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Appendix for ECM 5: Boiler Retrofit DHW Boiler, Recreation Center

I. Energy Savings Calculations

ECM 5 Boiler Retrofit DHW Recreation Center Savings Calculation

Preliminary Savings Estimate

Date:	1-Aug-12
Project:	City of Greeley Colorado
Location:	Recreation Center
Measure:	ECM 5 Boiler Retrofit (DHW Boiler)

ECM 5 Boiler Retrofit	
Estimated Savings (Therms/Yr):	1,107

Savings Estimate

Date:	27-Aug-12
Project:	City of Greeley Colorado
Location:	Recreation Center
Measure:	ECM 5 Boiler Retrofit (DHW Boiler)

	Note:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Utility Therms (Total)	1	11,089	9,103	8,754	7,111	5,941	3,207	2,354	2,772	5,044	8,129	12,858	13,429	89,791
Pool Heating Therms (Input) 42%	2	4,724	3,878	3,729	3,029	2,531	1,366	1,003	1,181	2,149	3,463	5,477	5,721	38,251
Net Heating and DHW Therms (Input)		6,365	5,225	5,025	4,081	3,410	1,841	1,351	1,591	2,896	4,666	7,380	7,708	51,540
Heating Therms (Input)		5,601	4,598	4,422	3,592	3,001	1,620	1,189	1,400	2,548	4,106	6,495	6,783	45,355
DHW Therms (Input)	3	764	627	603	490	409	221	162	191	347	560	886	925	6,185
Existing DHW Therms (Output @ 78%)		596	489	470	382	319	172	126	149	271	437	691	722	4,824
Condensing Boiler Efficiency	4	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Proposed DHW Therms (Input)		627	515	495	402	336	181	133	157	285	460	727	759	5,078
Savings DHW (Therms)		137	112	108	88	73	40	29	34	62	100	158	166	1,107

Notes:

1. 3-Year average utility data
2. Pool Heating Therms based on ECM 5 (Pool Boiler) estimate
3. Assume DHW load is 12% of net pool and space heating fue
4. Condensing boiler thermal efficiency

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Appendix for ECM 5:
Boiler Retrofit, Pool Boiler, Recreation Center

I. Energy Savings Calculations

Costs due to Evaporation Heat Loss from Swimming Pools

Based on the Shah Method - See "Calculating Evaporation from Indoor Water Pools", HPAC Engineering, March 2004

1. **Calculated energy use does not include energy due to:**
   - Building envelope losses, pumps, fans.
   - Conduction, convection, radiation (which are small compared to evaporation losses)

2. **HEAT RECOVERY:**
   The energy to dehumidify the room air will equal the energy lost due to evaporation. This heat can be recovered and reused in pool water heating, using a heat pump unit (e.g. PoolPak).
   Enter percent of heat recovered and COP for dehumidification. (Typical heat recovery for PoolPak unit is 70% to 80%.)
   Enter the % exhaust air and make-up air in the cell "Other losses as a percent of total". This value is used in dehumidification calculation.

3. **POOL COVERS:**
   To model a pool cover, reduce the number of hours per year from 8,760 to the number of hours the pool is uncovered.

4. **ADJUST POOL WATER TEMPERATURE**
   ASHRAE (1995) recommends
   - Pleasure swimming: 75 to 85oF
   - Competitive swimming: 72 to 75oF
   - Therapeutic: 85 to 95oF

   NAVY NAVMED P-5010-4 recommends
   - Pleasure swimming: 78 to 82F
   - Competitive swimming: 76 to 78oF

   Refer to ASHRAE Applications Handbook.
   Navy's NAVMED P-5010-4, Rev. 1990, Section 4-10: http://www.nepmu5.med.navy.mil/assets/p5010/P5010Ch_4.pdf

5. **ADJUST ROOM AIR TEMPERATURE**
   ASHRAE (1995) recommends

ECM 5 Boiler Retrofit Pool Boiler Recreation Center Savings Calculation

Heating & Dehumidification Costs due to Evaporation from Swimming Pools

Water Surface Area (ft2)	7,400
Cost of heating fuel ($/MMBtu)	$7.14
Cost of dehumidification fuel ($/kWh)	$0.1000

Cost Conversion

$0.1000	$/kWh
$29.31	$/MMBtu

INPUT
OUTPUT

Pass mouse over cells of base case to view comments
No password for protection

Yellow = input, Blue=results, Green = Info Only
Pass mouse over cells of base case to view comments

	Base	ECM 5	ECM 2	ECM 3	ECM 4	ECM 5	ECM 6	ECM 7
Water's surface area (ft2)	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400
Description								
Water temperature (oF)	82	82						
Room air temperature (oF)	85	85						
Room relative humidity (%)	50%	50%						
Average number of people in pool	30	30						
Hours per year uncovered	8760	8760						
Cost of heating fuel ($/MMBtu)	7.14	7.14						
Cost of dehumidification fuel ($/kWh)	$0.1000	$0.1000						
Occupied Time (% of uncovered hours)	100%	100%						
Efficiency or COP of water heater	0.78	0.95						
Is there dehumidification?	No	No						
Efficiency or COP of dehumidification	1.00	1.00						
% Latent Heat Recovery (ht pmp dehum)	0%	0%						
Other losses as a percent of total	15%	15%						
A/N=Ratio (Area/No. of People)	247							

(Will be rounded to nearest 10%)

1.18

CASE 1:

Water's surface area (ft2)	7400
Water temperature (oF)	82
Room air temperature (oF)	85
Room relative humidity (%)	0.5
Average number of people in pool	30
Hours per year uncovered	8760
Cost of heating fuel ($/MMBtu)	7.14
Cost of dehumidification fuel ($/kWh)	0.1
Occupied Time (% of uncovered hours)	1
Efficiency or COP of water heater	0.95
Is there dehumidification?	No
Efficiency or COP of dehumidification	1
% Latent Heat Recovery (ht pmp dehum)	0
Other losses as a percent of total	0.15
A/N=Ratio (Area/No. of People)	247

HEATING AND DEHUMIDIFICATION DUE TO EVAPORATION FROM POOL SURFACE

Case	Indoor Temp oF	Indoor RH %	Water Temp oF	Heating Use MMBtu/yr	Heating Use $/yr	Dehumidification Use kWh/yr	Dehumidification Use $/yr	Heating Savings MMBtu/yr	Heating Savings $/yr	Dehumidification Savings kWh/yr	Dehumidification Savings $/yr	Total Savings $/yr	
Base	85	50%	82	3825	$27,313	0	$0	--	--	--	--		
ECM 5	85	50%	82	3141	$22,425	0	$0	684.5	$4,888	0	$0	$4,888	18%

If you get a divide by zero error for dehumidification, enter a non-zero efficiency.

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Appendix for ECM 5: Boiler Retrofit, DHW Boiler, FunPlex

I. Energy Savings Calculations

ECM 5 Boiler Retrofit DHW Boiler FunPlex Savings Calculation

Savings Estimate

Date:	1-Aug-12
Project:	City of Greeley Colorado
Location:	FunPlex
Measure:	ECM 5 Boiler Retrofit (DHW Boiler)

ECM 5 Boiler Retrofit	
Estimated Savings (Therms/Yr):	1,082

Savings Estimate

Date:	1-Aug-12
Project:	City of Greeley Colorado
Location:	FunPlex
Measure:	ECM 5 Boiler Retrofit (DHW Boiler)

	Note:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Utility Therms (Total)	1	14,110	13,310	11,520	10,030	9,110	6,990	6,160	4,410	7,290	9,370	12,300	16,370	120,970
Existing DHW Therms (Input)	2	706	666	576	502	456	350	308	221	365	469	615	819	6,049
Existing DHW Therms (Output @ 78%)		550	519	449	391	355	273	240	172	284	365	480	638	4,718
Condensing DHW Efficiency	3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Proposed DHW Therms (Input)		579	546	473	412	374	287	253	181	299	385	505	672	4,966
Savings DHW (Therms)		126	119	103	90	82	63	55	39	65	84	110	146	1,082

Notes:
1. 3-Year average utility data
2. From End Use Analysis
3. AO Smith Xi Thermal Efficiency

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Appendix for ECM 5: Boiler Retrofit, Lincoln Park Annex

I. Energy Savings Calculations

ECM 5 Boiler Retrofit Lincoln Park Annex Calculation

Savings Estimate

Date:	28-Aug-12
Project:	City of Greeley Colorado
Location:	LPA
Measure:	ECM 5 Boiler Retrofit

ECM 5 Boiler Retrofit	
Estimated Savings (Therms/Yr):	1,568

Savings Estimate

Date:	28-Aug-12
Project:	City of Greeley Colorado
Location:	LPA
Measure:	ECM 5 Boiler Retrofit

	Note:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Utility Therms (Total)	1	6,536	5,694	4,310	2,901	1,958	689	173	168	1,199	2,912	4,760	5,204	36,503
Existing DHW Therms (Input)	2	1,569	1,367	1,034	696	470	165	42	40	288	699	1,142	1,249	8,761
Existing DHW Therms (Output @ 78%)		1,224	1,066	807	543	367	129	32	31	224	545	891	974	6,833
Condensing DHW Efficiency	3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Proposed DHW Therms (Input)		1,288	1,122	849	572	386	136	34	33	236	574	938	1,026	7,193
Savings DHW (Therms)		281	245	185	125	84	30	7	7	51	125	204	224	1,568

Notes:
1. 3-Year average utility data
2. From End Use Analysis (24%)
3. AO Smith Xi Thermal Efficiency

Building: Lincoln Park Annex

CBECS Data

Electricity

Electric Intensity: 15.8 kWh/sqft

	End-use %	End-use Intensity (kWh/sqft)	% Difference from CBECS data
Lighting	31%	4.96	0.0%
Cooling	19%	3.05	2.0%
Ventilation	17%	2.73	2.0%
Office Equip.	12%	1.94	-4.0%
Other	9%	1.36	0.0%
Heating	6%	0.98	1.9%
Water Heating	2%	0.30	-1.9%
Cooking	2%	0.25	0.0%
Refrigeration	1%	0.22	0.0%
	100.0%	16	

Natural Gas

Natural Gas Intensity: 38.7 kBtu/sqft

Heating	72%	27.7	0.0%
Water Heating	20%	7.6	4.0%
Cooling	5%	1.9	-5.0%
Other	3%	1.2	0.0%
Cooking	1%	0.2	1.0%
	100.0%	38.7	

Estimated Building End Use

Electricity

Basline Consumption: 1,033,500 kWh/yr

	End-use %	End-use (kWh)
Lighting	31%	324,519
Cooling	21%	220,136
Ventilation	19%	199,466
Office Equip.	8%	85,781
Other	9%	88,881
Heating (pumping)	8%	83,714
Water Heating	0%	0
Cooking	2%	16,536
Refrigeration	1%	14,469
Total	100.0%	1,033,500

Natural Gas

Basline Consumption: 37,705 Therms

Heating	72%	26,997
Water Heating	24%	8,936
Cooling	0%	-
Other	3%	1,207
Cooking	2%	566
Total	100.0%	37,705