Airside Efficiency – A Must-have ECM

Once in a while, a solution comes along that changes the status quo by jumping across technological barriers and providing exceptional value. And what if this product could uncap a resource to improve your bottom line and the health of your building?

HVAC systems can consume 30% of the total building energy needed in library, student union, and classroom facilities; and in laboratory and research facilities the HVAC energy consumption can be up to 60%. When one considers the data of traditional airside energy conservation measures (ECMs), simple paybacks range from low cost quick payback to capital intensive long payback. The ECMs range from simple strategies such as night setback and/or supply air reset to full air handler replacement or variable air volume from constant volume conversion. However, few ECMs deliver more than 35% savings for the entire university campus. Consider the ROIs on the projects listed below:

Project Name	Investment	ROI (years)*
Leading Cancer Research Center, New York	$7.9M	1.5 years

*After utility rebates

ROI for Selected Lab Improvements

Airside efficiency has arguably the most dramatic financial impact of any ECM when you consider on average, our airside efficiency projects have a payback of 2.5 years with an average of 38% energy reduction in buildings.

Airside Efficiency- Driving NPVs While Providing Data

The following list of energy conservation measures is taken as the average cost and savings from five recently completed Energy Service Performance Contracts (ESPC) located in the US. The spaces utilizing demand control ventilation (*ECM #11 in Table 1*) are primarily labs and vivarium. These type of critical spaces are high revenue producing but also energy intensive environments that consume 5x-6x energy compared to traditional office or academic space, and provide significant opportunities for increased profitability via airside efficiency improvements.

ECM #	ECM Description	Est Savings ($)	Est Cost ($)	Payback (Yr)	NPVs (NPV of Savings)	NPVi (NPV of Investment)	SIR*
1	Controls System Retrocommissioning	$ 116,678	$ 44,100	0.38	$ 942,080	$ 41,367	23
2	Install VFDs	$ 93,888	$ 471,346	5.02	$ 1,028,891	$ 442,133	2
3	Pipe Insulation & Sealing	$ 55,670	$ 294,969	5.30	$ 610,071	$ 276,688	2
4	Submetering	$ 29,645	$ 447,880	15.11	$ 239,360	$ 420,121	1
6	Building Envelope Upgrades	$ 13,840	$ 209,273	15.12	$ 111,743	$ 196,303	0.57
7	Condensate Heat Recovery	$ 15,494	$ 73,721	4.76	$ 125,100	$ 69,152	1.8
8	Motor Replacement	$ 22,565	$ 165,275	7.32	$ 279,996	$ 155,032	1.8
9	Equipment Maintenance and Control	$ 43,571	$ 240,933	5.53	$ 351,799	$ 226,001	1.6
10	Solar Air Heating	$ 13,443	$ 238,813	17.77	178,430	$ 224,012	0.80
11	Demand Control Ventilation	$ 2,829,544	$ 6,328,840	2.24	31,008,183	$ 5,936,593	5.22
12	VAV Conversion	$ 112,928	$ 2,063,162	18.27	1,498,944	$ 1,935,292	0.77
13	Cooling Valves Upgrades	$ 16,052	$ 181,410	11.30	129,610	$ 170,166	0.76
14	AHU Repairs	$ 53,876	$ 621,247		435,002	$ 582,744	0.75
15	Interior Lighting Upgrades	$ 599,865	$ 10,491,279	17.49	6,573,751	$ 9,841,054	0.67
16	Install VFDs on Pumps	$ 2,942	$ 53,332	18.13	32,240	$ 50,026	0.64
17	Airflow Measuring Station Upgrades	$ 1,440	$ 19,393	13.47	11,624	$ 18,191	0.64
18	Building Envelope Upgrades	$ 15,608	$ 217,418	13.93	171,049	$ 203,943	0.84
19	DHW Heater Optimization	$ 32,384	$ 799,665	24.69	429,847	$ 750,104	0.57
20	HRU Installation	$ 19,177	$ 628,964	32.80	210,151	$ 589,982	0.36
21	Kitchen Exhaust Fan Controls	$ 19,829	$ 517,849	26.12	217,304	$ 485,754	0.45
22	Install VFDs on Pumps	$ 9,081	$ 203,829	22.45	99,513	$ 191,196	0.52
23	Pre Heat PIC Valves	$ 2,126	$ 41,363	19.46	17,163	$ 38,799	0.44
24	Airflow Improvements	$ 438	$ 10,459	23.87	3,537	$ 9,810	0.36
25	Controls Retrofit (Valves)	$ 8,105	$ 359,717	23.92	65,438	$ 337,422	0.36
	Totals	**$ 4,011,509**	**$ 24,680,137**	**6.15**	**$ 43,961,009**	**$ 23,150,520**	**1.90**

Table 1, Average ECMs cost and savings including Demand Control Ventilation (ECM#11)

Assumptions: 10 year financed term, 3.5% interest rate, 4.5% discount rate.

When you consider the NPV of the savings and the investment over the term of 10 years, the differences in NPV for the ECMs with and without demand control ventilation (DCV) are as follows:

			Payback (Yr)	NPVs (NPV of Savings)	NPVi (NPV of Investment)	SIR*
Project with Demand Control Ventilation			**6.15**	**43,990,747**	**$ 23,175,581**	**1.90**
Project without Demand Control Ventilation			**15.53**	**12,952,826**	**$ 17,213,926**	**0.75**
Difference in NPV				**31,037,921**	**5,961,655**	

Table 2, Difference in Net Present Value in Project with and without DCV

The DCV option by far has the best savings to investment ratio of 5.22 and yields more than **$31M** in NPV over a 10-year term.

In our experience, owners have often applied basic strategies such as HVAC, night setback and supply air reset, so there is considerable opportunity for dramatic reduction via demand control ventilation.

Consider the following energy reduction metrics for the cancer research center, which labs were retrofitted with demand ventilation and variable air volume systems.

Savings			
Annual Occ Energy Units Saved		**Annual Occ Energy Cost Savings**	
Cooling kWh	1,479,699	Cooling	$ 207,158
Heating Therms	12,722	Heating	$ 29,838
Reheat Therms	57,498	Reheat	$ 101,139
Heating kWh	-		
Reheat kWh	-		
Supply Fan kWh	345,300	Supply Fan	$ 48,342
Exhaust Fan kWh	179,797	Exhaust Fan	$ 25,172
Total kWh	2,004,796	Total	$ 411,649
Total Therms	70,220		
Peak kW	2,588		
Annual Unocc Energy Units Saved		**Annual Unocc Energy Cost Savings**	
Cooling kWh	3,710,374	Cooling	$ 519,452
Heating Therms	46,120	Heating	$ 108,169
Reheat Therms	172,968	Reheat	$ 304,254
Heating kWh	-		
Reheat kWh	-		
Supply Fan kWh	852,934	Supply Fan	$ 119,411
Exhaust Fan kWh	644,701	Exhaust Fan	$ 90,258
Total kWh	5,208,009	Total	$ 1,141,544
Total Therms	219,088		
Peak kW	4,251		
Annual Total Energy Units Saved		**Annual Total Energy Cost Savings**	
Cooling kWh	5,190,073	Cooling	$ 726,610
Heating Therms	58,843	Heating	$ 138,007
Reheat Therms	230,465	Reheat	$ 405,393
Heating kWh	-		
Reheat kWh	-		
Supply Fan kWh	1,198,234	Supply Fan	$ 167,753
Exhaust Fan kWh	824,497	Exhaust Fan	$ 115,430
Glycol Pump kWh	-	Glycol Pump	$ -
Total kWh	7,212,804	Total	$ 1,553,193
Total Therms	289,308		50%
Peak kW	2,611		

Table 3, Energy Savings Metrics for Lab Retrofits, for Leading Cancer Research Institution in New York, Resulting in Approximately 50% Energy Cost Reduction

Optimized Ventilation and Data Driven Analytics

In past practice, facility managers and environmental, health and safety professionals typically set these spaces at fixed rates because they did not have the means to continuously monitor air contaminants such as TVOCs, particulates, and CO2 to determine the optimal airside efficiency. Laboratory ventilation rate guidelines are usually applied as constants, with the chosen ventilation rate rarely dynamically controlled or otherwise tailored to the occupancy or conditions of the lab. This practice neither optimizes energy efficiency nor safety. Some guidelines simply recommend a range of 4 to 12 air changes per hour. The result can be excessive ventilation, and on top of that, no data driven analytics.

For example, the airside efficiency program reflected in table 3 is based on retrofitted spaces which were initially operating at fixed air change rates of 9.3 for labs and 20 for vivarium spaces. Through DCV, the air change rates were optimized and now operate safely at 6 air change rates for labs and 8 for vivarium spaces. This yields approximately 50% energy reduction for the building! Meanwhile facility managers and EH&S now have data on the operation and use of their buildings.

Healthy Buildings

Airside efficiency is an ECM that goes beyond impressive energy savings- it improves the indoor environment for occupants as well. Historically commercial buildings have been ventilated with fixed amounts of fresh air and are commonly over ventilated during low occupancy and under ventilated during full occupancy. The problem with fixed rates is building occupancy is diverse and occupants require the proper amount of fresh air for healthier environments and optimal productivity. During the energy crisis in the 1970's, building owners in that era recognized the high cost of ventilation and took matters in their own hands and limited ventilation. ASHRAE recognized this and this lead to increased fresh air requirements via ASHRAE 62.1. To go even further, USGBC recognized increased concentration of key pollutants including particles, nitrogen oxide, volatile organic compounds, and allergens affected occupant productivity and maintained that better IEQ led to a decrease number of self-reported symptoms (Joseph G. Allen, 2016). Buildings today can be challenging environments to provide proper environmental control, so why would we want to statically control fresh air delivery for buildings that are increasingly diverse?

Airside Efficiency solutions provide the flexibility required to effectively monitor the indoor environmental quality and then inform building management systems about changing conditions to properly adjust HVAC settings. The result is the right amount of ventilation for almost all types of situations. This leads to healthier buildings, more productive employees and ultimately a building that is more profitable as well.

References

Joseph G. Allen, 1. P. (2016). Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation,. *Environmental Health Perspectives*, 806-812.

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After spending 18 years as a merchant marine and then power industry, Rob transitioned into the field of performance contracting. During his time in that field he worked for Johnson Controls, Honeywell EMCOR and NORESCO. Rob is currently a strategic account manager for Aircuity and is in charge of developing strategic accounts and partners in Healthcare, Higher Ed, and Life Sciences markets in New York and the Southeast.