Whitestone Report

A Recent Whitestone Study of Energy-Saving Retrofits has Lessons for Other Green Projects

A recent study for a U.S. Department of Energy National Laboratory assessed the cost effectiveness of achieving federally mandated energy savings for an older building. Energy performance and cost data for newer technologies required extensive primary research. While proposed changes affected all building systems, over 75 percent of energy savings came from modifications to HVAC equipment.

This study evaluated the life cycle cost effectiveness of alternative combinations of energy-saving components for a laboratory at the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL).

Life Science Research Laboratory
- Built in 1970
- 115,000 GSFT
- Three floors of biological research and administrative space

Following an extensive review of energy-saving options, two alternative retrofit projects were specified by partner firm Jacobs Engineering. The first alternative had a lower initial cost, while the second had a higher initial cost but substantially greater energy savings. The second alternative's energy savings exceeded the 30 percent reduction mandated by recent Federal legislation.[1]

Table 1. Energy Reduction of Alternatives

Alternative	Initial Cost	Component Change*	Energy reduction from FY03
Alternative 1	$2.3 mil	Reflective coating to built-up roof, Double glazed windows, Water heater turbocharger, VAV air handlers, Secondary transformers, Variable volume exhaust hoods	16%
Alternative 2	$3.4 mil	Green roof w/ growing medium, Triple glazed windows, Water heater turbocharger, Heat recovery chiller, Variable volume fancoil system, Secondary transformers, Variable volume exhaust hoods w/ occupancy control	35%

* Some component changes not listed

Life cycle costs of the alternatives include initial installation, maintenance and repair (M&R), and energy consumption discounted over a 40 year period. M&R costs were estimated using the MARS Facility Cost Forecast System for the existing building and alternative component inventories. Calculations of energy consumption recognized direct energy savings (from energy-consuming equipment) and indirect savings (such as reduced heating and cooling loss from triple glazed windows). Notably, over 100 interviews and secondary sources, and a variety of models were required to obtain the necessary energy performance and cost data.

The analysis showed that the second alternative was the lower cost alternative—12 percent less than life cycle costs for the current building configuration and 16 percent than alternative 1—despite the higher initial cost. The rankings were robust, even when evaluated using the shorter investment period (25 years) and lower discount rate (2.6 percent) usually used for non-energy projects.[2]

Not all of the changes in alternative 2 were found to be cost effective. Much of the savings came from modifications to mechanical equipment; while changes to roof coverings (green roof with growing medium) and transformers would not recover their installation costs with subsequent operations savings.

Table 2. Annual Energy Savings by Building System

		Alternative 1		Alternative 2	
Uniformat	Title	Change in Energy Consumption (kBTU)[A]	Energy Savings[B]	Change in Energy Consumption (kBTU)	Energy Savings
B2020	Exterior Windows	-1,255,298	$18,783	-1,286,485	$19,250
B2030	Exterior Doors	0	$0	-193,833	$2,900
B3010	Roof Coverings	-37,056	$554	-118,089	$1,767
D2020	Domestic Water Distribution	-19,546	$1,036	-127,047	$2,292
D3030	Cooling Generating Systems	-91,799	$1,374	-2,679,807	$40,098
D3040	Distribution Systems	-4,828,006	$72,241	-13,333,982	$199,516
D3050	Terminal & Package Units	-240,211	$3,594	3,503,549	-$52,424
D5010	Electrical Service & Distribution	-6,582	$117	-18,934	$338
D5020	Lighting & Branch Wiring	-85,602	$1,528	-199,603	$3,562
E1010	Commercial Equipment	-31,935	$570	-31,935	$570
E1020	Institutional Equipment	0	$0	0	$0
Total[C]		**-6,596,036**	**$99,797**	**-14,486,167**	**$217,869**

[A] Change in Energy Consumption is the total annual change in energy requirements between the alternative building inventory and the baseline.
[B] Energy Savings is the total annual savings in energy costs from a decrease in kBTU consumption.
[C] All costs expressed in $2008.

[1] The Energy Independence and Security Act of 2007 requires a 30 percent reduction in energy consumption by 2015, calculated from a FY2003 baseline.

[2] OMB Circular A-94 specifies a discount rate of 2.8 percent for evaluating energy projects. The Energy Independence and Security Act of 2007 specifies a longer study period —40 years—for energy projects than the 25 years specified by OMB.

The findings from this study provide a number of lessons for the evaluation of similar projects in the future.

- Federally-mandated reductions in energy consumption of 30 percent by 2015 can be implemented in a cost effective way for older buildings, at least for facilities similar to our case study.
- Much of the necessary energy performance and M&R cost data for energy-saving components is not readily available and requires primary research.
- Not all energy saving changes in a retrofit project will be cost effective.

References

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