Mary E. W. Risteau District Court
& Multi-Service Center

2 South Bond Street
Bel Air, MD 21014

Energy Audit Report

Prepared for:

Maryland Department of General Services (DGS)

Prepared by:

UMD Smart and Small Thermal Systems (S2TS)
Principal Investigator (PI): Dr. Michael Ohadi

May 24, 2021

Project Team

In accordance with Governor Hogan's Executive Order 01.01.2019.08 Energy Savings Goals for State Government, this project was assigned to the UMD Smart and Small Thermal Systems team by the Maryland Department of General Services (DGS). The UMD S2TS team consisted of Soumya Agrawal, Ji Bae and Soham Joshi, supervised by Dr. Amir Shooshtari & Dr. Michael Ohadi.

Acknowledgment

We would like to acknowledge Mr. Robert Hamilton at the Bel Air District Court & Multi-Service Center for his help and cooperation during the walkthrough and for answering our questions. We would also like to thank Mr. Tony Myers for his help in coordinating the walkthroughs and offering technical insights as applicable.

Executive Summary

This energy audit supports Governor Hogan's Executive Order 01.01.2019.08 - Energy Savings Goals for State Government. The UMD S2TS team divided the audit into three phases: Building Comprehension, Energy Model Development, and Energy Efficiency Measure analysis. The team carried out a facility walkthrough, analyzed the utility data and building plans to evaluate the energy usage of the building, and summarized their findings in this report. This report identifies actionable energy-saving opportunities to increase the building's energy efficiency.

Major findings:

- Every Air Handling Unit (AHU) in the building runs at fixed temperature setpoints for 24 hours a day, all around the year, without any setback for the periods when the building is unoccupied.
- The existing boilers are original to the building, which was built in 1983.

List of recommended energy efficiency measures (EEM):

<u>EEM 1</u> - Upgrade Lighting

- LED fixtures

<u>EEM 2</u> – Update AHU Setpoints

- Update existing zone temperature setpoints to values recommended by ASHRAE.
- Configure setback temperature setpoints for the periods of unoccupied operation.

<u>EEM 3</u> – Replace Existing Boilers

- Install newer, more energy-efficient boilers.

See pages 19-20 for more details on the list of EEMs.

List of Additional Building Observations and Recommendations

- Adding insulation to refrigerant lines for condensing units no. 2 & 3 in the garage.
- Securely close the windows to prevent excessive infiltration and loss of conditioned air.
- Incorporating interior Green Walls for improved Indoor Air Quality.

See pages 22-23 for more details on the list of Additional Building Observations and Recommendations.

Savings associated with following all recommendations:

- Annual utility cost reduction of 14.7%, amounting to annual savings of $38,562.
- Annual electricity consumption reduction of 10.8%, amounting to annual savings of $24,230.
- Annual natural gas consumption reduction of 37.0%, amounting to annual savings of $14,332.

See pages 20-21 for more details on cost savings calculations.

Overview

Governor Hogan's Executive Order 01.01.2019.08 - Energy Savings Goals for State Government was issued in July 2019 to signal the Administration's desire to improve the energy efficiency of State-owned buildings to reduce their environmental impact, and to save taxpayers' money. The Executive Order set the energy savings goal at 10% savings over a 2018 baseline by 2029. The Executive Order requires DGS to audit 2 million square feet of State facilities annually, and to present the Audit Reports to each building's owner. The Executive order goes on to state that:

- Each unit of State government that occupies the space audited shall, to the fullest extent practicable, implement the measures identified in the audit.

The DGS Office of Energy and Sustainability will coordinate with each building owner on financing and implementing the measures identified in this audit report.

Building Description

The Mary E. W. Risteau Multi Service Center is also the District Court of Maryland for Harford County located at 2 S. Bond St, Bel Air, Maryland. The building was originally constructed in 1983 and is a four-story building with an overall area of 140,000 sq.ft..

Fig. 1 shows an overview of the building.

Fig. 1: Mary E. W. Risteau Multi-Service Center/District Court

The building primarily houses the courtrooms, judges' chambers, and office spaces on level 1, and office spaces, library/conference rooms, and storage spaces on level 2, 3 & 4. Level 4 also houses 2 mechanical rooms, which contain AHUs 4, 5, & 6.

The basement level primarily comprises of a parking garage for vehicles, along with holding cells for people awaiting court trials, and mechanical rooms - containing equipment such as chillers, condenser tanks, boilers, pumps, air compressors, AHU 1, 2 & 3, and a diesel-powered generator. The parking garage houses 5 condensing units - serving AHU 2 & 3, and individual split systems for a server room and 2 control rooms for elevators. The cooling towers are located outside - near the parking garage exit door, above ground level.

The building occupancy schedule is from 8 AM to 5 PM on weekdays (Monday to Friday). As per our discussions with the Maintenance Supervisor of the building, the building's HVAC systems operate 24 hours a day, all around the year, at fixed temperature setpoints - between 72° & 74° F for cooling and between 68°F & 73°F for heating, depending on each zone's requirements.

The building meets its energy demands from two commodities: electricity and natural gas, both of which are metered and supplied by utility companies (Electricity and Natural Gas: BG&E, WGL Energy). The building's annual average electricity consumption is 2,130 MWh and annual average natural gas consumption is 37,041 therms. Annual average utility cost of the building is $235,742.

Building HVAC Description

Chilled water for the cooling coils is supplied by two water-cooled screw compressor chillers - *York YSBBBBS1-CHB* and *YSBBBBS1-CFE,* with rated capacities of 142 TR (499.4 kW) and 146 TR (513.5 kW) respectively. The chillers are controlled by Johnson Controls' METASYS Building Automation System (BAS). Two constant speed pumps, rated at 15 HP (11.2 kW) each, supply the chilled water to cooling coils in AHUs 1, 4, 5 & 6. Fig. 2 shows the chiller units installed in the basement level mechanical room. They were installed in 2003.

Fig. 2: Chiller Units

Hot water is supplied by a gas-fired water heater (AO Smith) rated at 365 kBTUh (107 kW) and two gas-fired boilers (HB Smith Series 28), each with a capacity of 1709 MBH (501 kW). The boilers are controlled by the BAS system as well. 1 two-speed pump and 6 constant speed pumps supply hot water to AHU coils, VAV reheat coils, baseboard & ceiling-suspended unit heaters, and domestic hot water supply fixtures throughout the building. Fig. 3 shows a boiler unit installed in the basement level mechanical room. They are original to the building and were installed in 1983.

Fig. 3: Boiler Unit (1 of 2)

There are 6 AHUs in the building, which serve most of the building needs, with 4 supplementary split DX coil systems and multiple hot water unit heaters installed throughout the building. AHUs 1, 2 & 3 are in the basement level mechanical room, and AHUs 4, 5 & 6 are in the mechanical rooms on level 4. AHUs 1 & 2 serve the courtrooms and the judges' chambers respectively, on level 1. AHU 3 serves the holding cell in the basement. AHU 4 & 6 serve all four above-ground levels of the buildings, with different sections of each floor assigned to each AHU. AHU 5 serves certain sections of levels 1, 2 & 3. Apart from the holding cell, the basement level is not cooled or heated by any air handling unit, but air is exhausted and exchanged via ducts. A few unit heaters exist in the perimeter zone of the parking garage, along with one in each of the two stairwells.

AHUs 1, 2 & 3 have supply fans powered by constant speed motors, rated at 5 HP, 3 HP, and 1.5 HP, respectively. AHU 1 has a chilled-water cooling coil, while AHU 2 & 3 have DX (refrigerant) cooling coils. AHU 3 has a hot water preheat coil. AHUs 1 & 2 do not have heating coils, but the zones served by AHUs 1 & 2 have hot water heating coils in their supply ducts instead. AHUs 4, 5, & 6 are each equipped with a hot water preheat coil, a chilled-water cooling coil, and supply fans that are controlled by variable speed motors. All AHUs have a corresponding return air fan mounted in the ductwork; each return air fan is controlled by a constant speed or variable speed motor, corresponding to the supply fan motor type for each AHU. Supply air is delivered to each space via ducts, variable air volume (VAV) terminal units & diffusers.

A summary of the design specifications of the building's HVAC system retrieved from the building's mechanical drawings is shown in Table 1.

Table 1: HVAC design specifications summary

AIR HANDLING SYSTEM

FAN DATA

Nº	LOCATION	DUTY	TYPE	SUPPLY MAX.	SUPPLY MIN.	MIN. O.A. C.F.M.	EXT./TOT S.P. IN.WG	H.P.	RPM	REMARKS
1	BASEMENT (BOILER ROOM)	SUPPLY	CENTRIFUGAL	4,840	—	1,600	2 3/4 / 3 3/4	5	1,500	
		RETURN	IN-LINE AXIAL	4,840	—	—	1 1/4	2	1,550	
2	BASEMENT (BOILER ROOM)	SUPPLY	CENTRIFUGAL	3,490	—	1,100	2 1/4 / 2 3/4	3	1,350	
		RETURN	IN-LINE AXIAL	2,390	—	—	3/4	3/4	1,500	
3	BASEMENT (BOILER ROOM)	SUPPLY	CENTRIFUGAL	1,030	—	290	2 1/4 / 3	1 1/2	2,600	
		RETURN	IN-LINE	740	—	—	1	1/4	1,750	
4	FOURTH FLOOR (NOTE 4)	SUPPLY	CENTRIFUGAL	24160	9,500	6,385	6 / 7	40	1,816	
		RETURN	IN-LINE AXIAL	17,775	—	—	2 1/4	10	830	
5	FOURTH FLOOR (NOTE 4)	SUPPLY	CENTRIFUGAL	25,445	11,000	3,940	5 3/4 / 6 3/4	50	1,850	
		RETURN	IN-LINE AXIAL	22,015	—	—	2	15	904	MIN. RELIEF 1,310 CFM
6	FOURTH FLOOR (NOTE 4)	SUPPLY	CENTRIFUGAL	24,350	10,000	3,940	6 1/4 / 7 1/4	50	1,525	
		RETURN	IN-LINE AXIAL	20,480	—	—	2 1/4	15	900	MIN. RELIEF 60 CFM.

COOLING COIL DATA

Nº	C.F.M. MAX/	ENT. AIR °F DB	ENT. AIR °F WB	LVG AIR °F DB	LVG AIR °F WB	CAPACITY BTUH MIN.	MAX. GPM	MIN. SIZE	MIN. Nº ROWS	MAX. AIR PD. IN.WG	MAX. H_2O PD. FT.WG	REMARKS
1	4,840	82.3	68.5	55.0	54.5	211,075	35.5	45" × 30"	4	0.90	5.0	
2	3,490	82.1	68.2	57.0	56.0	138,225	—	36" × 30"	3	0.50	—	DIRECT EXPANSION
3	1,030	81.7	67.9	57.0	56.0	38,960	—	24" × 18"	4	0.50	—	DIRECT EXPANSION
4	24,160	80.8	66.4	55.0	54.5	892,350	149.0	2-108" × 33"	4	0.65	15.0	
5	25,445	80.2	66.0	55.0	54.5	905,845	151.0	2-108" × 33"	4	0.70	15.0	
6	24,350	80.2	66.0	55.0	54.5	866,860	144.5	2-108" × 33"	4	0.65	15.0	

NOTES:

SCHEDULE

HEATING COIL DATA

C.F.M.	ENT AIR F	LVG AIR F	MIN. CAP. BTUH.	MAX. GPM	MIN. SIZE	MIN Nº ROWS	MAX. AIR PD. IN.WG	MAX. H_2O PD. FT.WG	REMARKS
—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	
1,030	51.7	80.0	31,485	3.5	24" × 18"	1	0.125	5.0	
24,160	50.0	85.0	913,250	46.0	2-108" × 33"	1	0.125	5.0	
25,445	50.0	85.0	961,825	48.5	2-108" × 33"	1	0.125	5.0	
24,350	50.0	85.0	920,430	46.0	2-108" × 33"	1	0.125	5.0	

PUMP SCHEDULE

Nº	LOCATION	DUTY	TYPE	GPM	HEAD (FT.WG)	MOTOR HP	MOTOR VOLT	MOTOR PHASE	MOTOR RPM	M.O.D. Nº	REMARKS
1	BOILER RM.	CHILL. WATER	E.S.CENT.	240	110	15	460	3	1750	LP-4012	
2	BOILER RM.	CHILL. WATER	E.S.CENT	240	110	15	460	3	1750	LP-4012	
3	TANK RM.	COND. WATER	E.S.CENT	900	105	40	460	3	1750	LP-6012	SERIES OPERATION
4	TANK RM.	COND. WATER	E.S.CENT	900	105	40	460	3	1750	LP-6012	SERIES OPERATION
5	TANK RM.	COND. WATER	E.S.CENT	450	50	10	460	3	1750	LP-5008	OPT. COOL. TOWER
6	TANK RM	COND. WATER	E.S.CENT	450	50	10	460	3	1750	LP-5008	OPT. COOL. TOWER
7	BOILER RM.	HEATING	E.S.CENT	50	55	2	460	3	1750	LP-2008	PERIMETER BOX COILS
8	BOILER RM.	HTG.(STANDBY)	E.S.CENT	50	55	2	460	3	1750	LP-2008	PERIMETER BOX COILS
9	BOILER RM.	HEATING	E.S.CENT	220	80	7 1/2	460	3	1750	LP-3010	S/W ZONE PERIMETER
10	BOILER RM.	HEATING	E.S.CENT	220	80	7 1/2	460	3	1750	LP-3010	S/W ZONE PER. (STANDBY)
11	BOILER RM.	HEATING	E.S.CENT	50	65	2	460	3	1750	LP-2008	N/E ZONE PERIMETER
12	BOILER RM.	HEATING	E.S.CENT	50	65	2	460	3	1750	LP-2008	N/E ZONE PER (STANDBY)
13	BOILER RM.	HEATING	INLINE	10	50	2	460	3	1750	1638 SERIES	JUDGE AREA PERIMETER
14	BOILER RM.	HEATING	INLINE	10	50	2	460	3	1750	1638 SERIES	JUDGE AREA PER. (STD.BY)
15	BOILER RM.	HEATING	INLINE	35	40	1	460	3	1750	1616 SERIES	REHEAT COILS
16	BOILER RM.	HEATING	INLINE	35	40	1	460	3	1750	1616 SERIES	REHEAT COILS (STANDBY)
17	BOILER RM.	FIRE PUMP	SPLITCASE	1000	124	40	460	3	1750	ALLIS CHALMERS	
18	BOILER RM.	DOM. WATER BOOST	E.S.CENT	65 / 135	105 / 105	5 / 7 1/2	460 / 460	3 / 3	3450 / 3450	CC2006 / CC2006	PACKAGED SYSTEM
19	BOILER RM.	SUMP PUMP	—	400	25	5	460	3	1750	WELL 700	DUPLEX-10'-0" DEEP SUMP
20	BOILER RM.	DIESEL OIL PUMP	ROTARY	2.5	25 PSIG	1/4	120	1		VIKING 124	18" HG SUCTION CAPABILITY
21	BOILER RM.	JOCKEY PUMP	E.S.CENT	10	150	1.0	460	3	1750	ALLIS CHALMERS	
22	BOILER RM.	DOM. WATER CIRC	IN LINE	10	20	1/3	120	1	1750	1600 SERIES	

MECHANICAL EQUIPMENT CAPACITIES

1. CHILLER Nº1 -
   TO CHILL 240 GPM FROM 56°F ENTERING WATER TEMPERATURE TO 44°F LEAVING WATER TEMPERATURE, TOTAL COOLING CAPACITY 1,440,000 BTUH, KW 131, 460 VOLT/3 PHASE/60 Hz. CONDENSER PRESSURE DROP 20 FT. H_2O MAXIMUM; EVAPORATOR PRESSURE DROP 8 FT. H_2O MAXIMUM.

2. CHILLER Nº2 -
   SAME AS CHILLER Nº1

3. COOLING TOWER Nº1 -
   TO COOL 450 GPM FROM 95°F ENTERING WATER TEMPERATURE TO 85°F LEAVING WATER TEMPERATURE AT 78°F W.B. AMBIENT TEMPERATURE. MAXIMUM NOZZLE PRESSURE 55 PSIG.

4. COOLING TOWER Nº2 -
   SAME AS COOLING TOWER Nº1.

5. OPTIONAL COOLING TOWER Nº1 -
   SAME AS CAPACITY AS COOLING TOWER Nº1 EXCEPT 20 HP, 460 VOLT/3 PHASE/60 Hz.

6. OPTIONAL COOLING TOWER Nº2 -
   SAME AS OPTIONAL COOLING TOWER Nº1.

7. CONDENSING UNIT Nº1 (A.H.U. Nº2) -
   CAPACITY 138,225 BTUH WITH 95°F AMBIENT AIR, 460 VOLT/3 PHASE/60 Hz., FAN H.P. 3 @ 3/4 EACH, COMPRESSORS 2 @ 7.75 KW EACH, 40°F SUCTION TEMPERATURE.

8. CONDENSING UNIT Nº2 (AHU Nº3) -
   CAPACITY 38,960 BTUH WITH 105°F AMBIENT AIR, 200 VOLT/3 PHASE/60 Hz., FAN 1/2 HP, COMPRESSOR 3 HP, 47°F SUCTION TEMPERATURE.

9. BOILER Nº1 -
   FORCED DRAFT, CAST IRON SECTIONAL, 190°F AVERAGE WATER TEMPERATURE, CAPACITY 1,400,000 BTUH NET; 1,820,000 BTUH GROSS GAS FIRED, 3/4 HP, 460 VOLT/3 PHASE/60 Hz.

10. BOILER Nº2 -
    SAME AS BOILER Nº1.

11. AIR SEPARATION TANK - CHILLED WATER -
    480 GPM, MINIMUM SIZE 6", WATER PRESSURE DROP WITH STRAINER 2.0 FT. H_2O MAXIMUM.

12. AIR SEPARATION TANK - HEATING SYSTEM -
    350 GPM, MINIMUM SIZE 6", WATER PRESSURE DROP WITH STRAINER 2.0 FT. H_2O MAXIMUM.

13. EXPANSION TANK - HEATING SYSTEM -
    400 GALLONS MINIMUM CAPACITY, 3'-0" DIA. × 8'-0" LONG, TYPICAL OF 2 TANKS. ASME RATED.

14. EXPANSION TANK - CHILLED WATER SYSTEM -
    300 GALLONS - 3'-0" DIA. × 6'-0" LONG.

15. HOT WATER GENERATOR -
    GAS FIRED, 540,000 BTUH INPUT, 518 GALLON PER HOUR RECOVERY RATE, 500 GALLON STORAGE.

16. HEATING SYSTEM CHEMICAL TANK -
    5 GALLON CAPACITY.

17. CHILLED WATER CHEMICAL TANK -
    5 GALLON CAPACITY.

18. CONDENSER WATER TANK -
    55 GALLON POLYETHLENE TANK.

Summaries of specifications for the chillers & boilers installed in the building are shown in Table 2 & 3, respectively.

Table 2: Chiller specifications summary

Designation	CH-1	CH-2
Manufacturer	York	York
Model No.	YSBBBBS1-CHB	YSBBBBS1-CFE
Year Installed	2003	2003
Capacity	142 Tons	146 Tons
Compressor Type	Screw	Screw
Cooling Method	Water-Cooled	Water-Cooled

Table 3: Boiler specifications summary

Designation	B-1	B-2
Manufacturer	HB Smith	HB Smith
Model No.	28A-Δ-8	28A-Δ-8
Year Installed	1983	1983
Capacities		
I-B-R Burner Capacity (MBH)	2500	2500
Gross I-B-R Output (MBH)	1965	1965
Net I-B-R Output (MBH)	1709	1709

I = B = R Ratings, a

Designed and Tested According to the A.S.M.E. Boiler and Pressure Vessel Code

Boiler Number (Note 1)	Boiler Horse-power	I=B=R Gross Output (MBH)	Net I=B=R Ratings (Note 2)					Heating Surface (Sq. Ft.)	Furnace Volume (Cu. Ft.)	Water Contents (Gals.)		Water Working Weight (Lbs.)	Overall Length – (Note 8)		
			Steam		Water	I=B=R Burner Capacity									
			Sq. Ft.	MBH	MBH	Oil GPH (Note 3)	Gas MBH (Note 4)			Steam	Water		Carlin	Beckett	Power Flame
†28A-Δ-4	27	900	2813	675	783	8.0	1154 *	81.2	12.04	103.8	123.4	4,215	62¼	64	71⅛
†28A-Δ-5	35	1166	3646	875	1014	10.4	1491	105.3	16.14	125.8	150.3	5,038	70¼	72	83⅛
†28A-Δ-6	43	1433	4538	1089	1246	12.6	1827	129.4	20.24	147.8	177.2	5,861	80⅛	80¼	91⅛
†28A-Δ-7	51	1699	5458	1310	1477	15.0	2163	153.5	24.34	169.8	204.1	6,684	88⅛	88⅜	99⅛
†28A-Δ-8	59	1965	6358	1526	1709	17.4	2499	177.6	28.44	191.8	231.0	7,507	96⅛	96¾	107⅛
†28A-Δ-9	67	2232	7221	1733	1941	19.6	2836	201.7	32.54	213.8	257.9	8,331	108⅞	104¾	115⅛
†28A-Δ-10	75	2498	8079	1939	2172	22.0	3172	225.8	36.64	235.8	284.8	9,169	116⅞	116⅜	128
†28A-Δ-11	83	2764	8942	2146	2403	24.5	3508	249.9	40.74	257.8	311.7	9,992	125⅛	124⅜	137⅛
†28A-Δ-12	91	3031	9804	2353	2636	26.5	3844	274.0	44.84	279.8	338.6	10,815	133⅛	132½	145⅛
†28A-Δ-13	98	3297	10667	2560	2867	29.0	4180	289.1	48.94	301.8	365.5	11,649	141⅛	—	153⅛
†28A-Δ-14	106	3563	11525	2766	3098	31.5	4517	322.2	53.04	323.8	392.4	12,467	149⅛	—	161⅛
†28A-Δ-15	114	3830	12392	2974	3330	33.5	4853	346.3	57.14	345.8	419.3	13,511	—	—	169⅛
†28A-Δ-16	122	4096	13250	3180	3562	36.0	5189	370.4	61.24	367.8	446.2	14,375	—	—	177⅛
†28A-Δ-17	130	4362	14113	3387	3793	38.5	5525	394.5	65.34	389.8	473.1	15,239	—	—	191⅛
†28A-Δ-18	138	4629	14975	3594	4025	40.5	5862	418.6	69.44	411.8	500.0	16,103	—	—	199⅛

(Note 1) Important Ordering information
(†) Add Prefix for type of fuel to be burned. "LO" for light oil, "G" for Gas or "GO" for gas/oil.
(Δ) Insert "S" for steam, "W" for water.
Example: LO-28A-S-6 is the model no. for a six section steam boiler firing light oil.
(Note 2) Net I=B=R Water Ratings are based on an allowance of 1.15. Net I=B=R Ratings for steam boilers are based on piping and pick-up factor as follows: 4 and 5 section = 1.333, 6 section = 1.305, 8 section and larger = 1.288.

(Note 3) Light oil having a heat content of 140,000 BTU/Gal.
(Note 4) Gas having a heat content of 1,000 BTU/Cu. Ft., 0.60 specific gravity
(Note 5) Burner operation: Low-fire start, high-fire run, two position air.
(Note 6) Burner operation: On-off, (4 sect.); Low-fire start, high-fire run, two position air (5-14 sect.).
* When 5th heater is required—relocate steam uptake and dimensions "E" = 32 in. and "F" = 16 in.

HB Smith - Series 28A Boiler Specifications [24]; Boiler Number 28A-Δ-8 is installed in the building.

Methodology

The project can be generally divided into three phases: Building Comprehension, Energy Model Development, and Energy Efficiency Measure analysis.

Building Comprehension

Building comprehension is the process of data collection and analysis. This can be further divided into 4 categories: Utility Analysis, Building Walkthrough, Archival Review, and Monitoring the Building Automation System.

The first objective during the building comprehension phase is to understand the building's energy consumption patterns. Once notable patterns and characteristics of a building's energy consumption are known, they can be compared to available "benchmark" data to assess a building's relative performance.

A building walkthrough was conducted with the facility personnel. The aim was to provide a first-hand examination of all building spaces and equipment as well as establish relationships with people involved in the building's operations. The walkthrough was thorough and included visiting every available space, including mechanical and electrical rooms, offices, courtrooms. A walkthrough is often crucial in revealing operational issues and helping to elucidate building use patterns that cannot be found anywhere else. The building walkthrough revealed data, including integrity of the building envelope and mechanical systems, thermal zone temperature controls and setpoints, office and courtroom equipment, construction materials, schedules, and occupant behavior.

An archival review of the building's documentation was conducted alongside the utility analysis, before developing the energy model. The documents referenced included the floor plans, architectural, Mechanical, Electrical, and Plumbing (MEP) diagrams; but certain assumptions had to be made for the unavailable data.

In the final step of building comprehension, access to any Building Automation System (BAS) is sought out and analyzed. In this case, the facility has a working BAS system.

Energy Model Development

The energy model was developed as follows: simulation software was selected, a baseline model was developed, the model was calibrated, and the results were validated. For this project, the free building simulation software eQUEST-3.65 was used. eQUEST utilizes the DOE-2.3 simulation environment developed and provided by the Department of Energy and the Lawrence Berkeley National Laboratory. The software is qualified for commercial building tax deductions and has been widely used in comprehensive building energy analysis for over 20 years. It is well regarded for its simple user interface as well as its ability to create working whole-building energy models.

The early stages of energy model development began after the building walkthrough and utility analysis was completed, and once the archival review had begun. Fig. 4 describes the general flow of data in energy models. Building geometry, weather data, HVAC system data, internal loads, operating schedules, and simulation specific parameters are input in the simulation engine - which then simulates the energy consumption in the building.

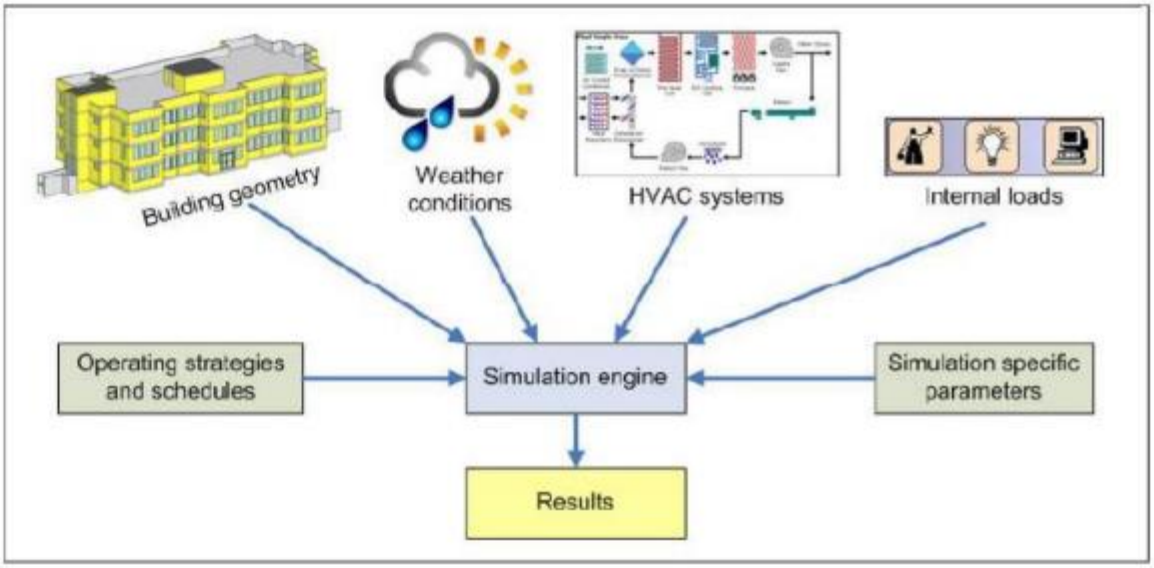

Fig. 4: General data flow of building energy simulation software. [2]

Energy Efficiency Measure Analysis

The energy efficiency measures were selected primarily through data obtained during the building comprehension phase, which included relevant diagnosis and analysis, including comparison and learnings from the relevant literature. For example, the ASHRAE Standard 90.1 - 2019: Energy Standard for Buildings Except Low-Rise Residential Buildings provides full-scope strategies and technical guidance for achieving at least 30% energy savings [3]. ASHRAE also provides registrants with function-specific Advanced Energy Design Guides for achieving additional energy savings up to 50% [4]. When possible, these energy conservation measures were analyzed by the energy model of the building.

Load Calculations

The building load calculations were carried out to determine the building loads and evaluate whether the current systems are undersized or oversized. From the eQUEST modeling output results (DOE-2 Simulation Results Viewer), it was found that the total cooling load was about 258 tons. The current chillers are rated at 142 tons and 146 tons and the DX coil condensing units have a total estimated capacity of 21 tons. Therefore, the total installed capacity is 309 tons. Hence, the total installed capacity of the current chillers and DX coil condensing units is oversized by about 20%. Focusing on the boilers, the total heating load was about 2554 MBH and the current boilers are rated at a maximum net capacity of 1709 MBH each. Therefore, combined capacity of the boilers is 3418 MBH. Hence, the boilers are oversized by about 34% when compared to the building's heating needs. A point to be noted is that these systems are most likely be oversized to accommodate for lead-lag operation, higher demand due to weather conditions, and other factors. Usually, having some degree of redundancy is also recommended. For example, it is recommended that Data Centers and Hospitals have a redundancy of N+1 or 2N due to the essential services being carried out at these sites, where N is the required number of units.

Utility Analysis and Benchmarking

Utility data from 2016 - 2019 were retrieved through the State of Maryland's EnergyCAP tool, which collects and stores energy consumption data from most facilities in the State of Maryland. Monthly energy consumption data for the electricity and natural gas were obtained in the units of kWh and therms, respectively, then converted to units of kBTU using conversion factors provided by the US DOE, and they are shown in Table 4 [5].

Table 4: Utility Analysis and EUI Summary Calculation

	Electricity		**Natural Gas**		**Water**	**Total Site Energy**	**EUI**
	MWh/yr	kBTU/yr	therms/yr	kBTU/yr	Gal/yr	kBTU/yr	kBTU/sq.ft ./Yr
Baseline Energy Usage	2071.6	7,068,299	37041.5	3,704,150	1,819,136	10,772,449	76.94

Fig. 5 and Fig. 6 show the average monthly electricity and natural gas consumption respectively for the years 2016-2019 and provides a few key insights.

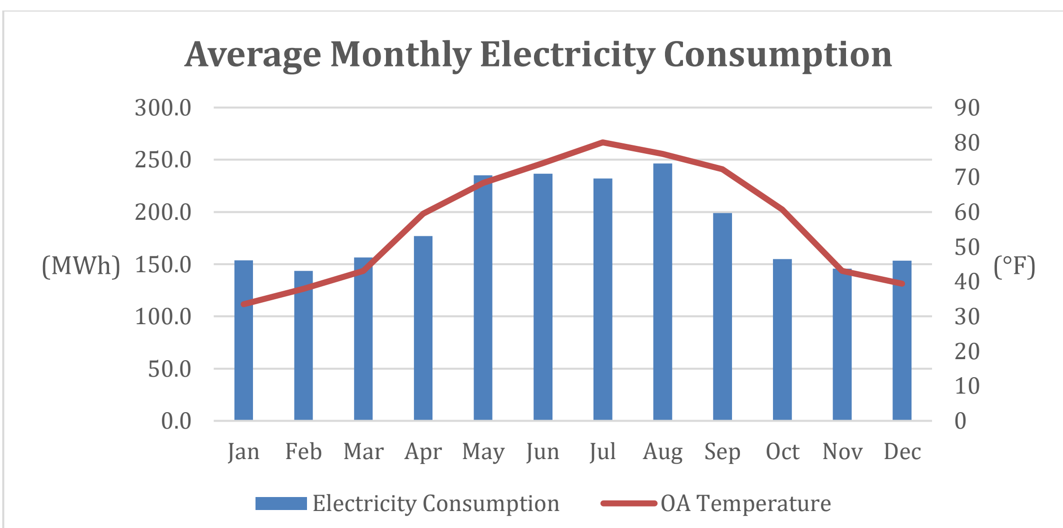

Fig. 5: Average Monthly Electricity Consumption [6]

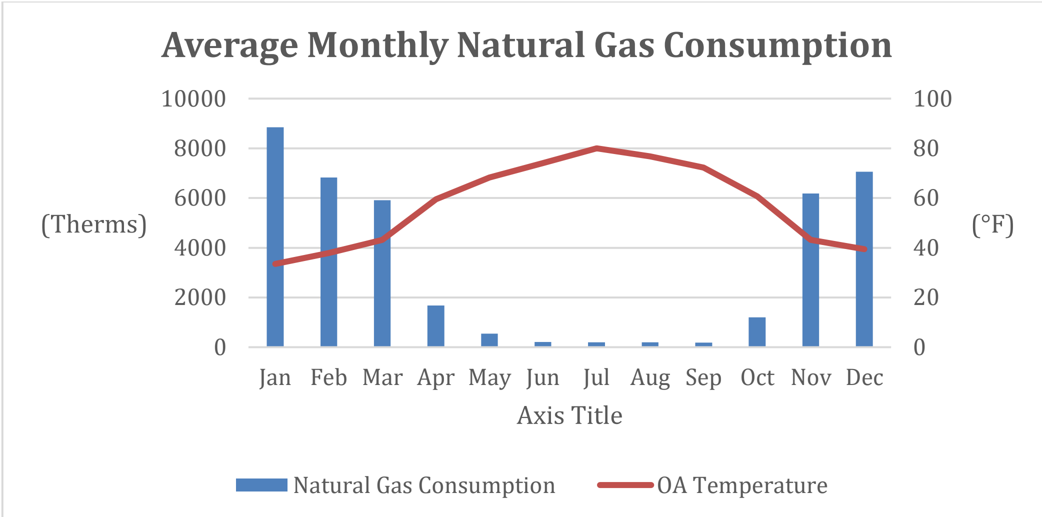

Fig. 6: Average Monthly Natural Gas Consumption [6]

Electricity consumption increases during the summer months due to the space cooling requirements. The use of electric unit heaters results in a slight increase in electricity consumption during the winter months. Natural gas consumption is highest during the winter months to provide the required space conditioning. The natural gas consumption in the summer is due to the reheat operation required to provide adequate humidification and occupant comfort.

Energy benchmarking assessment helps to identify the potential opportunities to improve energy efficiency and reduce the associated costs for utilities. To further verify the utility benchmarking calculations, benchmarking was performed using EnergyStar Portfolio Manager [7]. The Commercial Buildings Energy Consumption Survey (CBECS) database data was also used to evaluate the energy profile of the facility [8]. This comparison provides an opportunity to determine the scope of improving overall energy efficiency.

In the case of EnergyStar Portfolio Manager, the facility utility data was fed to the Portfolio Manager. These included electricity, natural gas, and water utility bills which were further supplemented with the facility data (such as floor area, building use, occupancy, etc.). Table 5. provides a summary of the result of benchmarking analysis using both the EnergyStar Portfolio Manager and the CBECS database. This table also compares the obtained value with the standard EnergyStar and CBECS score for a public courthouse [9].

Table 5: Benchmarking Results Summary

Parameter	Value	Benchmark Reference	Reference
Energy Star Score (1-100)	54	-	EnergyStar Portfolio Manager
Site EUI (kBTU/sq.ft.)	82.3	101.2	EnergyStar Portfolio Manager

CBECS ($/sq.ft.)	1.66	1.84	(Electricity + Natural Gas Utility Costs)/Building floor area

The overall Energy Star Score of 54 indicates that the building is already performing above median energy performance. An Energy Usage Intensity (EUI) value of 82.3 was obtained using EnergyStar Portfolio Manager and utility analysis (2016-2019) yielded a close value of 76.9. Based on the benchmarking analysis, the Bel Air District Court has an EUI that is less that than that of the average public courthouse (82.3 vs 101.2). The ($/sq.ft.) value is also lower than the CBECS average value for commercial offices (1.66 vs 1.84). This means that when compared to other courthouses, the Bel Air MSC is performing well and there might be fewer opportunities to increase the overall energy efficiency of the facility.

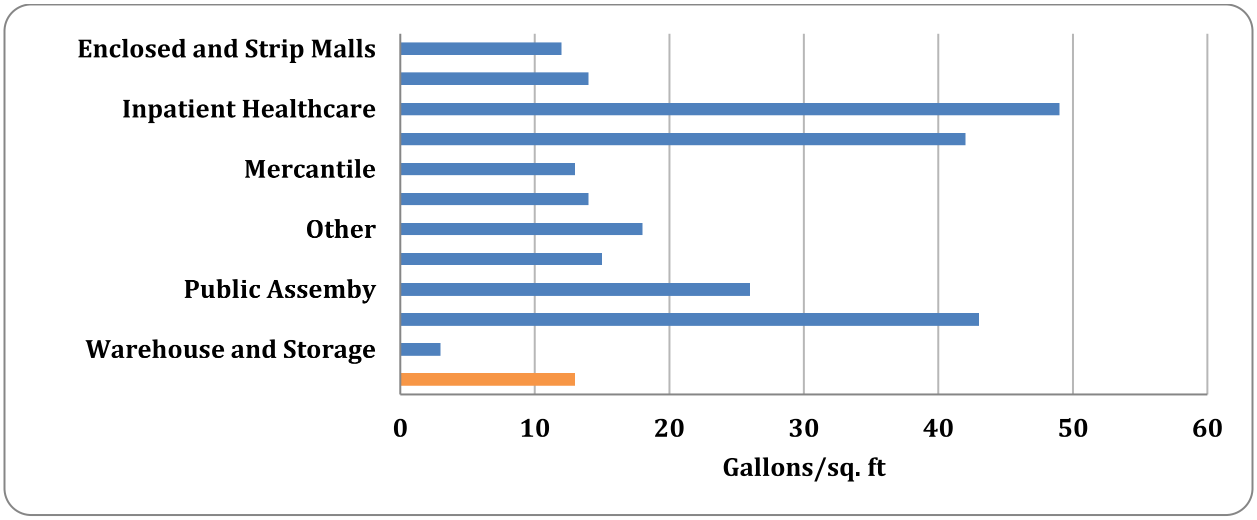

Fig. 7 Water Usage Intensity (Gallons per sq.ft.) [10]

Fig. 7 shows the water consumption data from the Commercial Buildings Energy Consumption Survey. The facilities included in the figure consists of commercial buildings greater than 200,000 sq.ft. When compared to these facilities, the Bel Air District Court with a floor area of 140,000 sq.ft. has a water intensity value of 12.99 gallons/sq.ft..

Energy Modeling

Baseline Energy Model

The physical structure of the Bel Air District Court & MSC was modeled in eQUEST. Initially, AutoCAD 2021 was used to create CAD drawing (.dwg) files based on PDF scans of the architectural plans. These CAD files were then imported into eQUEST to generate the initial building geometry. Floor dimensions were calculated using the documented reference scale. Then, the required zones were modeled into the floor layout and the subsequent HVAC systems were designed. The required model information (such as building envelope construction) was derived from the building plans and during the walkthrough. Certain informed assumptions were made for the unavailable data through physical observations, building plan analysis, and discussions with the facility personnel.

Each of the 4 levels was modeled and zoned separately to make the model as accurate as possible along with implementing the specific fenestration (windows and doors) details. Fig. 8 shows the 3-D representation of the building model, as rendered in eQUEST.

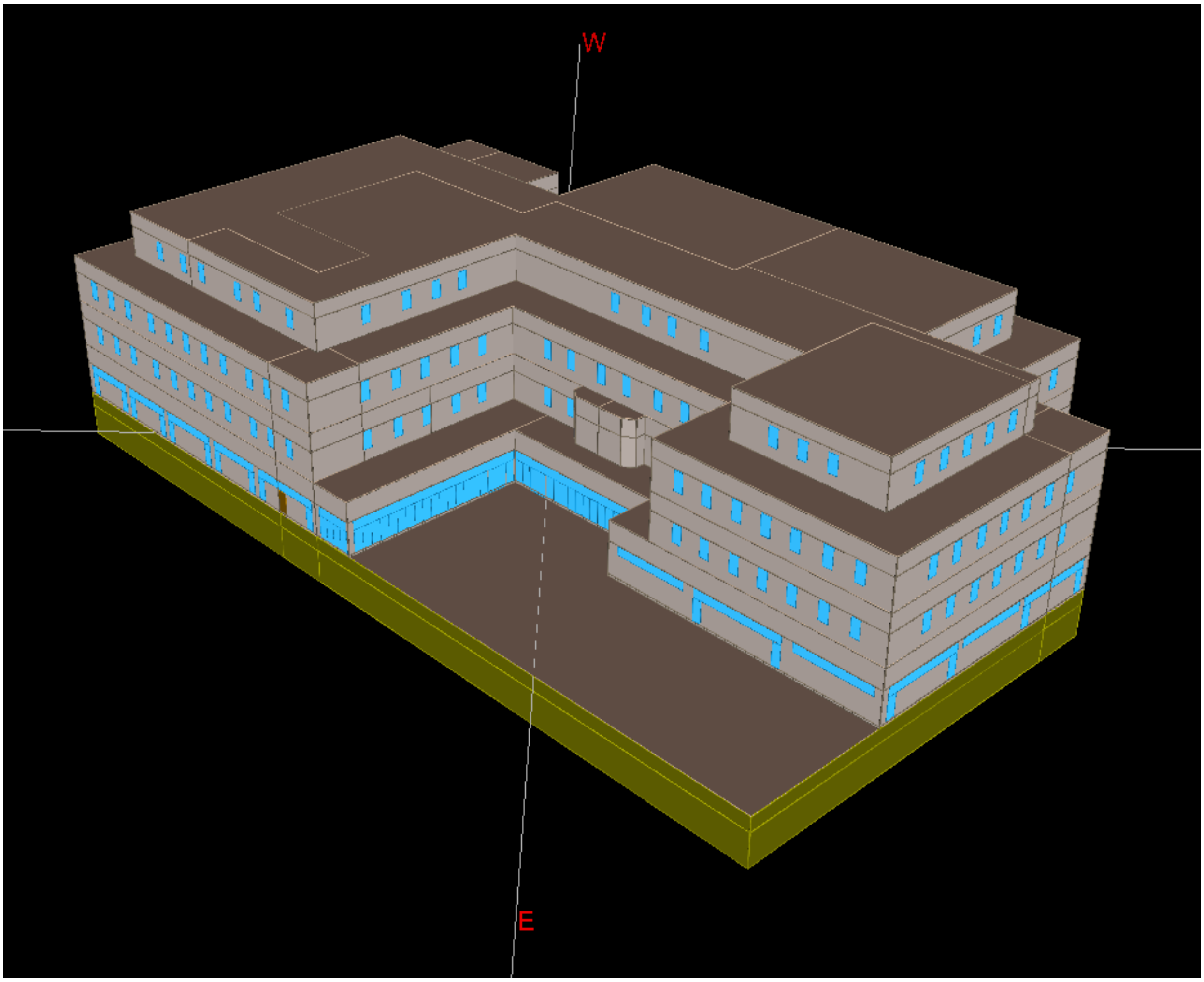

Fig. 8 (a) Building Energy Model rendered in eQUEST (viewed from east direction)

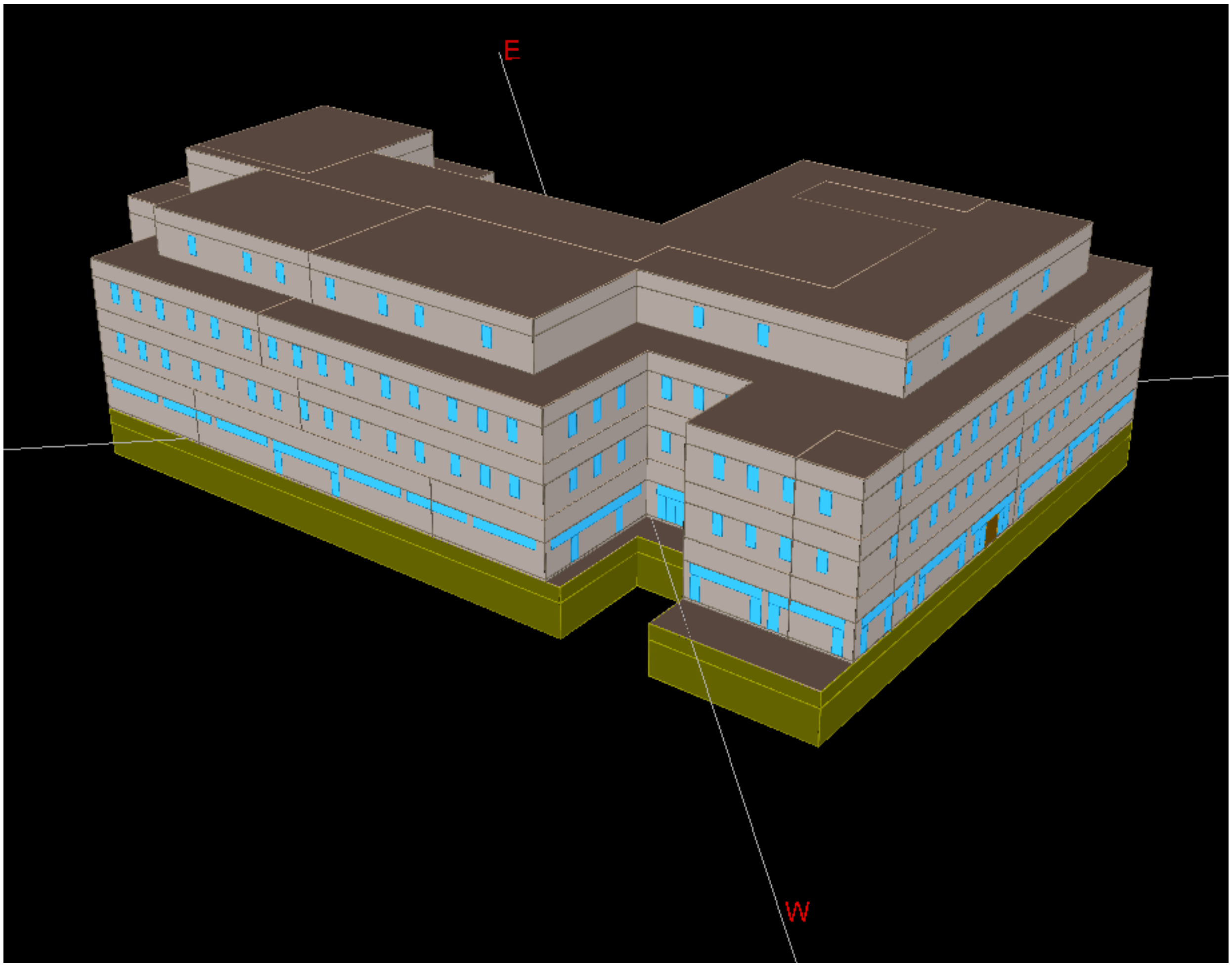

Fig. 8 (b) Building Energy Model rendered in eQUEST (viewed from northwest direction)

The energy model had a total of 30 thermal zones. Each thermal zone represented a space served, or not served, by an AHU on a given floor. Fig. 9 illustrates the thermal zone layout for level 1. Each zone was provided with unique VAV terminal specifications, exhaust capacities, and thermostats, if any, derived from the original mechanical drawings.

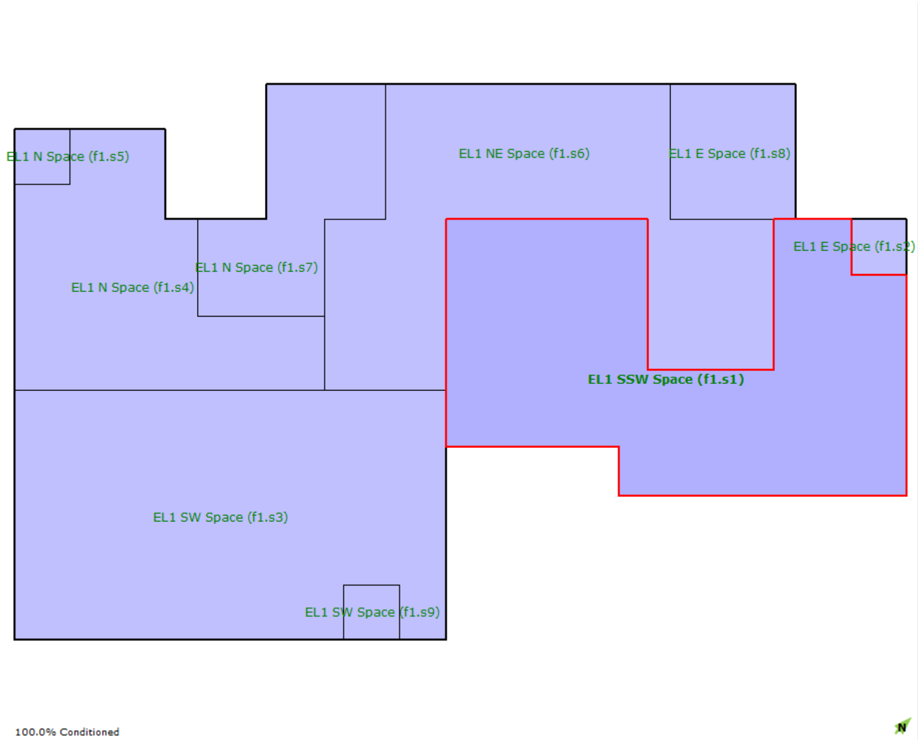

Fig. 9 Model thermal zone design (Level 1).

The main types of spaces defined - to specify the lighting & plug loads, occupancy, and their associated AHUs, were offices, courtrooms, lobbies, holding areas. These definitions were developed through the process of building comprehension.

eQUEST has two modes of data entry: “Schematic Design Wizard” and “Design Development Wizard”. Building envelope and boundary conditions, fenestration, and construction materials, space type definitions, occupancy & schedules, thermal zones, HVAC definitions and temperature set-point schedules, as well as equipment & lighting loads, were all entered using the “Design Development Wizard”.

Model Validation

Calibrating the baseline energy model to closely match the actual building energy consumption data is crucial. As discussed in an earlier section: *Utility Analysis and Benchmarking*, the main energy commodities are electricity and natural gas. Utility consumption data were averaged and compared to the eQUEST simulation results. Fig. 10 and Fig. 11 show the results of the baseline energy model’s monthly energy consumption as compared to the building’s actual monthly energy consumption data for both electricity and natural gas.

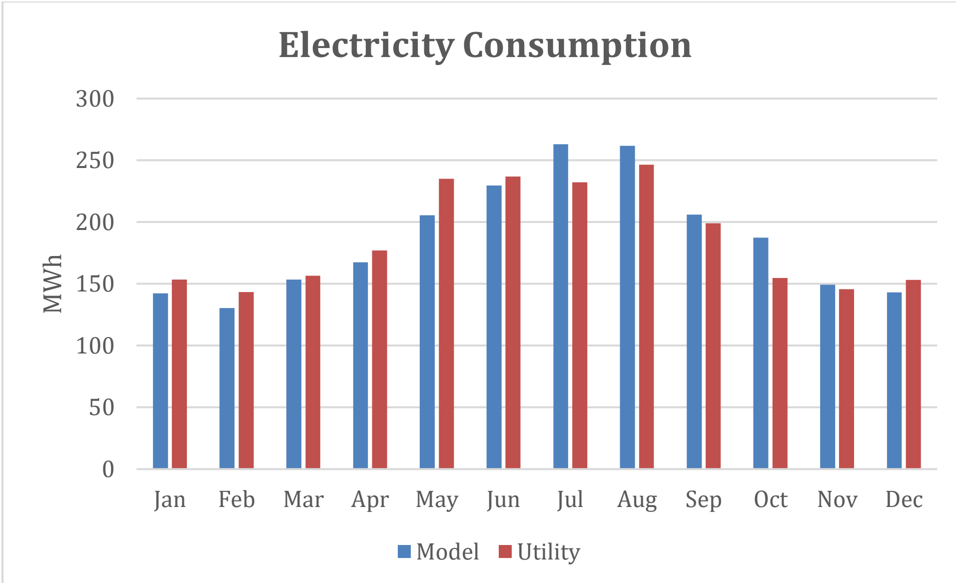

Fig. 10: Monthly electricity consumption comparison.

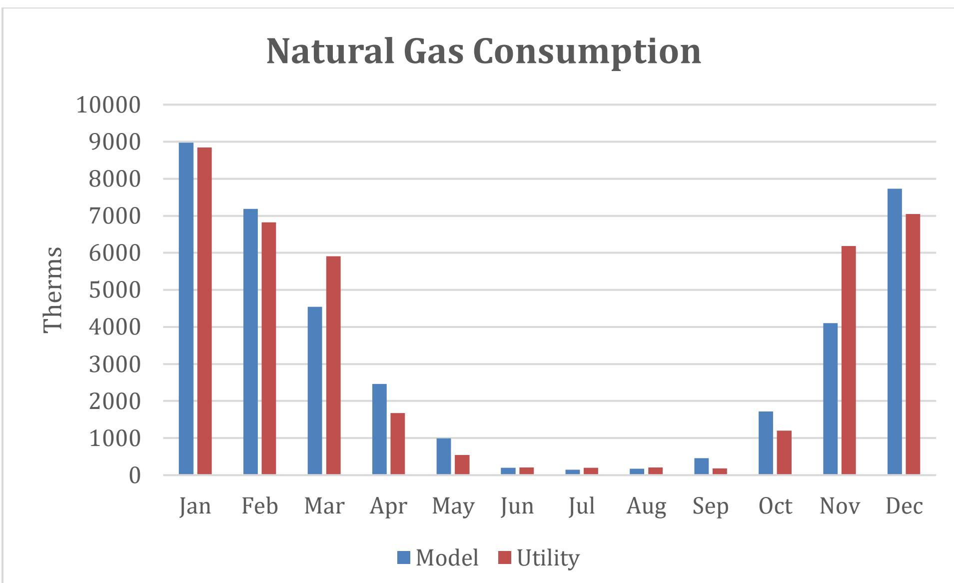

Fig. 11: Monthly natural gas consumption comparison.

The predicted monthly energy consumption from the baseline energy model closely matched the average monthly energy consumption reported by utility bills between 2017 and 2019. In the case of electricity consumption, the predicted values deviate from the average values of utility bills by ~0.6% per month (weighted average error), while the natural gas consumption values deviate by ~1.4% per month (weighted average error). This meets the ASHRAE calibration requirements as given by Guideline 14-2002 which allows a deviation of up to 15% [11]. The reason for the deviations in the electricity and natural gas consumptions may be due to discrepancies in the miscellaneous loads, occupancy, and scheduling of the building.

Energy Efficiency Measures

After the baseline energy model was validated, a series of actionable proposals aimed at increasing the building's energy efficiency were identified and simulated to estimate the energy and cost savings that will result from their implementation.

EEM 1 - Lighting Upgrades

The building currently employs fluorescent lighting. Most of the building is served by T8 fixtures and occupancy sensors. Upgrading these fixtures to LED solutions has multiple end-user benefits. LED lighting can yield significant energy savings while also reducing the maintenance and labor costs associated with fluorescent lighting. LED light fixtures have a longer rated life which would mean fewer costs associated with replacing them. This work would need to be contracted out as the lights would need to be retrofitted to fit LEDs.

Lighting control options further enhance the energy-saving potential of LED lighting. During the retrofit, controls such as daylight saving, occupancy sensing operation, and dimming can be integrated into the lighting system to yield energy savings. Transitioning towards LED lighting could yield energy savings of around 50% - 60%.

EEM 2 – AHU Setpoints & Schedules Update

The building occupancy schedule is from 8 AM to 5 PM on weekdays (Monday to Friday). But the building's Air Handling Units operate 24 hours a day, all around the year, at fixed temperature setpoints: between 72° - 74° F for cooling and between 68°F - 73°F for heating, depending on each zone's requirements.

As per our discussions with the Maintenance Supervisor of the building, the building gets too hot or cold if the AHUs are turned off or otherwise run with setbacks in their temperature setpoints during unoccupied hours. So, they are set to run all the time at their occupied setpoints, with the chillers and boilers being on intermittent mode of operation throughout the year, engaging and disengaging based on the net cooling and heating demands of all AHUs in the building.

We did not find setbacks defined in temperature setpoints of all AHUs for their unoccupied mode in the Building Automation System (BAS) - METASYS, but we noticed that one of them had its setbacks defined as 88°F for cooling and 60°F for heating. Another AHU had its high & low setpoints inverted for the discharged (supplied) air: 65°F as the high setpoint and 75°F as the low setpoint. These setpoints are also locked-out by the BAS system's configurators, preventing any changes to be made by the building operator.

Therefore, we would recommend correcting the above-mentioned errors in setpoints and updating the AHU schedules, so that:

- The AHUs operate at 77°F for cooling and 63 °F for heating during unoccupied hours, demanding lower cooling & heating loads from the chillers & boilers, while still keeping the building in a favorable range of temperature.

- As shown by the eQUEST simulation model, this EEM can also reduce the building's overall energy consumption considerably.

EEM 3 – Boiler Replacement

The boilers, installed in the basement level mechanical room. They are original to the building and were installed in 1983. From the manufacturer's specifications table for this series and capacity range, their efficiency can be calculated as 68%. Also, given that they are almost 4 decades old, their current operational efficiency should be much lower than 68%. We can see that from their rising natural gas consumption each year for the past few years.

Newer boilers are much more energy efficient, most of them being rated as at least 85% efficient. So, we defined an EEM with the boilers' efficiencies as 85% and simulated it for the building model in eQUEST. Evidently, it resulted in significant reductions in energy consumption and utility costs.

Energy Efficiency Measure Savings Summary

The Energy Efficiency Measures discussed above were simulated over the baseline energy model and the expected savings resulting from the implementation of these measures are summarized in the table below (Table 6). The table also includes the predicted savings of implementing all the EEMs simultaneously, labeled the "Combined EEMs". Note that the savings predicted by the "Combined EEMs" do not equal the sum of each individual EEM. This is an expected consequence of the interaction between multiple model parameters in a dynamic whole building energy simulation. The ability to model multiple energy efficiency measures simultaneously is another powerful feature of the whole building energy modeling. For the values shown in the summary table, the calculations were performed using the current chiller and boiler capacities.

Table 6: Energy and Cost Savings Summary

	EEM Simulated		Projected Energy Savings				Utility Savings*		
Energy Efficiency Measures (EEMs)	Electricity (MWh/yr)	Natural Gas (therms/yr)	Electricity (MWh/yr)	Natural Gas (therms/yr)	Electricity (%)	Natural Gas (%)	Electricity ($/yr)	Natural Gas ($/yr)	Total ($/yr)
EEM 1 - Lighting Upgrades	2126	39704	114	-1009	5.1	-2.6	11360	-1009	10351
EEM 2- AHU Setpoints & Schedules Update	2146	28731	93	9964	4.2	37.0	9300	9964	19264
EEM 3 - Boiler Replacement	2199	31903	40	6792	1.8	17.6	4020	6792	10812

Combined EEMs	1997	24363	242	14332	10.8	37.0	24230	14332	38562

***** The electricity rate considered was $0.10/kWh and for natural gas, the rate considered was $1/therm. These rates were estimated based on the utility analysis from EnergyCAP.

The annual electricity usage and natural gas usage derived from the Baseline model is 2239.1 MWh and 38695 therms, respectively. The total annual utility cost of electricity ($223,910) and natural gas ($38,695) is $262,605. The observed annual utility savings after implementing the EEMs are 14.7%.

Table 7: Carbon Footprint Analysis

	Projected Energy Savings		Carbon-dioxide Reductions	
Energy Efficiency Measures (EEMs)	**Electricity (MWh/yr)**	**Natural Gas (therms/yr)**	**Electricity (lbs./yr)**	**Natural Gas (lbs./yr)**
EEM 1 - Lighting Upgrades	114	-1009	83269	-11704
EEM 2 - AHU Setpoints & Schedules Update	93	9964	68169	115582
EEM 3 - Boiler Replacement	40	6792	29467	78787
Combined EEMs	242	14332	177606	166251

The carbon footprint analysis shown in Table 7 is estimated for a specific equipment efficiency, wherein the equipment degradation would result in an increase of carbon dioxide emissions for both the replacement and baseline equipment.

The above values are based on the State of Maryland estimates of 733 lbs. of CO2 emissions per MWh of electricity consumed based on 2019 data [14] and 11.6 lbs. of emissions per therm of natural gas consumed [15]. Implementation of all the EEMs would result in a reduction of 343,857 lbs. of carbon-dioxide emissions per year. However, it must be noted that the CO_2 emissions per MWh for the grid electricity source is projected to continue to drop over time (with a rate of 23 lbs./MWh per year until 2030 and 8 lbs./MWh per year afterwards) due to use of cleaner fuels and renewable energy sources. See Fig. 12 for more details.

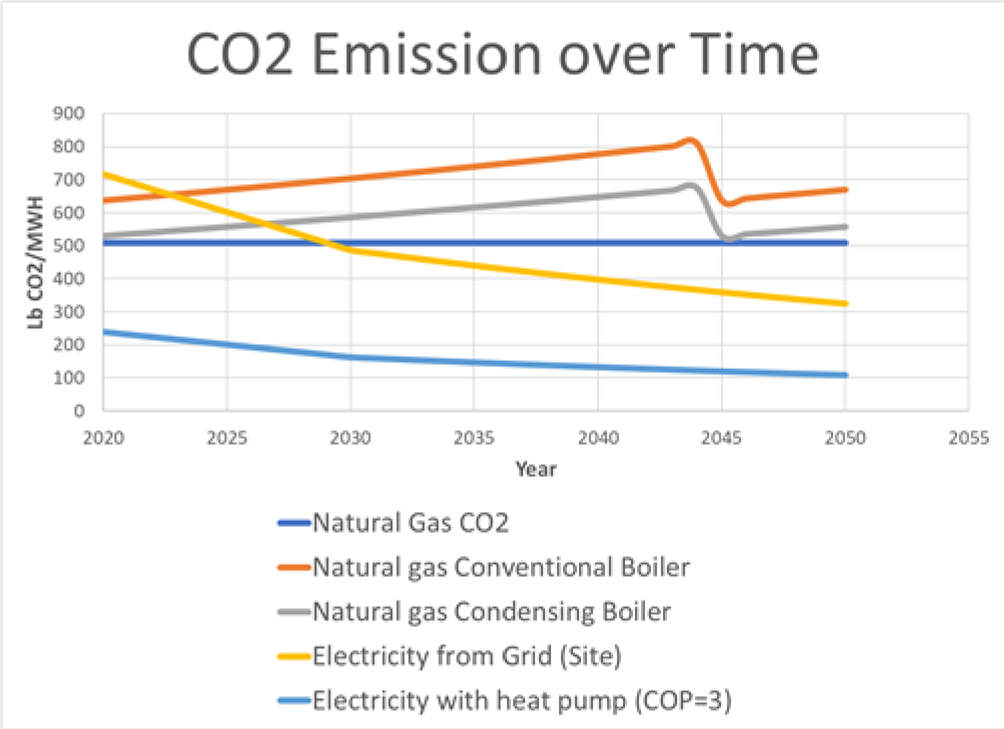

Fig. 12: CO_2 emissions over time

Rebate Savings Analysis

To offset the initial capital costs for these upgrades, utility rebate incentive programs can be utilized. Based on the information from Empower MD, since the Bel Air District Court is >75,000 sq. ft, it falls under the Large Building Tune-up category. Custom incentive tracks can be pursued where measures for the existing buildings include HVAC (rooftop units and in-room units), Variable Frequency Drives (retrofit constant speed fan and pump motors with VFDs, with incentives per motor HP controlled), and Prescriptive Lighting. Rebates can be classified into End-of-Life Replacement (up to 75% of the incremental costs for more efficient equipment, capped at $0.28/kWh saved annually) and Retrofit (up to 50% of the costs for more efficient equipment, capped at $0.28/kWh saved annually) categories.

The proposed EEMs must pass a cost-effectiveness test to be eligible for a custom rebate incentive. To evaluate rebate incentives for the proposed EEMs, the target kWh savings should be 1.5 to 2 times the dollar cost of the project. (Example: if the project cost is $100,000, then the target savings should be at least 150,000 kWh).

Additional Building Observations and Recommendations

Adding insulation to refrigerant lines for condensing units

During our walkthrough of the basement level, we noticed that the line carrying refrigerant to and from condensing units no. 2 & 3 in the garage, are missing the required insulation. Fig. 13 shows the uninsulated lines.

Fig. 13: Missing Insulation on Refrigerant-carrying lines

A lack of insulation results in unwanted heat transfer between the tubes and the surroundings, reducing the cooling capacity of the refrigerant by the time it reaches the evaporator coil in the air handing unit.

Therefore, adding insulation to the tubes will reduce thermal losses & energy consumption of the DX coil systems serving AHU 2 & 3, by increase their cooling efficiency.

Secured Closing of Windows to prevent excessive infiltration

During our walkthrough of the office spaces in the building, we noticed that most of the windows could be opened by the officers if they wanted to. The Maintenance Supervisor also mentioned that he has found that officers had kept windows open in the office space, which leads to an air pressure imbalance in the building, resulting in excessive infiltration and a loss of conditioned air.

Losing conditioned air directly translates into increased cooling and heating loads for the HVAC systems, thus increasing their energy consumption.

Hence, if locks can be added on the windows – so that officers would have to ask for permission from the maintenance supervisor before opening a window, then some amount of reduction can be ensured in the overall energy consumption of the building's HVAC systems, in comparison to the current conditions.

Green Wall

Adding Green walls in the lobby area of the building could be considered, to further condition the air in the space. A drip free indoor living wall option (for water containment) can be considered in the lobby. Green/living walls improve indoor air quality.

They naturally provide oxygen, humidity, and reduce particulates and volatile organic compounds. Additionally, studies have indicated plants increase productivity of the building's occupants, while improving their comfort level. Indoor living wall solutions provided by LiveWall could be considered for these areas in the lobby [16] (Fig. 14).

Fig. 14 (a): Areas in the lobby suitable for installation of Green Walls

Fig. 14 (b): Areas in the lobby suitable for installation of Green Walls

Future Scope

Building Decarbonization / Electrification Analysis

In 2018, direct greenhouse gas emissions from the residential and commercial building sector accounted for 12.3% of total U.S. greenhouse gas emissions [17]. Greenhouse gas emissions from this sector vary from year to year, often correlated with the seasonal fluctuations in energy use caused primarily by weather conditions.

Residential and commercial buildings use large quantities of energy for heating, cooling, lighting, and other needs. In 2012-2013, the median age of a U.S. home and commercial building was 37 years and 32 years, respectively. Slow turnover means that by the year 2050 much of the existing U.S. building stock will be 70 years old. Population and economic growth will also drive significant increases in the total building stock. Substantially decarbonizing the building sector requires steps in the near term to reduce the energy demand and carbon intensity of both existing buildings and new constructions. Replacing gas appliances with efficient electric appliances in existing buildings and constructing new buildings as all-electric is the primary approach to building decarbonization [18].

Electrification

Electrification of end uses will be a key pathway to reducing emissions. Assuming a decarbonized power sector, using electricity for heating, cooling, and hot water needs, instead of burning natural gas or fuel oil, can greatly reduce a building's emissions. Based on DGS's data on carbon emissions (Fig. 12, from above), by the year 2029, carbon emissions in lbs./MWh from the electricity grid will be along the same level as that from natural gas sources. This downward trend would continue after 2029 with CO_2 emissions from the electricity grid being less than that of natural gas sources. Heat pumps are currently one of the most, if not the most efficient available technology for space heating in the commercial and residential sectors. Although heat pumps have high initial capital costs, high efficiency and minimal maintenance make air source heat pumps a rewarding investment over the long term. Additionally, the CO_2 emissions for an electric heat pump is less than that of a natural gas boiler. Other existing renewable energy-powered thermal technologies such as geothermal heat pumps or solar water heaters can be installed as fossil fuel-powered replacements. Additional advancements in the heat pump for accommodating colder conditions could be adopted in the next few years.

Energy Efficiency

Buildings undergo several phases over their lifetimes, including design, construction, operation, and retrofits. In each stage, there are opportunities to improve energy efficiency and reduce emissions: designing a building to use more natural lighting or install district heating (like central Satellite Central Utility Building {SCUB} units in the UMD campus), sourcing construction materials that have less embodied carbon, changing consumer behavior and electricity usage patterns to reduce energy demand or planning major retrofits over the life of the building. Further areas where technological advances can increase energy efficiency include improving building envelopes and window insulation to control air and moisture and optimizing the cost and performance of LED lighting. Additional challenges include building occupants' lack of awareness and information about energy use, which could pave the way for further deployment of smart metering.

Electrification Analysis: Bel Air District Court

Currently, the Bel Air District Court & MSC satisfies its heating and cooling needs using traditional boilers and chillers. A previous section of this report discussed replacing the boilers with more efficient ones and their consequent energy savings. Here, an all-in-one Variable Refrigerant Flow

(VRF) system is discussed as an alternative technology to satisfy the building's heating and cooling loads, and further explore the scopes of building electrification.

VRF is an air-conditioning system configuration where there is one outdoor (condensor) unit and multiple indoor (evaporator) units. The term VRF refers to the ability of this system to individually control the amount of refrigerant flowing through every evaporator, enabling the use of multiple evaporators of differing capacities and configurations, individualized comfort control, simultaneous heating and cooling in different zones, and heat recovery from one zone to another. VRF systems operate on the direct expansion (DX) principle, meaning that heat is transferred to or from the space directly by circulating refrigerant through condensors/evaporators located near or within the conditioned space. Refrigerant flow control is the key to many advantages as well as the major technical challenge of VRF systems. Fig. 15 shows a schematic VRF arrangement.

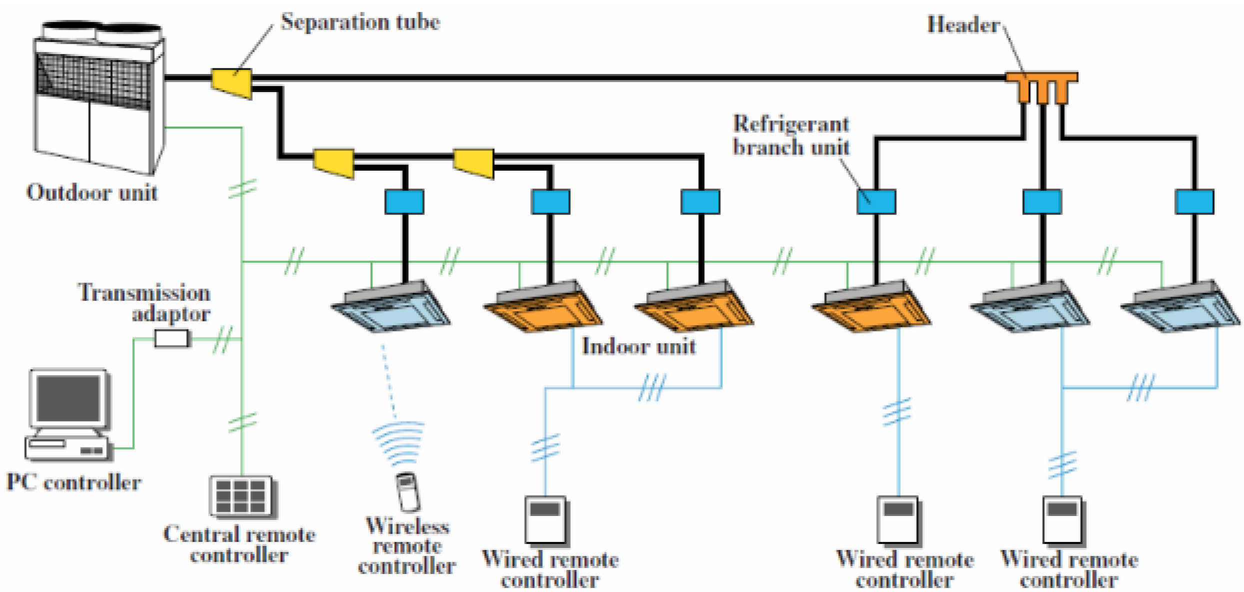

Fig. 15: A schematic VRF arrangement [19]

There are 2 types of VRF systems: heat pump and heat recovery. VRF heat pump systems permit heating or cooling in all indoor units but not simultaneous heating and cooling. VRF systems with heat recovery capability can operate simultaneously in heating and/or cooling mode, enabling heat to be used rather than rejected - as it would be in traditional heat pump systems.

All in one VRF systems such as the ones offered by Mitsubishi Electric can be considered for the Bel Air District Court building [20]. The City Multi products (R2 series, Y-series, WR2-series, WY-series) from Mitsubishi are designed for commercial applications. They provide zone control, design flexibility, quiet operation, hyper heating inverter (H2i), personalized comfort control, and simultaneous cooling and heating operations (R2 and WR2-series). The City Multi Controls Network (CMCN) enables control of multiple centralized controllers, and it can be utilized from any networked PC, tablet, or smartphone.

A VRF system could replace the current chillers and boilers of the building, and it would also enable progress towards the State of Maryland's future greenhouse gas and environmental goals, starting with Electrification of State Buildings and Elimination of Fossil Fuel Systems.

Future Renewable Energy Scope

Transitioning towards an all-electric system would not only help with the reduction of greenhouse gas emissions but also enable the opportunity to deploy renewable energy options at the site to supplement the energy demands.

Currently, the domestic hot water is supplied by a gas-fired water heater. A solar water heater can be installed on the roof to provide domestic hot water for the building, thus eliminating the need for natural gas altogether.

Solar PV panels can be installed at the site to provide supplemental electricity to the building. The solar system would need to be provided with a battery to offset the intermittent availability of sunlight throughout the year at the location. Using the NREL PVWATTS Calculator, an assumption of the system parameters can be made [21]. For example, at the Bel Air District Court, a 100 kW system can generate about 133,949 kWh/year of electricity. This system can be sized appropriately based on the available space at the site, preferably the roof. But since the available roof space at the courthouse is limited, further space can be explored near the site such as parking spaces or other open spaces. Further opportunities include purchasing renewable electricity from utilities wherein the sourced renewable energy could go hand in hand with the site renewable energy implementation. Rebate incentives can be claimed in the form of Solar Renewable Energy Credit (SRECs) [22], also called alternative energy credits in Maryland. SRECs are created for each 1000 kWh of electricity produced by a qualified alternative energy source. There is no specific size limit, but the systems generally must be connected to the distribution system serving the State, for qualifying.

Initial Scope of Work for EEM Implementation

	Current System or Specifications	**Proposed System or Specifications**	**Comments**
Boilers*	3418 MBH (1709 MBH each)	~3418 MBH	The two boilers combined represent a peak capacity of 33% over the peak load (2554 MBH); This seems reasonable when accounting conservatively for aging of the boilers and associated piping.
AHU Setpoints & Schedule Update	Operates with Fixed Temperature Setpoints.	Operates with Setbacks for the Temperature Setpoints	C: 77°F, H: 63°F; For periods of unoccupied operation.
Lighting	Fluorescent lamps	LED lamps	LED lamps, along with

			occupancy, daylight, and microphonic sensors.
Green Wall	None	1 or more	Install Green Walls

*The proposed capacity of the two boilers combined is some 33% higher than the building peak load requirements. Realizing the building uses two identical boilers, and with this 33% increased capacity some redundancy is built in and overall reasonable realizing the nature and mission of this building. Common practice seems to be (N+1) for commercial residential buildings.

Conclusions

The Mary E. W. Risteau District Court & Multi-Service Center is an interesting facility, being an old construction and still operating at better than the average levels for a public courthouse. The facility would benefit from a heating system upgrade on account of the boilers' age. Energy Efficient Measures were identified to upgrade the building's systems to newer technologies (such as LED lighting) and improve the building's energy-efficiency (by updating temperature setpoints for the HVAC system and installing newer boilers). The expected energy savings resulting from the implementation of energy efficiency measures will decrease the building's annual electricity consumption by 10.8% and natural gas consumption by 37.0%.

Detailed and accurate building energy auditing and modeling are highly involved processes, requiring substantial time, resources, and coordination. Buildings are complex systems whose behavior and energy consumption are often not understood without a thorough investigation of mechanical systems, electrical equipment loads, environmental conditions, and occupant behavior. The presented energy model in this report followed the above-mentioned important aspects. The generated baseline energy model detailed in this report can serve as a useful reference for several parameters applicable to a diverse range of courthouse facilities. This model can be further fine-tuned based on future developments to account for changes in the energy profile of the facility.

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