The Efficiency Comparison of Building HVAC Systems

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Introduction

The HVAC system maintains the atmosphere of a building. It is important for HVAC systems to be adequately sized and located, to ensure air quality standards and comfortable temperatures are maintained throughout the building. This research is a case study that takes a close look at such a system.

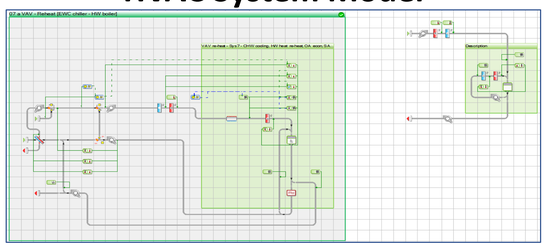
Aims + objectives

The objective of this project is to create an accurate building model based on an existing building design. This model will then be used to simulate heating and cooling loads and energy consumption as well as the efficiency of two differently sourced HVAC systems, in order to make a comparison and design decision. The software used to run this simulation is IESVE, which considers the location, orientation, and room function, to account for self-shading and internal gains. This will allow for a final recommendation to be made about the optimal system for the building.

Methodology

Step 1. Create the model geometry based off existing building design plans.
Step 2. Assign the location, orientation and define room usage for the model.
Step 3. Run heating and cooling load calculations.
Step 4. Based on the load numbers, size and create and HVAC system to service the building model.
Step 5. Run the energy consumption simulation of the HVAC system.
Step 6. Switch the source of the HVAC system.
Step 7 Re-run energy consumption simulation.
Step 8. Determine the efficiency of each system and compare.
Step 9. Provide a recommendation to client.

HVAC System Model

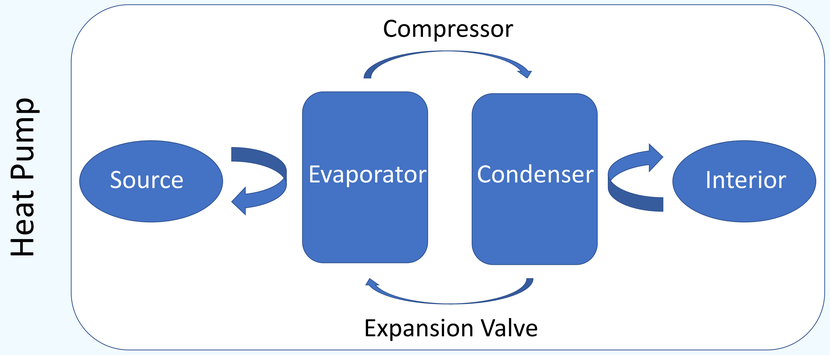


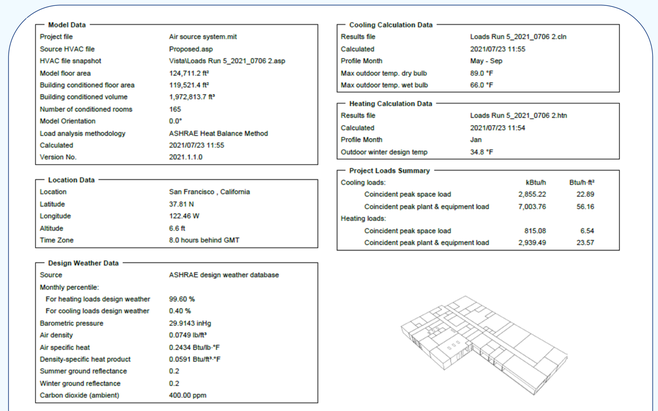
Air Source Energy Usage

	Interior Lighting (MBtu)	Receptacle Equipment (MBtu)	Space Heating (MBtu)	Service Water Heating (MBtu)	Space Cooling (MBtu)	Heat Rejection (MBtu)	Interior Central Fans (MBtu)	Exhaust Fans (MBtu)	Pumps (MBtu)
Date	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1	EUI Model 1
Jan 01-31	91.480	305.113	82.451	0.000	212.018	96.268	771.277	0.000	12.028
Feb 01-28	85.558	281.017	63.989	0.000	226.106	95.693	697.800	0.000	10.486
Mar 01-31	97.159	315.636	55.075	0.000	274.014	109.498	774.138	0.000	11.122
Apr 01-30	93.292	304.096	62.620	0.000	253.241	103.371	747.607	0.000	10.912
May 01-31	91.480	305.113	32.763	0.000	324.201	116.292	775.262	0.000	10.068
Jun 01-30	93.292	304.096	24.624	0.000	355.636	117.828	751.582	0.000	9.547
Jul 01-31	94.471	310.632	20.118	0.000	419.871	131.367	779.561	0.000	9.750
Aug 01-31	94.169	310.116	20.576	0.000	403.132	128.685	777.262	0.000	9.861
Sep 01-30	93.292	304.096	19.838	0.000	412.965	128.799	756.201	0.000	9.599
Oct 01-31	91.480	305.113	25.671	0.000	364.058	123.062	775.723	0.000	10.033
Nov 01-30	93.292	304.096	42.295	0.000	284.402	110.169	748.475	0.000	10.484
Dec 01-31	97.159	315.636	64.582	0.000	250.989	104.639	772.366	0.000	11.702
Summed total	1116.124	3664.759	514.601	0.000	3780.633	1365.671	9127.254	0.000	125.591

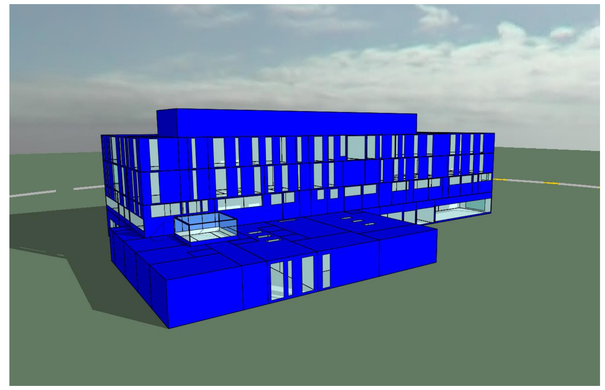
Water Source Energy Usage

	Interior Lighting (MBtu)	Receptacle Equipment (MBtu)	Space Heating (MBtu)	Service Water Heating (MBtu)	Space Cooling (MBtu)	Heat Rejection (MBtu)	Interior Central Fans (MBtu)	Exhaust Fans (MBtu)	Pumps (MBtu)
Date	EUI Model	EUI Model	EUI Model	EUI Model	EUI Model	EUI Model	EUI Model	EUI Model	EUI Model
Jan 01-31	91.480	327.673	69.547	0.000	116.093	56.624	696.069	0.000	19.526
Feb 01-28	85.558	301.986	51.613	0.000	130.973	57.438	629.157	0.000	20.119
Mar 01-31	97.159	339.343	45.559	0.000	165.861	67.138	696.847	0.000	23.059
Apr 01-30	93.292	326.890	51.736	0.000	152.774	64.784	674.137	0.000	22.845
May 01-31	91.480	327.673	24.106	0.000	203.303	67.720	693.174	0.000	24.685
Jun 01-30	93.292	326.890	15.696	0.000	236.732	72.266	672.160	0.000	27.345
Jul 01-31	94.471	333.793	8.155	0.000	290.218	77.355	694.761	0.000	34.037
Aug 01-31	94.169	333.223	8.683	0.000	274.177	75.129	692.115	0.000	34.339
Sep 01-30	93.292	326.890	8.834	0.000	291.760	77.168	673.544	0.000	33.410
Oct 01-31	91.480	327.673	15.830	0.000	233.452	73.258	692.151	0.000	27.854
Nov 01-30	93.292	326.890	32.756	0.000	171.171	65.395	670.750	0.000	24.044
Dec 01-31	97.159	339.343	53.895	0.000	150.100	64.268	695.542	0.000	23.275
Summed total	1116.124	3938.268	386.412	0.000	2416.615	818.544	8180.410	0.000	314.535





Building Loads



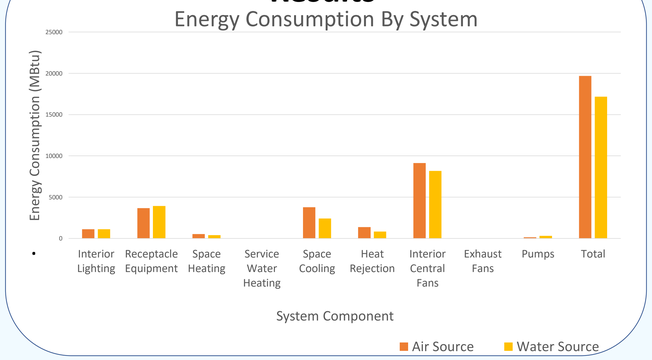
3D Model in IESVE

Conclusion

After running the energy-use calculations, the water source HVAC system was found to be more efficient. The water source system required 17171 Mbtus of energy for the year, while the air source system required 19696 Mbtus. The lower energy needs of the water source system can be attributed to smaller range in temperature of outside water sources compared to the larger range of outside air temperature throughout the year. In this case study, the energy consumption is a conservative value. Next steps in the project will be to alter the HVAC system model as the structural components of the building model are solidified. This will allow the energy consumption model to be more precise. The costs of the final HVAC systems will be calculated, and a final recommendation to the client will be made.

Further research areas of this project include altering the structural design of a building to maximize the system output in comparison to the size of the system. The modeling of a mixed-mode HVAC system would also allow for systems tailored to a buildings energy needs.

Results



Acknowledgements

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