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Energy Analysis Progress Report

for

Hamden Memorial Town Hall

Hamden, CT

by

Steven Winter Associates, Inc.

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1. Executive Summary

The Hamden Memorial Town Hall performs 19.2% better than ASHRAE 90.1-2004 requirements using the Performance Rating Method in Appendix G of the Standard. This earns 3 points under LEED-NC v2.2 EAc1.

Hamden Memorial Town Hall is approximately 95,000 sf of semi-new construction housing a police station, a fire station, and an auditorium. The new mechanical system includes hot water boiler and chiller system incorporated ERVs and Demand Control Ventilation measures.

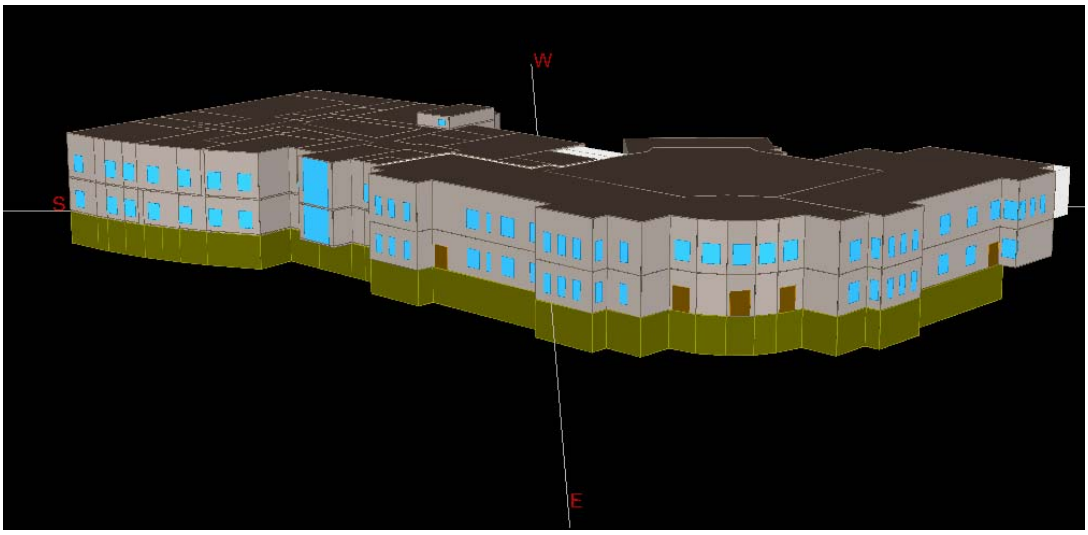


Figure: 3-D View of the Hamden Town Hall from eQUEST

2. Project Narrative

Design Summary:

1. **Architectural:** The Hamden Memorial Town Hall Project consists of 3-story building with two levels above the ground and a cellar below grade. In addition to renovating the existing part, a new portion is also being added keeping the historic look intact. The existing building houses a fire station, and auditorium for performances, meetings or other gatherings. The new addition houses a police station that composed of offices and cells. Areas operating 24 hours per day includes: a) Police Lower Level: both processing areas, all cell areas, lounge, patrol roll call and report rooms, locker rooms; b) Existing Lower Level: all fire station areas; police main level: communications – room A-131, main desk, lobby, juvenile holding, fingerprinting and bonding, interview rooms at main desk area; c) Existing Main Level: all fire station areas; police upper level: interview rooms; existing upper level: all fire station areas. All other areas are scheduled for regular business hours except that the Auditorium, Rotunda and Town Council chambers will be used once a month 6-10PM with some additional night meetings in that room each month.

- The new wall construction is typical masonry/CMU/concrete wall with a total assembly R-value of 12. The new roof construction has a total assembly R-value of 17. The building has 15% window to wall ratio. The total square footage included in the energy model is ~ 95,000 sf. The existing wall construction is brick with structural clay title back up, 12" total with a total assembly R-value of 3. The existing roof construction is 8-in concrete with total assembly R –value of 1.56

- **Mechanical:** The building is conditioned with 9 ERV units providing air to the air-handlers. Chilled water is provided by a 10.2 EER air-cooled chiller. Hot water is provided by a Low NOx boiler with 87% thermal efficiency. The boilers and the chiller will feed a four pipe distribution system throughout the building. Air handlers are arranged to serve the required zoning of the facility and is provided with an economizer cycle for free cooling during cooler times of the year. A system of CO2 sensors are designed to control the ventilation introduced in the building.

- **Lighting:** As per the design information, the target lighting power density of the building is 1W/sf

Energy Modeling Summary:

- **Simulation software:** Both the baseline and proposed design were modeled in eQuest, an hour by hour energy simulation program. eQuest has the ability to model hourly variations in occupancy, lighting power, equipment power, thermostat set points and HVAC system operation.

- **Energy Rates:** The energy rates used for both the baseline and proposed designed cases were assumed to be $.1483/kWh and $1.028/therm.

- **Weather Data:** The analysis was based on U.S climatic data for Bridgeport, CT (Climate Zone 5A) and the building envelope requirements prescribed in Table 5.5-5 of ASHRAE 90.1-2004. The TMY2 weather file for Hamden Town Hall (bridgect.bin) was used for the analysis.

3. Building Energy Efficiency Measures

Envelope and Glazing

- R-17 roof
- Glazing: Assembly U-value =0.29, SC =0.38

Mechanical Systems

- Variable speed drives on secondary hot water pump and primary chilled water pump
- Demand controlled ventilation provided by space CO_2 sensors.
- Economizer
- Energy recovery on exhaust air stream
- 87% efficient condensing boiler
- 10.2 unit EER air-cooled chiller
- 87% efficient indirect DHW

4. Comparison of Budget Design versus Design Energy Case

Parameter		ASHRAE 90.1 2004 Table 5.5-5	Current Design Hamden-CT
Envelope			
Below Grade Wall		18-in concrete, C-1.140	2-in rigid insulation, U = 0.108
	Existing	8-in concrete, U= 0.641	8-in concrete, U = 0.641
Roof	New Roof	R-15 continuous insulation, Overall Require U =0.063	8" concrete with insulation, Assembly U=0.058
	Existing Glazing	SHGC= 0.81, U=0.88	SHGC= 0.81, U=0.88
Windows	1 & 2nd Office Floor Glazing	U-value =0.57, SHGC = 0.39, SC =0.44	Viracon, 1-40 Low E, double pane, U=0.29, SC =0.38
Wall	New Wall	Steel-Framed, Overall Required U = 0.084	South: typical 1'-4 in masonry wall : West : typical 1'-4 in Stone Veneer Wall; North: 1'-4inc CMU/Concrete Wall, Assembly U = 0.084
	Existing Wall	Brick with structural clay title back up, 12" total, Assembly U = 0.325	Brick with structural clay title back up, 12" total, Assembly U = 0.325
Shading Devices		None	Canopy at the auditorium entrance
Mechanical Systems			
Plant Heating Source		Fossil Fuel Furnance	Aerco BMK-3.0LN-2 Low Nox Boiler, 6Mmbh input, 5.2 Mmbh output
Boiler/Furnace Efficiency		80%	87%
Hot Water Pumps (Primary)		NA	2 @ 260 gpm @ 50' TDH, 5hp motor, constant speed
Hot Water Pump Power (Primary)		NA	14.34 w/GPM
Hot Water Pumps (Secondary)		NA	700 gpm @ 130' TDH, 40 hp motor, variable speed
Hot Water Pump Power (Secondary)		NA	42.6 w/GPM
Plant Cooling Source		DX air conditioned unit, EER = 9	Trane RTAC-350 nominal 350 ton air-cooled chiller, EER = 10.2
Chilled Water Pumps (Primary)		NA	625 gpm @ 50' TDH, 15 hp motor, constant speed
Chilled Water Pump Power (Primary)		NA	17.9 w/GPM
Chilled Water Pumps (Primary)		NA	850 gpm @ 120' THD, 40 hp motor, variable speed
Chilled Water Pump Power (Primary)		NA	35.09 w/GPM
Data Center Room AC		EER=12	EER=12
Air Handling Unit System Type		Package Single Zone	VAV units in the core zones, Fan coil units in the perimeter zones
VAV boxes			1000 cfm avg. @ 0.5" w.g esp, 1hp ECM motor, constant volume series arrangement
ERV		None, 100% OA	100% OA, 80% efficency 8 units:10000cfm supply fan @ 4" w.g tsp, 15 hp motor, 9000cfm exhaust fan @ 3" w.g tsp, 7.5 hp motor, both with VFD 1 unit: 5000 cfm supply fan @ 3.5" w.g tsp, 7.5 hp motor, 4,000 cfm exhaust fan @ 3" w.g tsp, 5 hp motor, both with VFD
Economizer		OA Temperature Control, 70F high limit shut off	Enthalpy, 70F high limit shut off
Ventilation Air		As per ASHRAE 90.1 2004	As per design
Outside Air		17.5cfm/person and 0.06 cfm/sf (ASHRAE 62.1 2004)	17.5cfm/person and 0.06 cfm/sf
Total static pressure for supply fan		As per ASHRAE 90.1 2004	4" w.g tsp
Demand Control Ventilation		None	CO2 Detectors
Energy Management System		Manual	Direct Digital Control
Toilet Exhaust System		50 CFM per toilet	75 CFM per water closet/urinal
Kitchen Hood Exhaust Fan		600cfm, 1/2 hp	600 cfm, 1/2 hp
Tailpipe Exhaust System in Firehouse		800cfm, 7" w.c, 3 hp	800cfm, 7" w.c, 3hp
Static pressure for exhaust fan		Same as proposed	4" w.g tsp
Hot Water System Type		Gas DHW heater, 80% efficiency	Gas DHW heater, 87%
Lighting & Equipments			
		Buiding Type, 1W/sf	Buiding Type, 1W/sf
Lighting	Occupancy Sensors	None	None
Equipment Power Density	Offices	Same as proposed	0.5 W/ft2
	Lab/Computer Room	Same as proposed	1 W/ft2
	Training Room	Same as proposed	1 W/ft2
		Same as proposed	2500 lb at 6hp
	Elevators (2)	Same as proposed	4000 lb at 11.1hp

5. Energy Summary by End Use

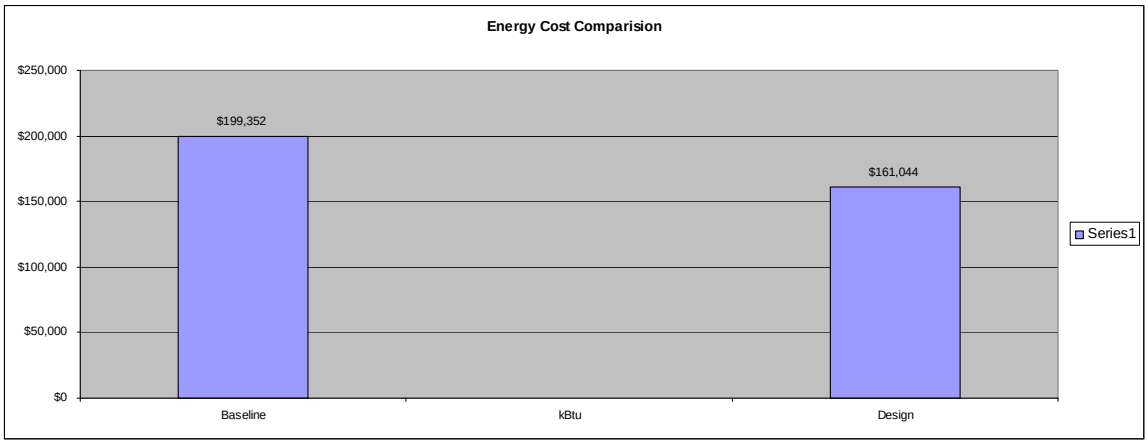
End Use	Regulated?	Energy Type	Proposed Building Energy	Base Building Energy	Optimized Energy Performance
			[10^3 Btu]	[10^3 Btu]	[%]
Lighting - Conditioned	**yes**	Elec	799,232	799,232	0%
Space Heating	**yes**	Gas	4,592,400	7,990,500	43%
Space Cooling	**Yes**	Elec	186,817	227,139	18%
Pumps	**yes**	Elec	454731	65,526	-595%
Fans	**yes**	Elec	1,061,795	1,486,095	29%
Service Water Heating	**yes**	Gas	98,100	107,700	9%
Office Equipment	**No**	Elec	94,008	94,008	0%
TOTAL BUILDING CONSUMPTION			**7,272,363**	**10,770,200**	**32%**
TOTAL REGULATED BUILDING CONSUMPTION			**7,178,355**	**10,676,192**	**33%**

Note: Energy Consumption is listed in units of site energy
10^3 Btu = kWh x 3.413 10^3 Btu = kWh x 3.413

Energy and Cost Summary by Fuel Type

Type	DEC Use [10^3 Btu]	DEC Cost [$]	ECB Use [10^3 Btu]	ECB Cost [$]	DEC / ECB Energy %	DEC / ECB Cost %
NONRENEWABLE (REGULATED + UNREGULATED)						
Electricity (Total)	2,596,583	$112,825	2,672,000	$116,102	3%	3%
Gas (Total)	4,690,500	$48,218	8,098,200	$83,249	42%	42%
Total Nonrenewable (Regulated + Unregulated)	**7,272,363**	**$160,404**	**10,770,200**	**$199,352**	**42%**	**19.2%**

6. Result Summary



Graph 1: Energy Cost Comparison

The above graph demonstrates the annual energy cost savings between the baseline ASHRAE 90.1 2004 case and the proposed Hamden Memorial Town Hall case. The annual energy cost savings are 19.2%

7. Parametric analysis

EEM #1 thru 5 are individual EEM's performed on the Design Case. While, EEM#6 and 7 are combination of two or more EEMs.

1. EEM1 – Add storm windows to existing windows with: Overall assembly U=0.55, SC=0.46
2. EEM2 – Replace existing windows with double pane, low E windows: center of glass U=0.29, SC =0.38
3. EEM3 – Add to existing exterior wall 3" space (2 ½" stud and ½" air gap) with foam Icynene insulation, overall assembly U =0.063
4. EEM4 – Add to existing exterior wall 4" space (3 ½" stud and ½" air gap) with foam Icynene insulation, overall assembly U =0.051
5. EEM5 – Add to existing roof 2 inches of rigid continuous insulation, overall assembly U =0.065
6. Combination EEM1 and EEM3
7. Combination EEM1, EEM3 and EEM 5

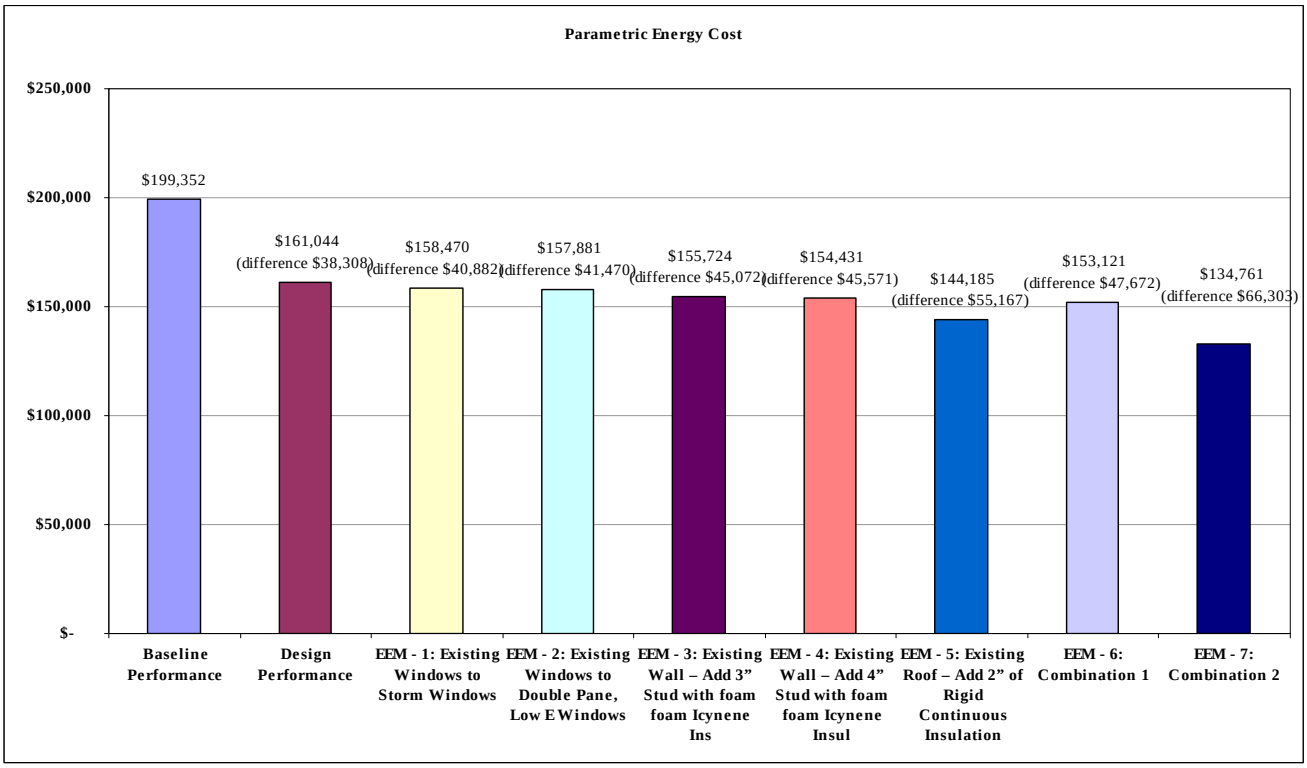
Utility Prices

		Winter	Summer	
eQUEST rates	Electric	$ 0.1483	$ 0.1483	per KWH
	Gas	$ 1.0280	$ 1.0280	per THERM

Energy

		KWH	Therm	Total Charge ($)	Percent Savings	LEED Points
	Baseline Performance	782,889	80,982	$ 199,352		
	Design Performance	760,792	46,905	$ 161,044	19.22%	3
EEM - 1	Existing Windows to Storm Windows	735,938	47,987	$ 158,470	20.51%	3
EEM - 2	Existing Windows to Double Pane, Low E Windows	733,188	47,811	$ 157,881	20.80%	3
EEM - 3	Existing Wall – Add 3" Stud with foam foam Icynene Ins	746,789	42,345	$ 154,279	22.61%	4
EEM - 4	Existing Wall – Add 4" Stud with foam foam Icynene Insul	745,148	42,097	$ 153,781	22.86%	4
EEM - 5	Existing Roof – Add 2" of Rigid Continuous Insulation	687,267	41,112	$ 144,185	27.67%	5
EEM - 6	Combination 1	720,603	43,594	$ 151,680	23.91%	4
EEM - 7	Combination 2	638,330	37,339	$ 133,049	33.26%	7

Table 1: Energy Cost Calculations



Graph 2: Parametric Energy Cost Comparison

Summary of the Parametric Analysis-

- EEM#6 – Addition of 2" of continuous rigid insulation to the existing roof gives the maximum energy savings when compared to any of the individual EEM's.
- The increase of adding 4" of metal stud from 3" achieves a difference of less then a percentage of savings. The LEED points also remain unchanged.
- EEM Combination #2 is replacing the existing single pane windows to storm windows, adding 3" of metal stud behind the existing walls and addition of 2" continuous rigid insulation to the existing roof. These combinations of strategies give energy savings up to 32% when compared to the ASHRAE 90.1 basecase. This gives 7 LEED points in EAc1 category.