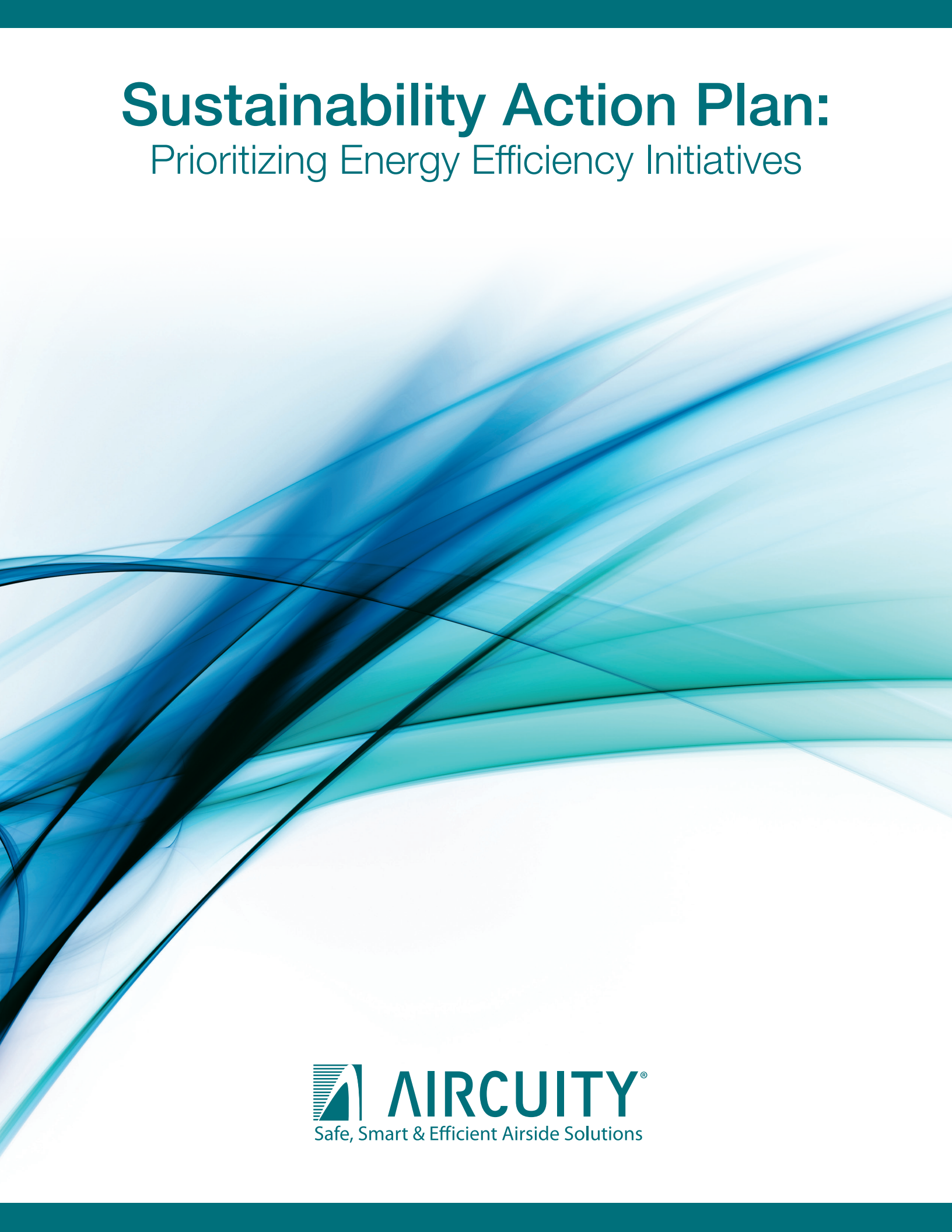
Sustainability Action Plan:

Prioritizing Energy Efficiency Initiatives



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Sustainability Report

Targeting CO_2 Reduction across Campus

Over 670 colleges and universities have taken a leadership role in CO_2 reduction efforts to make a positive impact on climate change. By publicly committing to reduce their CO_2 emissions, higher education institutions are leading by example rather than simply exploring this very real issue in a purely theoretical manner. As institutions research strategies, implement and analyze the true impact of those efforts, and teach others thru specific sustainability curriculum, they not only make a direct impact on greenhouse gas emissions, they provide tremendous leverage by educating a generation of "green thinkers" who are not only sensitive to world climate change, but are equipped with the tools to make significant positive changes.

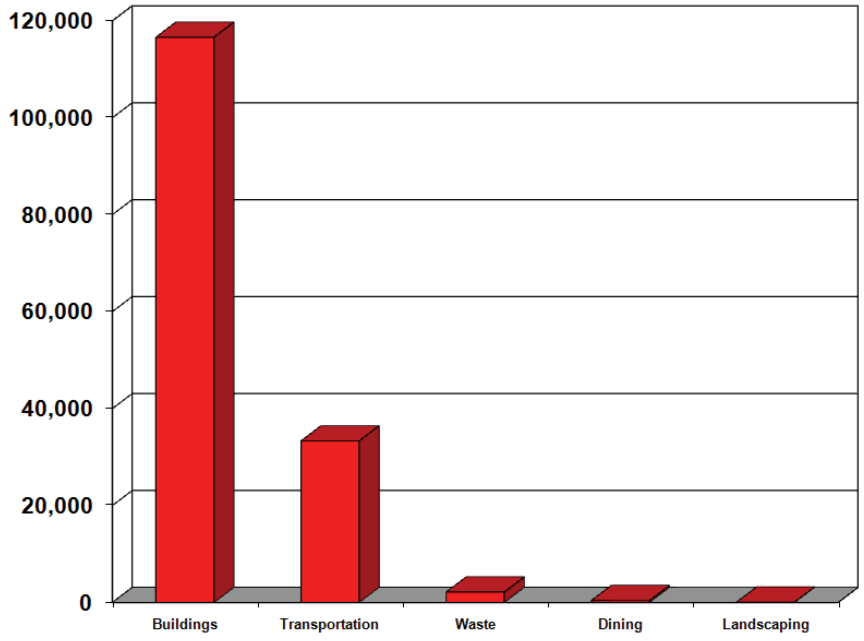
Although many strategies to mitigate CO_2 emissions will inevitably overlap, energy efficiency projects should take priority over alternative energy purchases. It should be self-evident that energy efficiency projects that significantly lower energy consumption deliver savings that help fund further efficiency initiatives. Put another way, energy efficiency is the greenest of all green strategies.

Achieving *absolute* CO_2 reduction is made even more difficult by the growth of colleges and universities and the increased use of electrical power throughout a campus. Sustainability action plans need to address the emissions created from existing buildings, new construction projects, and higher energy intensity (watts used per square feet). This study focuses on energy conservation measures applied to buildings, using a "typical" college campus in terms of size, location, and building types.

Focus on Reducing Building Energy Consumption

College carbon footprint inventories clearly show that building energy use is by far the largest source of carbon emissions. The chart below shows the FY 2007-2008 carbon footprint inventory for the University of Delaware. Approximately 76% of the university's CO_2 emissions came from buildings.

***Buildings** are the largest source of carbon emissions on a campus.*



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Which Buildings to Focus on First?

Energy use can vary widely by building type and use. Office and general classroom space have less energy requirements than student unions or libraries, with laboratories being the most dominant energy consumer by a large margin. At the University of Delaware, laboratories occupy just under 19% of the total campus square footage but account for over 43% of the total carbon footprint.

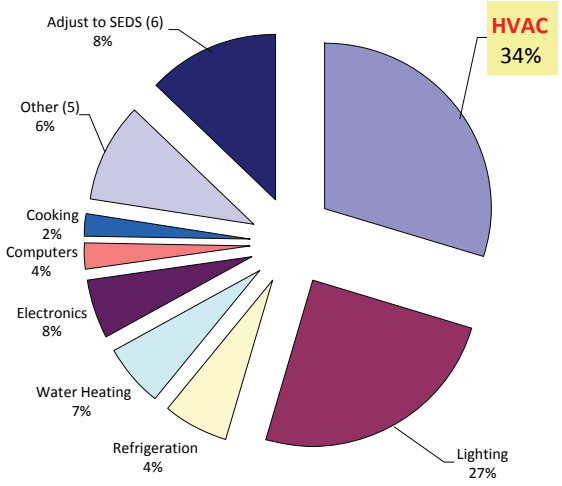
Laboratories have the largest CO_2 footprint on a campus.

Building Type	Sq Ft	% of Campus	CO_2	% of CO_2
Dormitory	1405	25.1%	40003.05	16.6%
Laboratories	1052	18.8%	104434.99	43.2%
Classrooms	813	14.5%	19025.15	7.9%
Parking Garages	595	10.6%	317.83	0.1%
Sports Buildings	496	8.8%	15729.31	6.5%
Offices	386	6.9%	14669.95	6.1%
Student Centers	263	4.7%	18781.33	7.8%
Libraries	252	4.5%	9501.53	3.9%
Cultural Center	181	3.2%	7474.76	3.1%
Dining Halls	165	2.9%	11561.5	4.8%
Total	**5608**	**100.0%**	**241499.4**	**100.0%**

Which Energy Conservation Measure to Pick?

Measuring the energy use within a building reveals that the two dominant energy drivers are HVAC and lighting, which combined account for 50-60% of a building's energy use. Energy efficiency measures in these two areas alone can provide significant impact on a campus energy reduction plan. For example, a 10-20% reduction in HVAC energy cost will translate into a 3.5-7% reduction in overall building energy consumption, while a 30% reduction in computer use would net only 1.2% in building energy use.

Commercial Building End Energy Use



Source: 2008 Buildings Data

Further consideration also needs to be given to the current state of technology within each building to accurately predict the remaining efficiency potential. Many colleges have already implemented lighting retrofit programs involving more efficient lighting and motion detection, which may limit the potential return of further lighting enhancement projects.

*Implementing energy efficiency solutions directly reduces a building's **HVAC** costs.*

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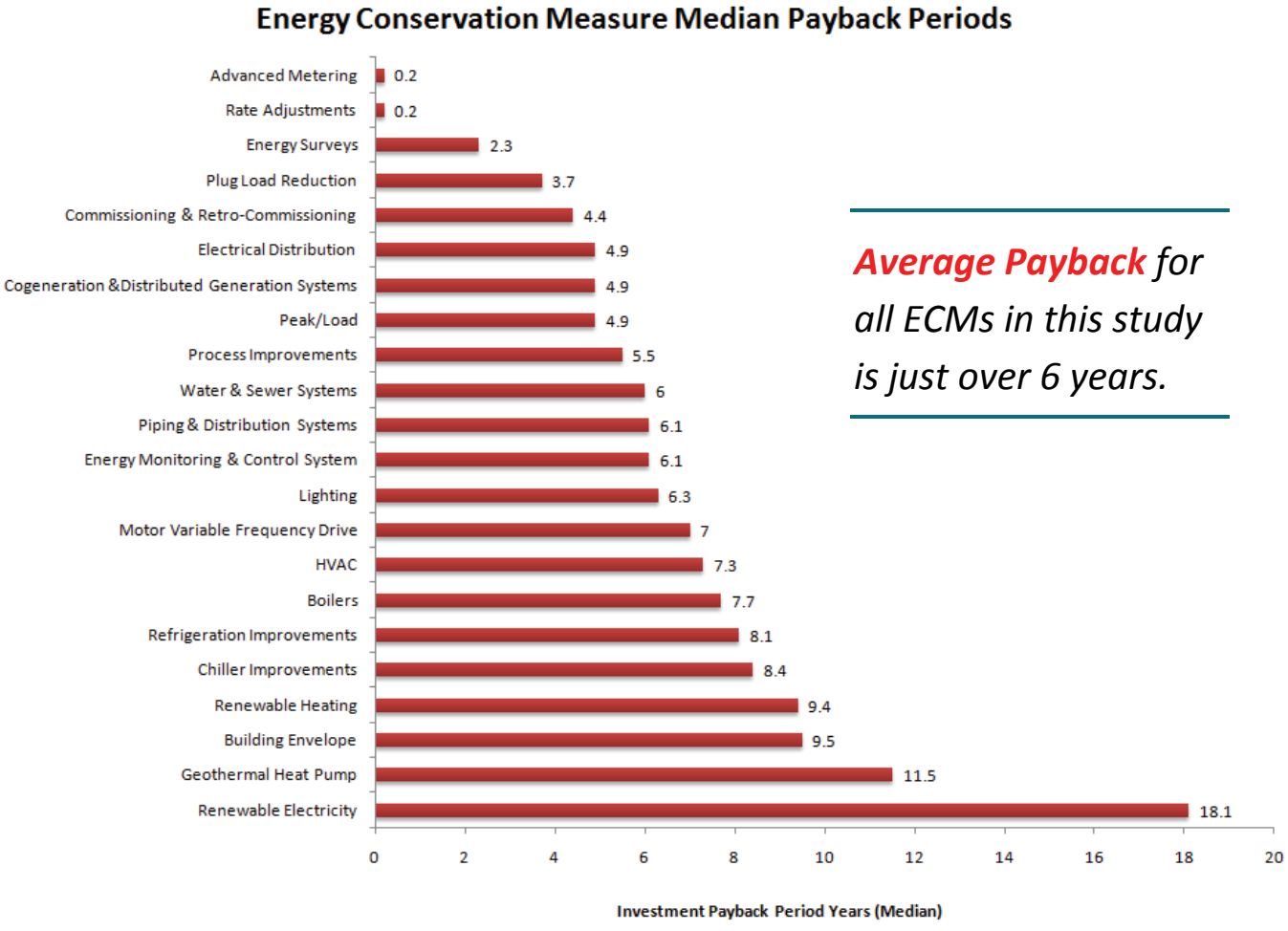
Comparing Energy Conservation Measures

There is no simple formula for evaluating every possible energy conservation measure as the exact impact and return on investment will vary from campus to campus and even from building to building. New construction offers a different palette of choices from energy retrofit projects, which can further complicate the development of an overall sustainability plan.

The Department of Energy researched a wide range of different energy conservation strategies to calculate the expected return on investment. This data was presented in congressional hearings in January of 2010 and is summarized in the chart below. The study identified initiatives such as advanced metering to have very rapid payback, while renewable electric had the longest median payback. Unfortunately, this data did not include the impact, or reduction potential, of each conservation measure.



***Average Payback** for all ECMs in this study is just over 6 years.*

Data is based on research conducted by the D.O.E.
http://www1.eere.energy.gov/office_eere/testimony_kidd_012710.html

To obtain detailed information about the potential impact and payback of energy conservation measures requires a specific building example. The following table lists 9 different energy saving strategies developed for a new construction project of an animal research facility. The study examined the trade-offs associated with the cost of each measure related to their energy savings impact. This data clearly shows that not all energy savings strategies will provide adequate savings to warrant implementation.

Summary of Energy Analysis Options

Option:	Description:	Annual Energy Cost Savings		Simple Payback
		Dollars:	Percent:	(Years):
	Building Rotated 90 deg. (facing East)	$ (1,495.00)	-1.10%	No Payback
Building Rotation	Building Rotated 180 deg. (facing South)	$ (1,903.00)	-1.40%	No Payback
	Building Rotated 270 deg. (facing West)	$ (2,942.00)	-2.20%	No Payback
	Improved exterior walls	$ 1,308.00	1.00%	9.6
Walls	More improved exterior walls	$ 1,613.00	1.20%	21.6
	Most improved exterior walls	$ 2,270.00	1.70%	18.7
	Improved windows	$ 521.00	0.40%	2.3
Windows	More improved windows	$ 865.00	0.70%	2.2
	Most improved windows	$ 1,128.00	0.80%	2.1
	Improved roof	$ 281.00	0.20%	47.8
Roof	More improved roof	$ 892.00	0.70%	17.5
	Most improved roof	$ 1,724.00	1.30%	9
Lighting	Alternative lighting approach	$ 4,604.00	3.50%	Immediate
	Reduced ceiling height (9'-6")	$ 2,166.00	1.60%	Immediate
Ceiling Height	Reduced ceiling height (9'-0")	$ 4,393.00	3.30%	Immediate
	Reduced ceiling height (8'-6")	$ 6,375.00	4.80%	Immediate
More Efficient	High-efficiency chillers and boilers	$ 7,959.00	6.00%	5.7
HVAC	High-efficiency air handling units	$ 10,628.00	8.00%	4.4
Heat Recover	Flat plate heat exchanger heat recovery	$ 1,282.00	1.00%	41.4
	Enthalpy wheel heat recovery	$ 13,411.00	10.10%	3.7
DCV	Demand-controlled ventilation	$ 26,926.00	20.20%	1.8

Data is based on research conducted by The Clark Enersen Partners for vivariums.

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Demand Control Ventilation: An Overlooked Opportunity?

One strategy for reducing HVAC energy (and the carbon emissions associated with that energy use) is to vary the amount of ventilation based on the actual demands of that facility. Many building ventilation systems have calculated ventilation rates that are based on a theoretical occupancy level that is quite often much higher than actual occupancy. This creates a situation where a building is "over-ventilated" wasting energy by heating, cooling, and moving air throughout a building when it isn't needed. Using sensors to detect actual occupancy levels and using that information to control ventilation rates is called demand control ventilation (DCV).

DCV strategies can be successfully deployed in any college/university facility that has varying occupancy (student centers, arenas, libraries, etc.). More sophisticated DCV systems not only detect CO_2 levels to control ventilation based on occupancy, they detect other indoor environmental quality parameters to achieve energy reduction while maintaining a comfortable and productive environment.

Laboratory facilities are great candidates for DCV because they typically use 100% outside air, and they operate at relatively high air change rates. Using multi-parameter sensing technology, air change rates can be kept low when the laboratory air is clean (which is the case more than 90% of the time) and the airflow can be raised when contaminants or occupancy requires additional ventilation. The cost savings of these systems is so significant that simple payback is typically achieved in 1-3 years. The chart below shows two different facilities at the University of Pennsylvania that implemented lab DCV and measured absolute savings for an entire year.

Penn Facility	Building Size	Installed Sq Ft	Steam/BTU Savings	Power kWh Savings	Chilled Water BTU Savings	% CO_2 Reduction	ROI Payback
Lynch Laboratory	110,000 GSF	4,199	506,900,724	24,139	200,522,015	17%	**2.5 yrs**
Hill Pavilion Vivarium	125,000 GSF	1,979	778,590,481	38,322	210,444,980	42%	**1.7 yrs**

Rapid Payback *allows schools to reinvest capital towards additional sustainability projects.*

Overcoming Financial Barriers

One of the biggest obstacles to maintaining forward momentum on a sustainability plan is access to capital. Initial financial outlays may be significant for some energy conservation measures, and replenishment funding may be based on the energy savings of each completed project.

Implementing a DCV strategy across a college campus leverages financial resources by providing the biggest CO_2 reduction with the fastest return on investment thru lower energy costs. Facility managers will develop multi-year plans for phasing in energy retrofit projects across campus, and rapid payback of DCV projects will allow for capital expenses to be "recycled" to cover these costs every few years.

Summary

Successful sustainability action plans will focus on energy reduction as a first priority, starting with the highest energy buildings. When examining the impact and payback of different energy conservation measures, general savings data must be followed up with specific analysis of each building due to the wide variance of results based on building type, geography, and other location specific parameters. Finally, demand control ventilation should be examined as a part of any campus-wide sustainability action plan as it may very well be the most significant ECM that can be implemented on a college or university campus.