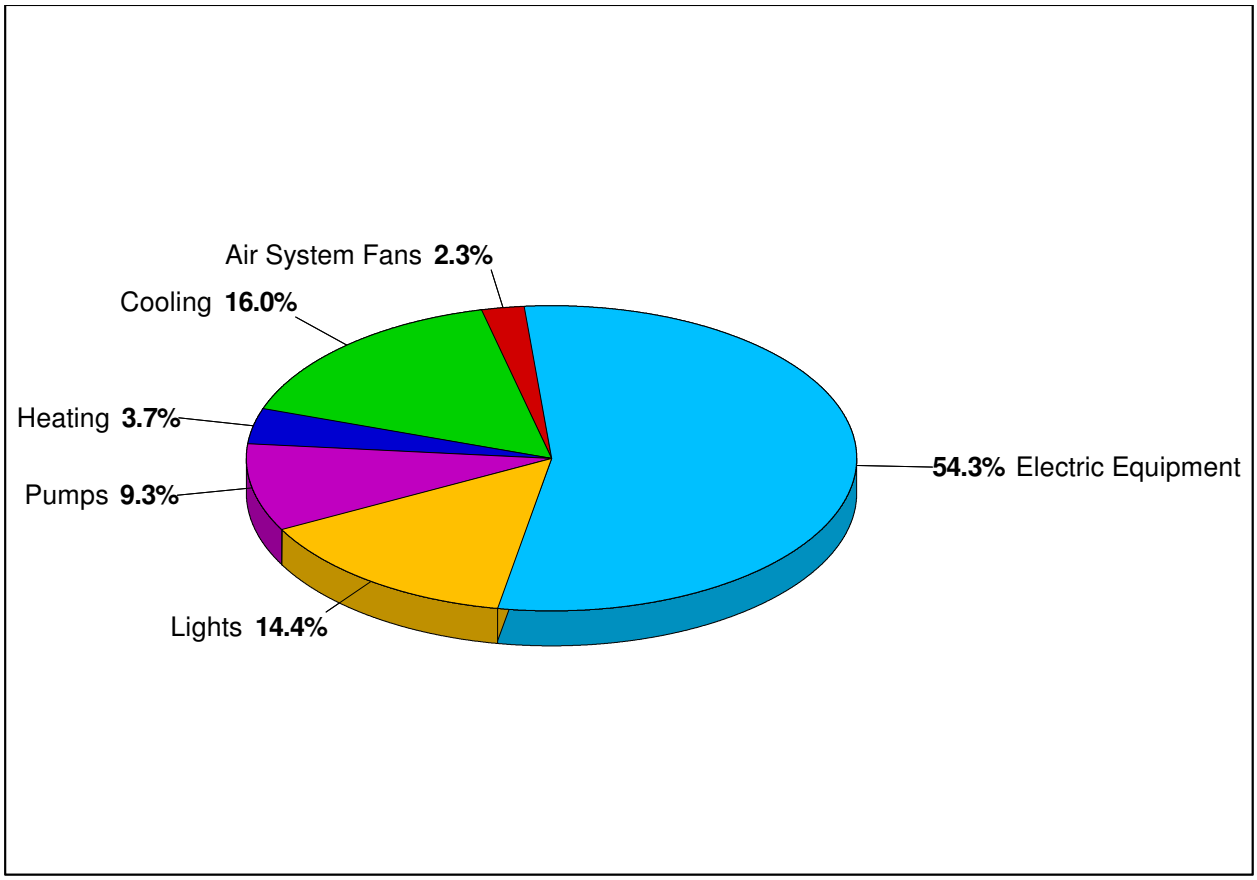
Component	TRY STREET TERMINAL BLDG ($/ft²)
HVAC Components	
Electric	1.583
Natural Gas	0.213
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Remote CW	0.000
HVAC Sub-Total	**1.796**
Non-HVAC Components	
Electric	3.931
Natural Gas	0.000
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Non-HVAC Sub-Total	**3.931**
Grand Total	**5.727**
Gross Floor Area (ft²)	141317.0
Conditioned Floor Area (ft²)	141317.0

Note: Values in this table are calculated using the Gross Floor Area.

Table 5. Component Cost as a Percentage of Total Cost

Component	TRY STREET TERMINAL BLDG (%)
HVAC Components	
Electric	27.6
Natural Gas	3.7
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Remote CW	0.0
HVAC Sub-Total	**31.4**
Non-HVAC Components	
Electric	68.6
Natural Gas	0.0
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Non-HVAC Sub-Total	**68.6**
Grand Total	**100.0**

Annual Component Costs - TRY STREET TERMINAL BLDG



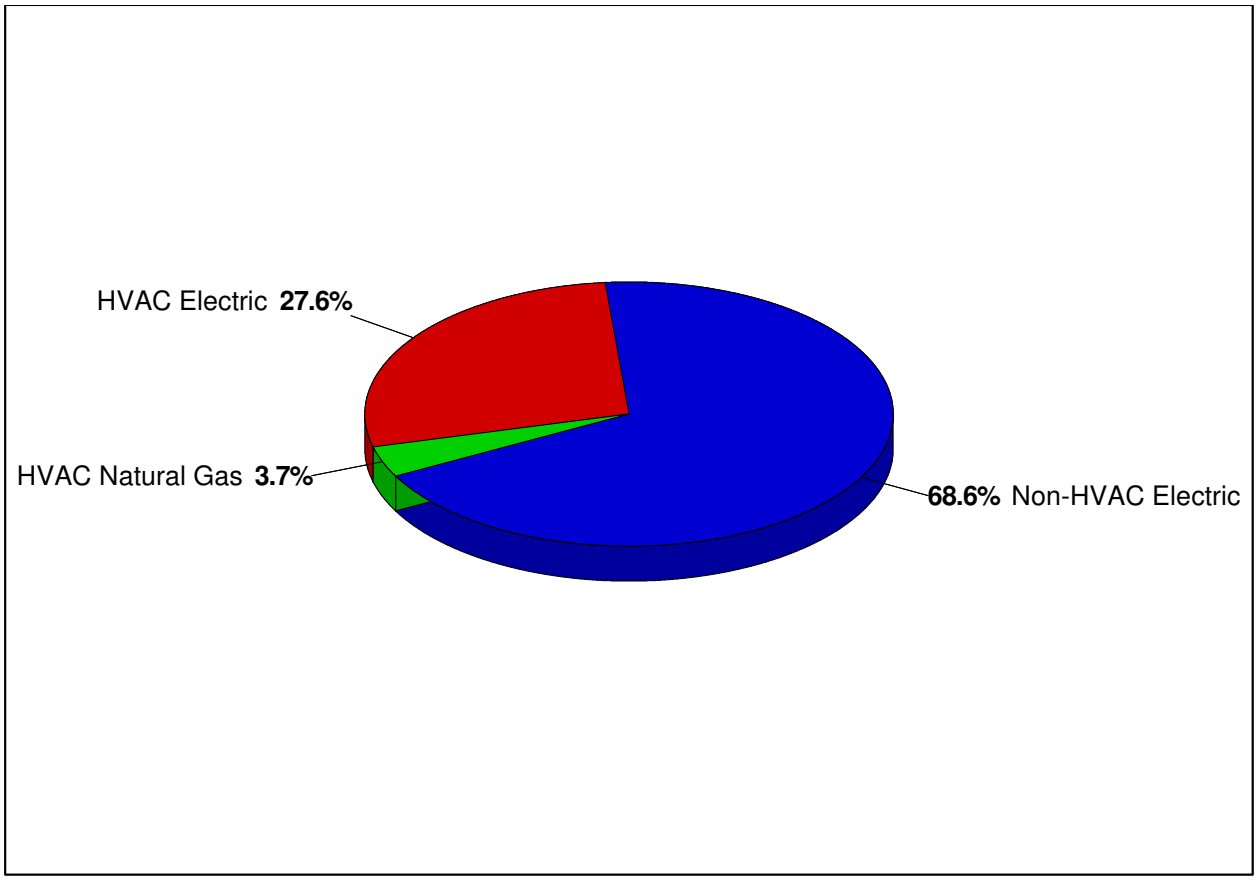
1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	18,554	0.131	2.3
Cooling	129,843	0.919	16.0
Heating	30,234	0.214	3.7
Pumps	75,128	0.532	9.3
Cooling Tower Fans	0	0.000	0.0
HVAC Sub-Total	**253,758**	**1.796**	**31.4**
Lights	116,317	0.823	14.4
Electric Equipment	439,187	3.108	54.3
Non-HVAC Sub-Total	**555,505**	**3.931**	**68.6**
Grand Total	**809,263**	**5.727**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **141317.0** ft²
Conditioned Floor Area ..... **141317.0** ft²

Annual Energy Costs - TRY STREET TERMINAL BLDG



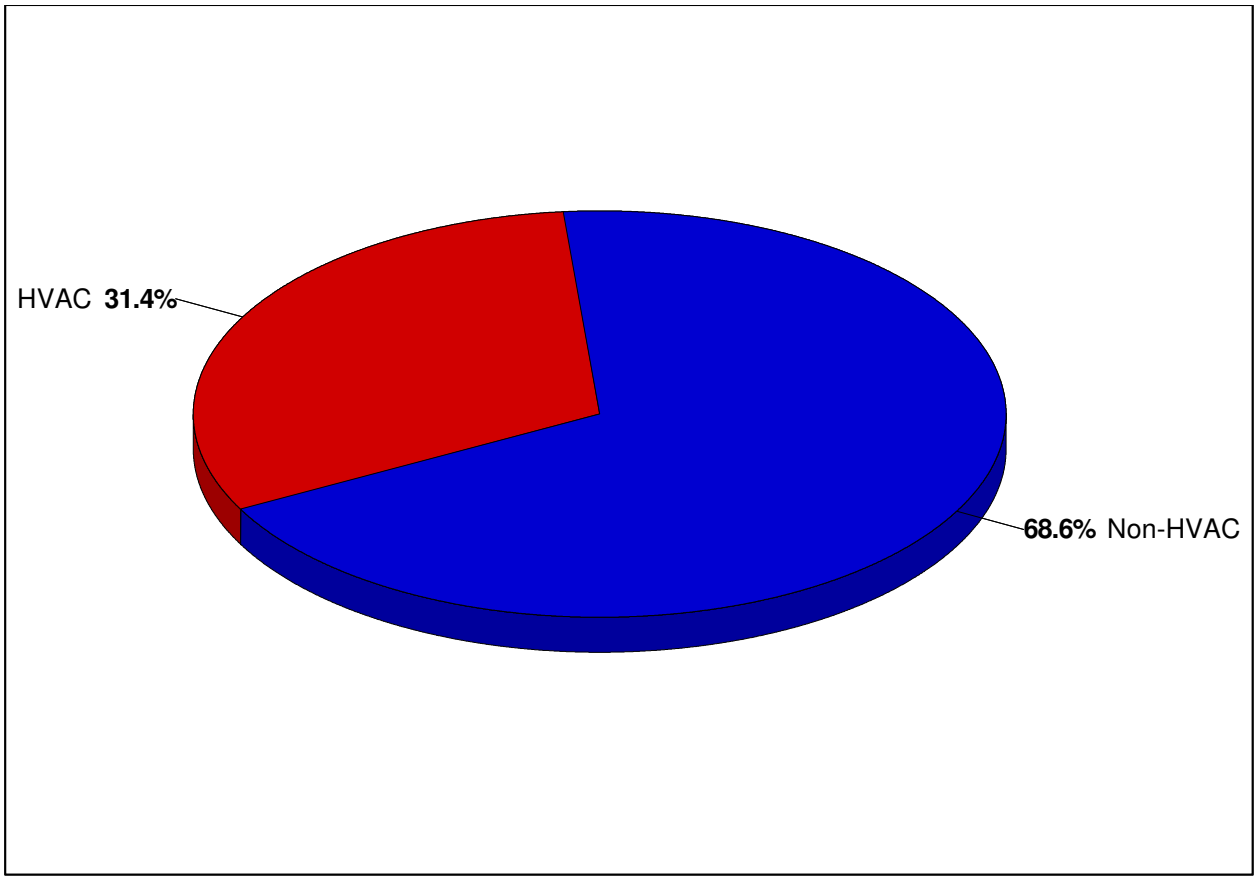
1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	223,635	1.583	27.6
Natural Gas	30,126	0.213	3.7
HVAC Sub-Total	**253,762**	**1.796**	**31.4**
Non-HVAC Components			
Electric	555,486	3.931	68.6
Natural Gas	0	0.000	0.0
Non-HVAC Sub-Total	**555,486**	**3.931**	**68.6**
Grand Total	**809,248**	**5.727**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **141317.0** ft²
Conditioned Floor Area ..... **141317.0** ft²

Annual HVAC & Non-HVAC Cost Totals - TRY STREET TERMINAL BLDG



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	253,758	1.796	31.4
Non-HVAC	555,505	3.931	68.6
Grand Total	**809,263**	**5.727**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **141317.0** ft²
Conditioned Floor Area ..... **141317.0** ft²

Energy Budget by System Component - TRY STREET TERMINAL BLDG

GSHP model 4 04/13/2007
Penn State 06:52AM

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	23,738,400	167.980
Heating Coil Loads	2,135,980	15.115
Grand Total	**25,874,384**	**183.095**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	727,645	5.149	727,645	5.149
Cooling	5,092,232	36.034	5,092,232	36.034
Heating	1,894,203	13.404	1,894,203	13.404
Pumps	2,946,381	20.849	2,946,381	20.849
Cooling Towers	0	0.000	0	0.000
HVAC Sub-Total	**10,660,461**	**75.436**	**10,660,461**	**75.436**
Lights	4,561,784	32.281	4,561,784	32.281
Electric Equipment	17,224,220	121.884	17,224,220	121.884
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**21,786,004**	**154.164**	**21,786,004**	**154.164**
Grand Total	**32,446,465**	**229.601**	**32,446,465**	**229.601**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (100.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **141317.0** ft²
   Conditioned Floor Area ..... **141317.0** ft²

Energy Budget by Energy Source - TRY STREET TERMINAL BLDG

GSHP model 4 04/13/2007
Penn State 06:52AM

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	23,738,400	167.980
Heating Coil Loads	2,135,980	15.115
Grand Total	**25,874,384**	**183.095**

2. Energy Consumption by Energy Source

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
HVAC Components				
Electric	8,770,619	62.063	8,770,619	62.063
Natural Gas	1,889,973	13.374	1,889,973	13.374
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**10,660,592**	**75.437**	**10,660,592**	**75.437**
Non-HVAC Components				
Electric	21,785,276	154.159	21,785,276	154.159
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**21,785,276**	**154.159**	**21,785,276**	**154.159**
Grand Total	**32,445,868**	**229.596**	**32,445,868**	**229.596**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (100.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **141317.0** ft²
   Conditioned Floor Area ..... **141317.0** ft²

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RETScreen® International

Clean Energy Project Analysis Software

Ground-Source Heat Pump Project Model

Clean Energy Decision Support Centre

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RETScreen® Energy Model - Ground-Source Heat Pump Project

Training & Support

Site Conditions		Estimate	Notes/Range
Project name		**Commercial System**	See Online Manual
Project location		**Pittsburgh, PA**	
Available land area	m²	4,383	
Soil type	-	Heavy soil - damp	
Design heating load	kW	357.1	Complete H&CLC sheet
Design cooling load	kW	1,159.9	

System Characteristics		Estimate	Notes/Range
Base Case HVAC System			
Building has air-conditioning?	yes/no	Yes	
Heating fuel type	-	**Natural gas**	
Heating system seasonal efficiency	%	80%	55% to 350%
Air-conditioner seasonal COP	-	3.0	2.4 to 5.0
Ground Heat Exchanger System			
System type	-	Groundwater	
Design criteria	-	Cooling	
Typical land area required	m²	226	
Pumping depth	m	15	
Wellbore depth	m	20	
Maximum well flow rate	L/s	50	0.5 to 60.0
Required groundwater flow rate	L/s	33	
Number of supply wells required	-	1	
Heat Pump System			
Average heat pump efficiency	-	User-defined	See Product Database
Heat pump manufacturer		Trane - high eff.	
Heat pump model			
Standard cooling COP	-	4.75	
Standard heating COP	-	3.60	
Total standard heating capacity	kW	845.5	
	million Btu/h	2.885	
Total standard cooling capacity	kW	1,150.0	
	million Btu/h	3.924	
Supplemental Heating and Heat Rejection System			
Suggested supplemental heating capacity	kW	0.0	
	million Btu/h	0.000	
Suggested supplemental heat rejection	kW	0.0	
	million Btu/h	0.000	

Annual Energy Production		Estimate	Notes/Range
Heating			
Electricity used	MWh	101.7	
Supplemental energy delivered	MWh	0.0	
GSHP heating energy delivered	MWh	**233.8**	
	million Btu	797.6	
Seasonal heating COP	-	2.3	2.0 to 5.0
Cooling			
Electricity used	MWh	561.4	
GSHP cooling energy delivered	MWh	**2,362.7**	
	million Btu	8,061.6	
Seasonal cooling COP	-	4.2	2.0 to 5.5
Seasonal cooling EER	(Btu/h)/W	14.4	7.0 to 19.0
			Complete Cost Analysis sheet

RETScreen® Heating and Cooling Load Calculation - Ground-Source Heat Pump Project

Site Conditions		Estimate	Notes/Range
Nearest location for weather data		Pittsburgh, PA	See Weather Database
Heating design temperature	°C	-16.1	-40.0 to 15.0
Cooling design temperature	°C	33.0	10.0 to 40.0
Average summer daily temperature range	°C	11.0	5.0 to 15.0
Cooling humidity level	-	Medium	
Latitude of project location	°N	40.5	-90.0 to 90.0
Mean earth temperature	°C	12.8	Visit NASA satellite data site
Annual earth temperature amplitude	°C	14.0	5.0 to 20.0
Depth of measurement of earth temperature	m	15.0	0.0 to 3.0

Building Heating and Cooling Load		Estimate	Notes/Range
Type of building	-	Commercial	
Available information	-	Descriptive data	
Building floor area	m²	13,120	
Number of floors	floor	10	1 to 6
Window area	-	Above average	
Insulation level	-	High	
Occupancy type	-	Continuous	
Equipment and lighting usage	-	Moderate	
Building design heating load	kW	357.1	
	million Btu/h	1.218	
Building heating energy demand	MWh	233.8	
	million Btu	797.6	
Building design cooling load	kW	1,159.9	
	ton (cooling)	329.9	
Building cooling energy demand	MWh	2,362.7	
	million Btu	8,061.6	Return to Energy Model sheet

RETScreen® Cost Analysis - Ground-Source Heat Pump Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: Enter new 1

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Other - Feasibility Study	Cost	0	$ -	$ -			
Sub-total:				**$ -**	0.0%		
Development							
Other - Development	Cost	0	$ -	$ -			
Sub-total:				**$ -**	0.0%		
Engineering							
Other - Engineering	Cost	0	$ -	$ -			
Sub-total:				**$ -**	0.0%		
Energy Equipment							
Heat pumps	kW cooling	1,150.0	$ 100	$ 115,000			$200 - $570
Well pumps	kW	17.4		$ -			$425 - $3,400
Circulating pumps	kW	19.5	$ 850	$ 16,617			$250 - $1,900
Circulating fluid	m³	0.00	$ 2,600	$ -			$2,400 - $5,300
Plate heat exchangers	kW	1,150.0	$ 20.00	$ 23,000			$7.00 - $20.00
Trenching and backfilling	m	0	$ -	$ -			$4.00 - $9.00
Drilling and grouting	m	40	$ 12.00	$ 480			$11.00 - $38.60
Ground HX loop pipes	m	0	$ 2.50	$ -			$1.50 - $3.50
Fittings and valves	kW cooling	1,150.0	$ 12.00	$ 13,800			$8.00 - $20.00
Other - Energy Equipment	Credit		$ -	$ -			
Electric central heating system	Credit	1	$ 20,000	$ (20,000)			
Sub-total:				**$ 148,897**	86.8%		
Balance of System							
Supplemental heating system	kW	0.0	$ -	$ -			$35 - $110
Supplemental heat rejection	kW	0.0	$ -	$ -			$500 - $750
Internal piping and insulation	kW cooling	1,150.0	$ 20	$ 23,000			$20 - $70
Other - Balance of System	Cost	0	$ -	$ -			
Credit - Balance of System	Credit	1	$ 1,000	$ (1,000)			
Sub-total:				**$ 22,000**	12.8%		
Miscellaneous							
Training	p-h	14	$ 40	$ 560		1 - 16	$40 - $100
Contingencies	%	0%	$ 171,457	$ -		10% - 40%	
Sub-total:				**$ 560**	0.3%		
Initial Costs - Total				**$ 171,457**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Property taxes/Insurance	project	0	$ -	$ -			
O&M labour	m²	1,000	$ 2.50	$ 2,500			$1.00 - $3.00
Travel and accommodation	p-trip	0	$ -	$ -			
Other - O&M	Cost	0	$ -	$ -			
Credit - O&M	Credit	1	$ 3,500	$ (3,500)			
Contingencies	%	5%	$ 170,897	$ 8,545		2% - 15%	
Sub-total:				**$ 7,545**	13.1%		
Fuel/Electricity							
Electricity	kWh	**663,161**	**$ 0.087**	$ 57,695			
Incremental electricity load	kW	**-62.3**	**$ 120**	$ (7,479)			
Sub-total:				**$ 50,216**	86.9%		
Annual Costs - Total				**$ 57,761**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Heat pump compressor	Cost	10 yr	$ 5,000	**$ 5,000**		
Air-conditioner replacement	Credit	12 yr	$ 6,000	**$ (6,000)**		
				$ -		
End of project life	Credit	-	$ 2,000	**$ (2,000)**		

Go to GHG Analysis sheet

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Ground-Source Heat Pump Project

Use GHG analysis sheet? Yes Type of analysis: Standard

Background Information

Project Information

Project name	Commercial System
Project location	Pittsburgh, PA

Global Warming Potential of GHG

1 tonne CH_4 =	21	tonnes CO_2	(IPCC 1996)
1 tonne N_2O =	310	tonnes CO_2	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Natural gas	100.0%	56.1	0.0030	0.0010	45.0%	8.0%	0.491
Electricity mix	100%	135.5	0.0072	0.0024		8.0%	0.491

Base Case Heating and Cooling System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Natural gas	100.0%	56.1	0.0030	0.0010	80.0%	0.254
Cooling system						
Electricity	100.0%	135.5	0.0072	0.0024	300.0%	0.164

Proposed Case Heating and Cooling System (Ground-Source Heat Pump Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	100.0%	135.5	0.0072	0.0024	229.8%	0.214
Cooling system						
Electricity	100.0%	135.5	0.0072	0.0024	420.8%	0.117

GHG Emission Reduction Summary

	Base case GHG emission factor (t_{CO2}/MWh)	Proposed case GHG emission factor (t_{CO2}/MWh)	End-use annual energy delivered (MWh)	Annual GHG emission reduction (t_{CO2})
Heating system	0.254	0.214	233.8	9.45
Cooling system	0.164	0.117	2362.7	111.05
			Net GHG emission reduction t_{CO2}/yr	**120.50**

Complete Financial Summary sheet

RETScreen® Financial Summary - Ground-Source Heat Pump Project

Annual Energy Balance

Project name		Commercial System	Electricity required	MWh	663.2
Project location		Pittsburgh, PA	Incremental electricity load	kW	(62.3)
			Net GHG reduction	t_{CO2}/yr	120.50
Heating energy delivered	MWh	233.8			
Cooling energy delivered	MWh	2,362.7			
Heating fuel displaced	-	Natural gas	Net GHG emission reduction - 25 yrs	t_{CO2}	3,012.61

Financial Parameters

Avoided cost of heating energy	$/m³	0.060	Debt ratio	%	0.0%
GHG emission reduction credit	$/$t_{CO2}$	-	Income tax analysis?	yes/no	No
Retail price of electricity	$/kWh	0.087			
Demand charge	$/kW	120			
Energy cost escalation rate	%	2.0%			
Inflation	%	2.0%			
Discount rate	%	10.0%			
Project life	yr	25			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	0.0%	$	-	O&M	$	7,545
Development	0.0%	$	-	Fuel/Electricity	$	50,216
Engineering	0.0%	$	-			
Energy equipment	86.8%	$	148,897	**Annual Costs and Debt - Total**	**$**	**57,761**
Balance of system	12.8%	$	22,000			
Miscellaneous	0.3%	$	560	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**171,457**	Heating energy savings/income	$	1,698
				Cooling energy savings/income	$	68,519
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**70,217**
Periodic Costs (Credits)						
Heat pump compressor		$	5,000	Schedule yr # 10,20		
Air-conditioner replacement		$	(6,000)	Schedule yr # 12,24		
		$	-			
End of project life - Credit		$	(2,000)	Schedule yr # 25		

Financial Feasibility

Pre-tax IRR and ROI	%	7.4%	Calculate GHG reduction cost?	yes/no	No
After-tax IRR and ROI	%	7.4%			
Simple Payback	yr	13.8	Project equity	$	171,457
Year-to-positive cash flow	yr	12.0			
Net Present Value - NPV	$	(36,432)			
Annual Life Cycle Savings	$	(4,014)			
Benefit-Cost (B-C) ratio	-	0.79			

Yearly Cash Flows

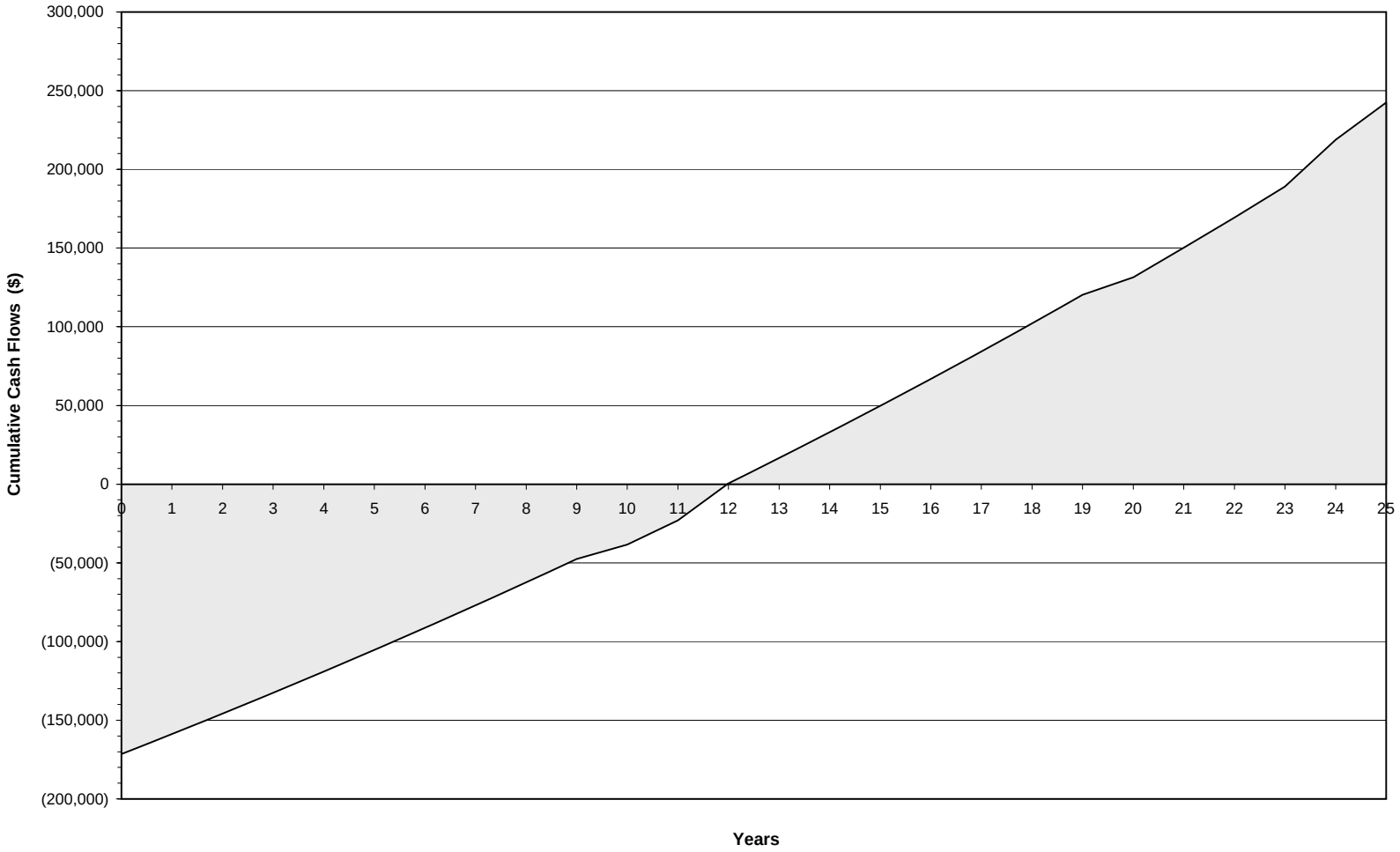
Year	Pre-tax	After-tax	Cumulative
#	$	$	$
0	(171,457)	(171,457)	(171,457)
1	12,706	12,706	(158,752)
2	12,960	12,960	(145,792)
3	13,219	13,219	(132,573)
4	13,483	13,483	(119,090)
5	13,753	13,753	(105,337)
6	14,028	14,028	(91,308)
7	14,309	14,309	(77,000)
8	14,595	14,595	(62,405)
9	14,887	14,887	(47,518)
10	9,089	9,089	(38,429)
11	15,488	15,488	(22,941)
12	23,407	23,407	467
13	16,114	16,114	16,581
14	16,436	16,436	33,017
15	16,765	16,765	49,782
16	17,100	17,100	66,882
17	17,442	17,442	84,324
18	17,791	17,791	102,115
19	18,147	18,147	120,262
20	11,080	11,080	131,342
21	18,880	18,880	150,222
22	19,258	19,258	169,479
23	19,643	19,643	189,122
24	29,686	29,686	218,808
25	23,717	23,717	242,526

Cumulative Cash Flows Graph

GSHP Project Cumulative Cash Flows
Commercial System, Pittsburgh, PA

Total Initial Costs: $ 171,457

Net average GHG reduction (t_{CO2}/yr): 120.50



IRR and ROI: 7.4%

Year-to-positive cash flow: 12 yr

Net Present Value: $ -36,432

RETScreen® Sensitivity and Risk Analysis - Ground-Source Heat Pump Project

Use sensitivity analysis sheet? No