13 Energy Analysis

13.1 Enthalpy Wheel

Using an enthalpy wheel greatly reduces the load on the building from ventilation air. This ventilation load is caused by the difference in temperature of the outside air and room air. By recovering heat and moisture from exhaust air, enthalpy wheels can reduce ventilation load by 80% (this report assumes an 80% efficient EW). Using TMY data from Portland, OR[j], the following charts show a typical heating and cooling day. The building is only ventilated during occupancy hours.

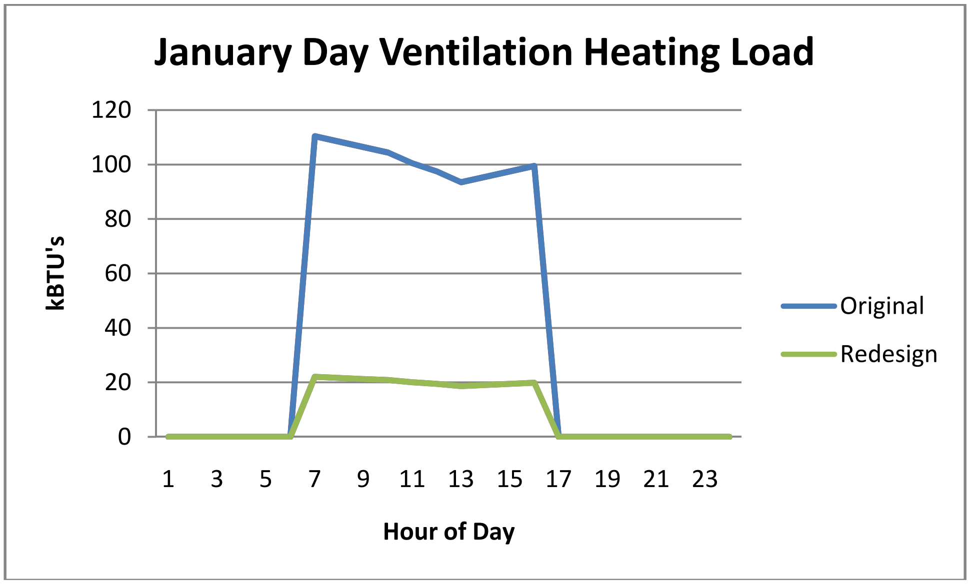

Figure 13.1.1. Ventilation heating load for January 19

Combining days over the entire year produces an annual energy saving as seen in the table below. Note most of the savings come in space heating. Assuming \$.08/kWh utility rate (Appendix H), yearly cost savings from the enthalpy wheel total **\$1,208**.

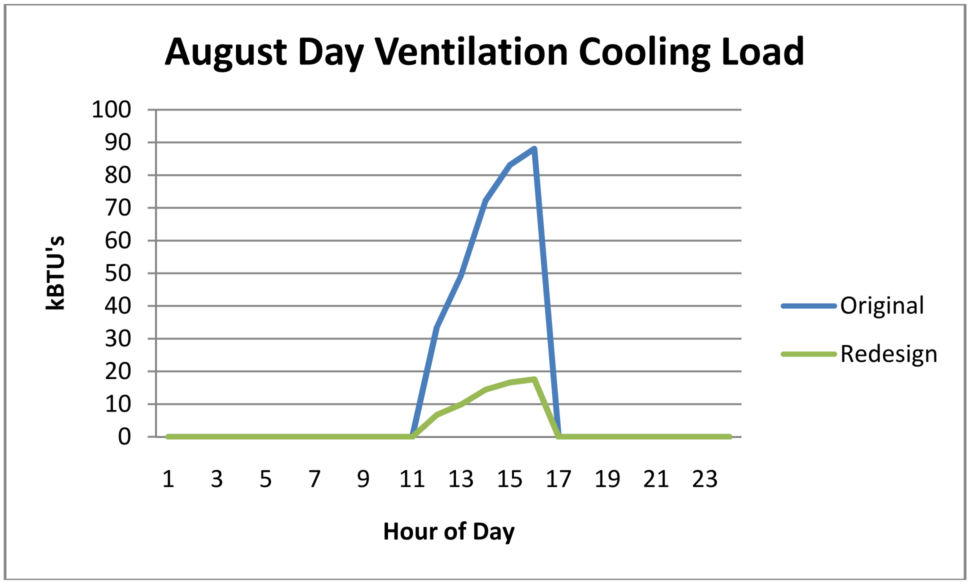

Figure 13.1.2. Ventilation cooling load for August 26

Table 13.1.1. Redesign Yearly Ventilation Savings

	Original	Redesign	Savings	Savings (per SF)
Total Heating Energy (kBTUx000)	252.8	50.6	202.21	4.35 kBTU/SF
Total Cooling Energy (kBTUx000)	11.1	2.2	8.9	.19 kBTU/SF
Energy to Heat Recovery Chiller[1] (kWhx000)	18.9	3.8	**15.1**	.32 kWh/SF
Heating Therms	2528	528	2000	.043 thms/SF

[1]Appendix G, COP = 4.1; also see equation 16.4

In addition to year round energy savings, the enthalpy wheel will also decrease the peak cooling load on the building. With a smaller load, chiller size can be reduced. Using the equation:

$$Q_{cooling}=1.08*CFM*(T_o-T_i) \tag{13.1}$$

One can see that a large change in ΔT will create a proportional change in load. With an 80% efficient enthalpy wheel, outdoor air temperature seen by the AHU reduces from 90F to 77.2F (assuming 74F indoor air, Section 6).

	Outdoor Air	Load (BTU/hr)	Savings
Original	90F	88300	
Enthalpy Wheel	77.2F	17660	**70640 BTU/hr = 5.89 Tons**

13.2 Fan Energy

The main advantage of DOAS is the reduction in fan energy. In the McKinstry Oregon Headquarters, supply air flow is as high as 36,000 CFM. By only supplying ventilation air, that can be reduced to a constant flow of 5,110 CFM. In addition, since the DOAS is a CAV system, there is no need for fans in the VAV units.

To calculate fan energy in for DOAS, one can assume constant volume for all occupied hours during the year. Using the following equation, one can calculate fan power, and from that yearly energy.

$$\text{Fan Power}_{kW} = P_{inwg}*Q_{CFM}/(8500*\text{Eff}_{fan}) \tag{13.2.1}$$

Efficiencies for supply and return fan are 63% and 42% respectively. (Jim Flores). Pressure drop is calculated from the longest duct run in the building. From Table 10.2 return and supply ΔP are 2.4” and .95” respectively. In addition, exhaust fans from the mechanical schedule also add to energy consumption (Appendix G).

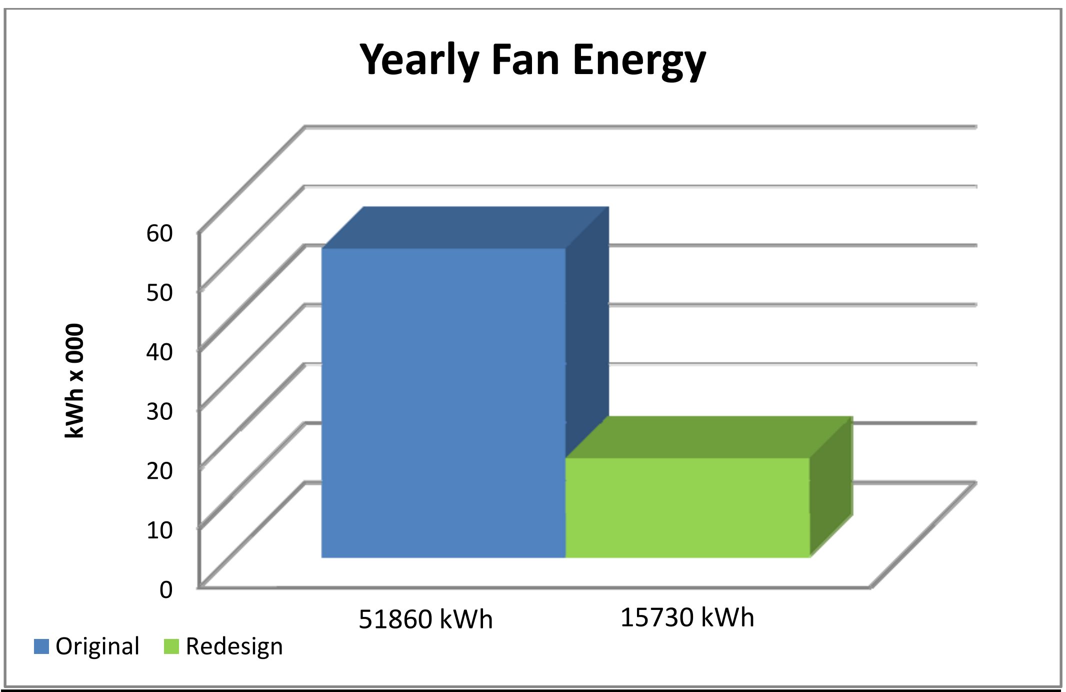

Figure 13.2.1. Yearly fan energy

Yearly savings comes to **36,130kWh**. The original fan energy value is based on the Energy Model built in Technical Assignment 2 (Wyczalkowski). Assuming $0.08/kWh utility rate (Appendix H), annual cost savings amount to **$2,890**.

14 Cost Analysis and Construction breadth

14.1 First cost analysis

All costs include area of future expansion.

DUCTWORK

With DOAS, the ductwork will be smaller because of reduced supply air. Appendix B shows detailed calculations and RS Means[k] costs for all of the ductwork in the main section of the first floor. By extrapolating SF costs over the entire building, one can find total savings.

Table 14.1.1. Original vs Redesign Ductwork Costs[1]

	Cost/SF	Total Cost	Savings
Original	$0.56	$26,042	
Redesign	$0.23	$10,426	**$15,615**

[1]Detailed Cost Breakdown in Appendix B

PIPING

Piping first costs will go up, because of the addition of chilled water pipes. Hot water pipes can be kept the same size as original, according to pressure drop tables[d]. In addition, the redesign includes steel[k] and PEX piping[L], where appropriate. With high copper prices, these alternatives provide additional cost savings to the owner.

Table 14.1.2. Original vs Redesign Piping Costs[1].

	Hot Water Piping	Chilled Water Piping	Total Cost	Savings
Original	$40,050	$0	$40,050	
Redesign	$30,990	$50,070	$81,060	**($41,010)**

[1]Detailed cost breakdown in Appendix C