Generic Lab Building
123 Lab Street Boston, MA

Technical Assistance
Study Report

Draft Final Report
MM/DD/YYYY

Prepared for:
(Electric and Gas Program Administrators)

Prepared by:

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EXECUTIVE SUMMARY

Electric PA lead (and gas PA if applicable) and Generic Lab owner acquired the services of HVAK Engineering Inc. to conduct a technical assistance (TA) study to evaluate whole building energy savings, broken down by energy conservation measures (ECMs), for Generic Lab in Boston, MA. Whole building energy savings were evaluated by comparing the project as designed to IECC 2015 and the Mass Save Baseline Document. This study was carried out under Mass Save's Whole Building Program, Large Building Path.

Whole building savings were broken down into 6 measures for purposes of this study. The measures were analyzed by generating an hourly simulation of building energy consumption using the eQuest modeling tool version 3.65. The measures were modeled such that each ECM was built upon previous measures, so that the final run reflects the combined analysis and shows net, interactive energy savings for the project. Summary information regarding the evaluated measures and whole building savings is provided below in Table 1 and Table 2.

A brief summary of each measure presented in this report is provided below.

ECM #1: High Performance Glazing

The majority of the building envelope will consist of curtainwall systems. This measure provides a building envelope with overall performance exceeding the minimum requirements of IECC 2015. Note that fenestration comprises approximately 25% of the total vertical wall area.

ECM #2: High Efficiency Lighting

This measure provides an energy efficient lighting system for the building. The proposed lighting system will consist mainly of a mixture of LED fixtures. The average installed LPD is 0.63 W/sf.

ECM #3: High Efficiency Active Chilled Beams

This measure provides an energy efficiency solution for the HVAC system of the building compared to the traditional VAV system. This building will use active chilled beams to heat and cool the building.

ECM #4: High Efficiency RTUs

The building will be equipped with RTUs with higher efficiency than the IECC 2015 code requirement.

ECM #5: High Efficiency Boilers

The building will be equipped with four 2,375-MBH output hot water boilers. This measure provides high-efficiency condensing boilers in place of standard code-compliant non-condensing boilers. The hot water supply temperature will be maintained at 140°F; the design return temperature is 110°F.

Data Center (located in the basement)

The energy model will be utilized in conjunction with supplemental energy analysis (outside the capability of eQuest model) to determine and validate energy savings for ECMs outlined below.

ECM #6: Passive Chilled Door Rack Level Cooling via Water to Water Heat Exchanger

The proposed data center will utilize local rack cooling system. Heat generated from server is removed at its source, therefore minimize the amount of hot exhaust air from entering common space and optimize data center thermal and energy performance.

In addition to the measures presented in this report, there are opportunities for additional prescriptive incentives. The opportunities are exterior lighting and compressed air. These applications will be completed by HVAK Engineering, Inc.

Energy Savings and Carbon Emissions/Environmental Impact

The baseline building is predicted to use 4,756,070 kWh of electricity and 131,180 therms of natural gas. Compared to the baseline building, the proposed facility is expected to save 723,971 kWh of electricity, and 18,025 therms of natural gas, corresponding to a reduction of 7.5 million lbs in carbon dioxide emissions per year. This represents a 15% reduction in site energy use.

Table 1: Summary of Energy Conservation Measures

		Energy Savings				Total Energy Cost Savings	Incremental Cost	Simple payback
		Electric Savings		Natural Gas Savings				
ECM #	Measure Description	kWh	$	Therms	$	$	$	years
ECM #1	High Performance Glazing	0	$0	0	$0	0	$0	0.0
ECM #2	High Efficiency Lighting	0	$0	0	$0	0	$0	0.0
ECM #3	High Efficiency Active Chilled Beams	0	$0	0	$0	0	$0	0.0
ECM #4	High Efficiency RTUs	0	$0	0	$0	0	$0	0.0
ECM #5	High Efficiency Boilers	0	$0	0	$0	0	$0	0.0
ECM #6	Passive Chilled Door Rack Level Cooling	0	$0	0	$0	0	$0	0.0
All Measures	Total Savings and Costs	0	$0	0	$0	0	$0	0.0
	Percentage Reductions	0%		0%		0%		
Non-Electric / Non-Gas Benefits (impacts)		Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Ann. Cost [$]	One-time Cost [$]	
		0	0	0	0	$0	$0	

Table 2: Whole Building Energy Consumption Summary

		Electric		Natural Gas		Site Energy	Total Cost
		kWh	$	Therms	$	kBTU	$
Baseline	Usage	0	$0	0	$0	0	$0
	Usage/area	0.00	$0	0.00	$0	0.0	$0
Proposed	Usage	0	$0	0	$0	0	$0
	Usage/area	0.00	$0	0.00	$0	0.0	$0
Savings		0	$0	0	$0	0	$0
Savings (Percentage)		0%	0%	0%	0%	0%	0%

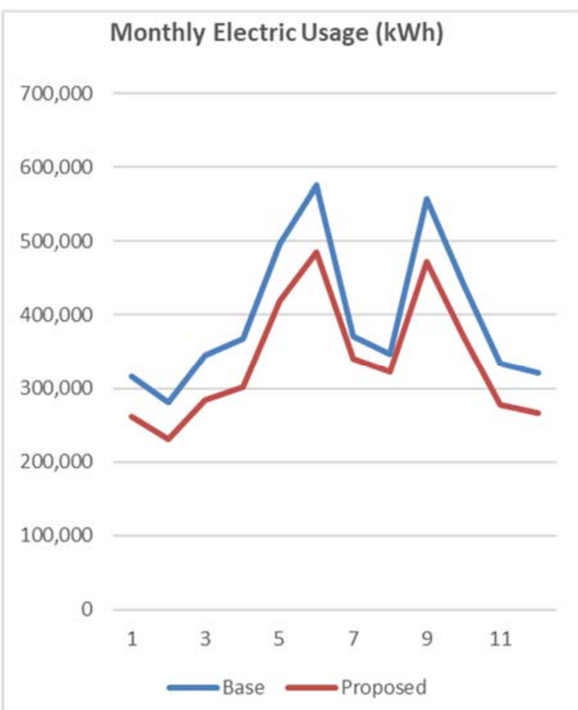
NOTE: Building floor area is ###,### square feet

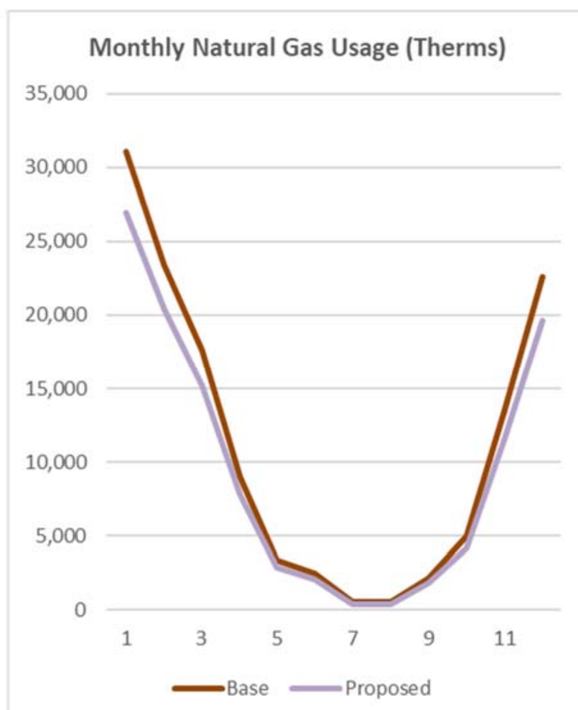
Table 3: Monthly Energy Savings Summary Table

The following table presents the electric energy use and demand profiles for both the base case and proposed case (all measures combined) and the resultant energy savings under evaluation.

Month	Electric Use (kWh)			Natural Gas Use (therms)		
	Base	Proposed	Savings	Base	Proposed	Savings
January	316,823	261,690	55,133	31,098	26,978	4,120
February	280,968	231,572	49,396	23,431	20,463	2,968
March	345,080	283,741	61,339	17,646	15,206	2,440
April	367,838	301,149	66,689	9,025	7,768	1,257
May	496,732	418,556	78,176	3,340	2,839	501
June	575,973	485,699	90,274	2,451	2,027	424
July	370,496	339,919	30,576	513	350	164
August	346,293	322,135	24,158	513	350	164
September	558,088	472,315	85,773	2,136	1,791	345
October	442,667	371,484	71,184	4,931	4,177	754
November	334,467	278,121	56,346	13,474	11,544	1,930
December	320,645	265,718	54,928	22,616	19,657	2,958
TOTAL	**4,756,071**	**4,032,100**	**723,971**	**131,176**	**113,150**	**18,025**

The numerical values of the previous table are presented below in graphical form for illustration purposes





FACILITY DESCRIPTION

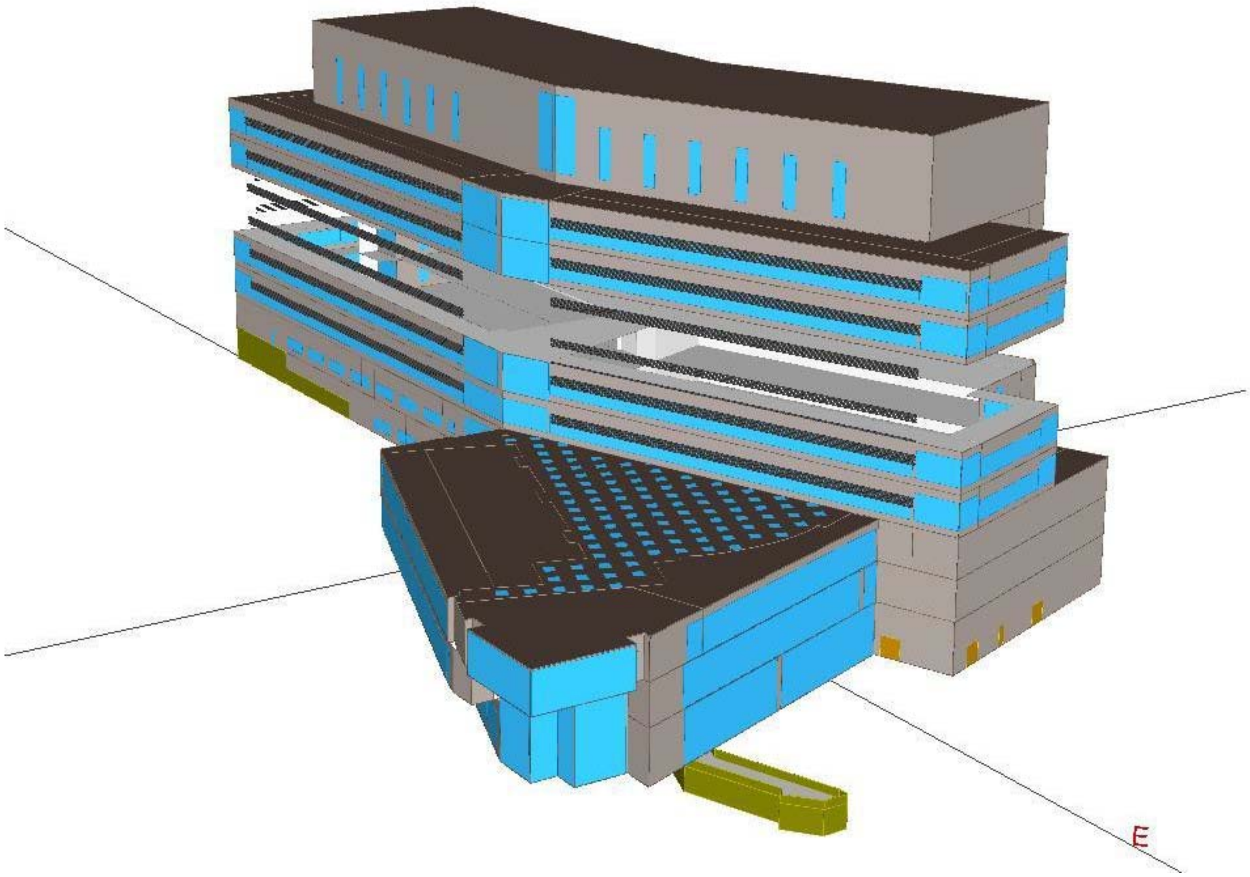


Figure 1: eQuest model of the Generic Lab Building

General

The Generic Lab Building will be constructed in Boston, MA and will house research labs, offices and conference areas, and data center. Electricity and natural gas service will be provided by Eversource. Construction is expected to be completed by MM/YYYY.

Architectural

The building has a total area of approximately 190,000 square feet on nine floors consisting of lab space (approximately 40% by area), offices, conference rooms, and teaching rooms (45%), data center (10%) and a café (5%).

The exterior wall construction typically consists of stone or terracotta veneer followed by an air cavity, 3" of rigid insulation, and 8" concrete masonry units.

The building has total window area approximately 25% of the building wall area. Window glass is chiefly of types Viracon VE1-2M and VRE1-59. The center of glass U-value is 0.29 for both.

Occupancy

Occupancy is expected during extended office hours throughout the year, with some limited usage at weekends. See table below for further building occupancy details.

Area Type	Peak Occupancy (sf/person)	Occupancy Schedule
Laboratories	200	7am-9pm weekdays; 10% occupancy at weekends
Offices	200	7am-9pm weekdays; 10% occupancy at weekends
Conference Rooms/Cafe	50 (average over all spaces)	60% of peak occupancy, 7am-9pm weekdays

Airside Mechanical Systems

The lab space will be served by 5 main VAV air handlers that supply 36,000cfm each. All AHUs will contain chilled water cooling coils. A central glycol run-around exhausts heat recovery system, including supplemental hot water heating via heat exchangers, will serve AHUs L1-L3. Laboratory air will be exhausted via two exhaust air plenums (containing glycol heat recovery coils), each of which will be equipped with three mixed flow (induction) fans. The fans will be staged, and fan speed will be modulated, to maintain the duct static pressure setpoint and to maintain the required stack velocity; no outside air bypass will be provided.

The proposed HVAC system for the office spaces consists of active chilled beams. Two (2) dedicated outside air systems with energy recovery wheels provide ventilation air to the spaces. Two (2) ERUs, which provide 100% outside air, and two (2) AHUs, which provide 100% return air, supply into a common riser that distributes air to the chilled beams on each office floor. The AHUs and ERUs are served by a hot water and chilled water loop. Each AHU and ERU supplies 32,000 CFM max each into the common riser. The ERUs include a 60% effective energy recovery wheel, which recovers energy from the air being exhausted.

Waterside Mechanical Systems

A hot water loop provides heating to the chilled beams and AHUs throughout the building. The hot water loop is equipped with three (3) variable speed pumps which supply 140°F water and return 120°F water. There are four (4) condensing boilers with a capacity of 2,700 MBH each. Due to the low return water temperature these operate at over 90% efficiency.

A chilled water loop provides cooling for the chilled beams and AHUs. It is equipped with two (2) 500-ton chillers with a COP of 6.181. The primary chilled water loop consists of three (3) variable speed pumps. This loop supplies chilled water at 42°F with a return temperature of 56°F.

Additionally, three (3) variable speed pumps serve the secondary chilled water loop, which supplies the AHUs and ERUs. The secondary loop also provides chilled water to a dedicated chilled beam loop, which serves chilled beams in the office areas. Two (2) variable speed pumps serve the chilled beam loop.

Lighting Systems and Equipment Loads (including Process Equipment)

The lighting system for the proposed building will consist mainly of a variety of LED fixtures. The average lighting power density for the proposed building is 073 W/ft^2.

The equipment load is assumed to be 1.0 W/ft^2 for office and conference spaces, and 5.0 W/ft^2 for labs, with the exception of the equipment corridors and computer rooms which are assumed to use 10 W/ft^2. Equipment loads comprise all non-HVAC equipment plugged into convenience outlets including computers, monitors, etc. Lab equipment loads include process equipment such as electric autoclaves, centrifuges, spectrometers, and fume hoods.

Domestic Hot Water System

In the Generic Lab Building, domestic hot water will be used in kitchens, lab equipment wash stations, and lavatory sinks. The energy consumption associated with domestic hot water was based on a peak daily flow of 50 gpm. The proposed domestic hot water heater is gas-fired with 80% thermal efficiency.

Energy Management Systems

The facility will have a building-wide energy management system with direct digital controls for all air handling units, VAV terminal units, pumps, exhaust fans, etc. Each direct digital control will monitor temperature, flow rate, and other desired attributes. The building energy management system is integrated with the HVAC and lighting controls to ensure optimized performance

ANALYSIS METHODOLOGY

To analyze future energy consumption patterns of the Generic Lab Building and the efficiency of the various energy conservation measures considered for the site, a computer model of the facility was developed and building consumption simulations were performed using the eQUEST v3.65 building analysis program. eQUEST uses the latest DOE-2.2 building energy analysis software as its calculating engine. This very flexible program permits modeling of a variety of building types and components including complex building geometry, lighting systems, HVAC systems, central plant equipment, and utility rate structure.

The eQUEST model was compiled using information obtained from architectural design drawings (contained in X% CD set from AAA Architects dated 5/1/2018) and assumed anticipated use schedules for the facility (from Generic Lab sustainability manager). Boston weather data (in TMY3 format) was used in the analysis. Electric utility cost and cost savings were calculated using Eversource's G3 rate (2018 prices), while thermal energy cost and cost savings employed Eversource's G43 rate structure (based on 2018 May and November prices). Results of the eQUEST model for the as-designed building predict an energy use of approximately ### kWh/year ($$$/yr) of electricity and ### therms/year ($$$/yr) of natural gas. The total predicted utility cost amounts to $$$/year.

The baseline building was modeled assuming that the major components of the building envelope and mechanical systems would at least meet the efficiency requirements of IECC 2015 and the Mass Save baseline document.

ECM 1 was evaluated against the baseline, and each consecutive ECM thereafter was run against the previous ECM, resulting in a cascading model such that the final ECM is also the combined run.

Cost estimates were prepared for each ECM. These estimates are generally from equipment vendors, data from Means Mechanical and Electrical cost data books, or first-hand experience with similar projects.

Table 4: Energy End Use Summary

End Use	Electricity (kWh)				Gas (therms)				Total (MMBTU)	
	Base	Prop.	Savings	% Savings	Base	Prop.	Savings	% Savings	Base	Prop.
Lighting	0	0	0	0%	0	0	0	0%	0	0
Task lighting	0	0	0	0%	0	0	0	0%	0	0
Misc. equipment	0	0	0	0%	0	0	0	0%	0	0
Heating	0	0	0	0%	0	0	0	0%	0	0
Cooling	0	0	0	0%	0	0	0	0%	0	0
Heat rejection	0	0	0	0%	0	0	0	0%	0	0
Auxiliary (pumps)	0	0	0	0%	0	0	0	0%	0	0
Vent fan	0	0	0	0%	0	0	0	0%	0	0
Refrigeration	0	0	0	0%	0	0	0	0%	0	0
Sup. heat pump	0	0	0	0%	0	0	0	0%	0	0
DHW	0	0	0	0%	0	0	0	0%	0	0
Exterior	0	0	0	0%	0	0	0	0%	0	0
TOTAL	0	0	0	0%	0	0	0	0%	0	0

Figure 2: Base Case Energy Use

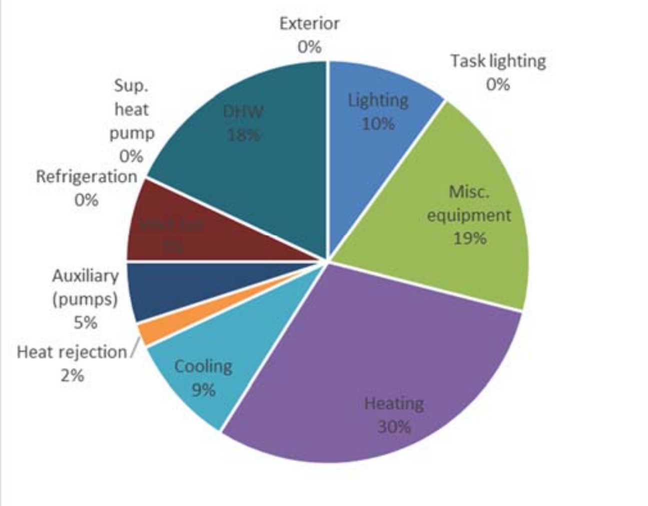
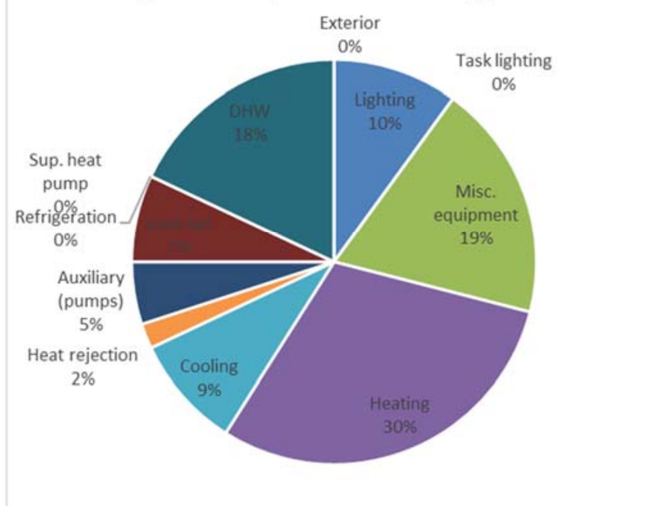


Figure 3: Proposed Case Energy Use



ECM #1: High Performance Glazing

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

The majority of the building envelope will consist of curtain wall systems. This measure provides a building envelope with overall performance exceeding the minimum requirements of IECC 2015. Note that fenestration comprises approximately 25% of the total vertical wall area.

<u>Base Case:</u> The opaque and vision areas of the envelope have thermal performance corresponding to the minimum values listed in IECC 2015:

a. Opaque areas: U-0.065
b. Vision areas: assembly U-0.45, SHGC-0.4

<u>Proposed Case</u>: Windows are low-e triple-glazed. The main envelope constructions are as follows:

a. Type 1 (office): U-0.10 opaque; U-0.36, SHGC-0.24 vision
b. Type 2 (lab): U-0.048 opaque; U-0.35, SHGC-0.33 vision

Savings Calculation Methodology

In base and proposed case models, the window and wall constructions were selected to produce the thermal performance values shown above.

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

ECM #2: High Efficiency Lighting

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

This measure provides an energy efficient lighting system for the building. The proposed lighting system will consist mainly of LED fixtures. This measure will save electricity due to lower fixture power consumption for given lighting levels, and lower cooling loads due to reduced heat gain. A corresponding natural gas penalty is associated with the heat gain reduction.

Base Case: The average lighting power density (LPD) for the building is 0.96 W/ft^2 which is 10% lower than the maximum allowed LPD in IECC 2015 using the space-by space-method in accordance with the Mass Save Baseline Document.

Proposed Case: The average installed LPD is 0.73 W/ft^2. Please see the table below for the LPDs by space type.

Savings Calculations Methodology

According to the COMcheck, the total installed lighting power is expected to be 162.0 kW. The LPD values used in the model changed in the model as indicated:

Space Type	Base LPD	Proposed LPD
Laboratory	1.63	1.40
Restrooms	0.88	0.83
Corridors	0.59	0.50
Lobby	0.81	0.67
Elevator Lobby	0.58	0.52
Open Office	0.88	0.87
Enclosed Office	1.00	0.96
Elec/Mech	0.86	0.77

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

ECM #3: High Efficiency Active Chilled Beams

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

This measure provides an energy efficiency solution for the HVAC system of the building compare to the traditional VAV system. The office space of this building will use active chill beam to heat and cool.

Base case: The office areas are equipped with a variable air volume AHU with hot water reheat. The AHU is equipped with chilled water coils and supplies air at 55-65°F to the VAV boxes serving the spaces. The air is then reheated at the VAV boxes to provide a discharge air temperature of 90°F when heating is required. The minimum flow has been established to be 0.4 CFM/SF. Chilled water will be supplied at 44° to the AHU.

The system has been auto-sized within eQUEST to provide 280,000 total CFM to the office areas. Using the fan power sizing requirements outlined in IECC 2015, the total fan horsepower was calculated to be 445 HP. For eQUEST modeling purposes this averages to 0.0011 kW/CFM. The AHU operates per the occupancy schedule as outlined below. It maintains space temperature setpoints of 70°F during occupied heating and 75°F during occupied cooling.

Mon-Fri: 7AM-9PM
Sat: OFF
Sun: OFF

Based on standard design practices for office buildings, the variable air volume AHUs are located in the interior mechanical room on each tenant floors. A dedicated outside air unit, located on the roof, supplies 100% outside air to the VAV. Under normal operating conditions, it has been estimated that 35,000 CFM of outside air will be supplied to the unit.

IECC 2015 requires any AHU with a cooling capacity above 135,000 Btu/hr be equipped with either an air-side or water-side economizer to take advantage of free cooling due to the outdoor conditions. Since the AHU is only provided a fixed minimum amount of outside air, a water-side economizer has been included in both the baseline and proposed cases.

Proposed Case: Active chilled beams will be installed in all office spaces. Chilled beams uses natural convection rather than fans to heat and cool the building. The chilled beams will be equipped with chilled water and hot water coils to provide space conditioning. The chilled beams will be supplied ventilation air via a rooftop air handling unit

The chilled beams will be supplied ventilation air via a rooftop air handling unit/ERU. The AHU is 180,000 CFM max and will provide minimum 50% outside air at all times. Under normal operating conditions, it has been estimated that 70,000 CFM of total air will be supplied to the unit. Approximately 50% of the total supply CFM will be outside air. This equals 35,000 CFM of outside air (same as base case).

The chilled beams will maintain space setpoints of 70°F during occupied heating and 75°F during occupied cooling. Due to possible condensation issues, the chilled water temperature supplied to the chilled beams must maintain a setpoint that is greater than the dewpoint within the space.

Savings Calculation and Methodology

In order to simulate Chilled Beams in eQUEST, the HVAC system type for "VAV-Chilled Beam" which serves the office areas, was changed from "Variable Air Volume" in the baseline case to "Fan Coil" in the proposed case. The fan power was changed from 0.00140 kW/CFM to 0.0 kW/CFM. This represents a workaround which is used for eQUEST since the software cannot model chilled beams directly. The design chilled water loop temperature for the secondary chilled beam loop was changed from 44°F to 55°F.This is to represent the chilled water setpoint which must be greater than the dewpoint within the space.

Additionally, the supply airflow to the thermal zone "Dummy Zone - OA for Office" was increased from 35,000 CFM to 70,000 CFM. The outside air flow remained unchanged at 35,000 CFM. This zone was created in order to model the ventilation air supplied to the tenant office areas (chilled beam or VAV). The baseline design is 100% outside air while the proposed design is 50% outside air; however the total outside air CFM is the same in both models.

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

ECM #4: High Efficiency RTUs

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

This measure involves the installation (3) RTUs with higher efficiency than the IECC 2015 code requirement.

Base Case: Base on IECC 2015, the minimum required efficiency for air cooled RTUs between 240MBH and 760MBH is 10 EER.
Proposed Case: The RTUs used in this building are of the same size as the base case and will have efficiency levels ranging from 11.5 to 12.5 EER.

Savings Calculation and Methodology

In eQuest, the cooling energy input ratio (EIR) is equal to (1/EER – 0.012167)/(1/3.413 - 0.012167). The following table summarizes the efficiencies of the units used in this project:

	Size	Baseline		Proposed	
	[MBH]	EER	EIR	EER	EIR
AC-1	350,000	10	0.312762	12	0.253414
AC-2	450,000	10	0.312762	12.5	0.241544
AC-3	300,000	10	0.312762	11.5	0.266316

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

ECM #5: High Efficiency Boilers

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

The building will be equipped with four 1,400-MBH output hot water boilers. This measure provides high-efficiency condensing boilers in place of standard code-compliant non-condensing boilers. The hot water supply temperature will be maintained at 140°F; the design return temperature is 110°F.

Base Case: The four boilers are non-condensing and have full-load thermal efficiency of 85% per the Mass Save Baseline document.
Proposed Case: The boilers are of condensing type, with full-load thermal efficiency of 95% at standard rating conditions (80°F return water temperature).

Savings Calculation and Methodology

In the baseline model, the boilers are of eQuest type "hot water"; in the proposed case, the boiler type is changed to condensing hot water. The heating EIR is equal to (1/thermal efficiency). The heating EIR is changed from 1.25 in the base case to 1.04 in the proposed case.

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

ECM #6: Passive Chilled Door Rack Level Cooling via Water to Water Heat Exchanger

Savings and Costs Summary

Electricity				Natural Gas		Energy Cost Savings	Measure Incremental Cost	Simple Payback
kWh	kW		$	Therms	$			
	Summer	Winter						
0	0.000	0.000	$0	0	$0	$0	$0	0.0

Measure Description

Base case: Data center is cooled with traditional computer room air conditioning units at the perimeter.
Proposed Case: The proposed data center will utilize local rack cooling system. Heat generated from server is removed at its source, therefore minimize the amount of hot exhaust air from entering common space and optimize data center thermal and energy performance

Savings Calculation and Methodology

The savings for this measure were calculated using the attached spreadsheet. The resultant loads were incorporated into the eQuest model. The baseline data center used 45.89 kW while the proposed data center has a 26.43 kW load.

Energy End Use Summary

	Lighting	Heating	Cooling	Heat rejection	Auxiliary (pumps)	Vent fan	Refrig.	DHW	Total
Electric Savings (kWh)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas Savings (therms)	0	0	0	0	0	0	0	0	0
Savings %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Non-Electric / Non-Gas Benefits (Impacts)

Oil [MMBTU]	Propane [MMBTU]	Water [Gallons]	Sewer [Gallons]	Recurring Annual Cost [$]	One-time Cost [$]
0	0	0	0	$0	$0

APPENDICES

A. Minimum Requirements Documents (submitted as a separated document)

B. Miscellaneous Supporting Data

1. L P D analysis performed by HVAK Engineering
2. HVAC schedules (pdf)
3. Control sequences (pdf)

C. Prescriptive Applications (submitted as separate documents)

1. Exterior Lighting
2. Compressed Air

D. Study Proposal