

Columbia University PlaNYC Challenge
Summary: Baseline Greenhouse Gas Emissions Inventory 2005-06 and Action Plan
October 23, 2008

As a participant in the PlaNYC Mayoral Challenge, Columbia University agreed to reduce its greenhouse gas emissions for its Morningside campus and residential properties by 30% per gross square foot from the baseline year of July 2005-June 2006. This action plan anticipates that Columbia University will reduce 78,765 metric tons of carbon equivalent (MtCO₂e) by the year 2017. The University's proposed action plan for the Morningside Campus and residential properties is set forth in the table immediately below:

Columbia University PlaNYC Challenge Proposal							
Action Plan Summary							
Definition	Value	Formula/ Variables					
Baseline CO ₂ emissions (MtCO ₂ e)	160,508	A					
Baseline total square footage (GSF)	10,235,743	B					
Baseline CO ₂ emissions per 1000 gross square feet (MtCO ₂ e)	15.68	C = A/B*1000					
Baseline CO ₂ emissions per gross square foot (lbsCO ₂ e)	34.57	C = (A*2204.6)/B					
Projected 2017 emissions (MtCO ₂ e)	195,324	D					
Projected additional square footage by 2017 (GSF)	388,000	E					
Projected 2017 total square footage (GSF)	10,623,743	F = B + E					
Projected CO ₂ emissions per 1000 gross square feet (MtCO ₂ e)	18.39	G=D/F*1000					
Projected CO ₂ emissions per gross square foot (lbsCO ₂ e)	40.53	G=(D*2204.6)/F					
Target CO ₂ e endpoint per 1000 gross square foot (MtCO ₂ e)	11.0	H = .70*C					
Target CO ₂ e reduction per 1000 gross square foot (MtCO ₂ e)	4.7	I = C - H					
Target CO ₂ e endpoint (MtCO ₂ e)	116,615	J = F * H					
Target CO ₂ e reduction (MtCO ₂ e) *	78,710	K = D - J					
Target % reduction in CO ₂ emissions per square foot	30%	L = I / A					
Sector	Strategy Name	(M) Estimated reduction: MtCO ₂ e/year	(N) = (M)/(D) % Reduction of Forecast Emissions	(O) = (M)/(K) % of Target Emissions Reduction	Estimated Total Nominal Cost	Annual Recurring Savings	Simple Payback Time (yrs)
Morningside Campus Buildings							
	Plant Conversion	9,766	5.00%	12.41%	\$ 13,815,585	\$ 541,027	26
	Cogeneration	23,707	12.14%	30.12%	\$ 36,000,000	\$ 5,193,036	7
	Other Capital Measures	8,822	4.52%	11.21%	8,050,000	2,680,117	3
	Equipment Replacements & Retrofits	15,889	8.13%	20.19%	34,835,000	5,349,395	7
	Operations and Maintenance	10,964	5.61%	13.93%	31,168,936	3,700,296	8
	Behavior Alterations / Conservation	7,528	3.85%	9.56%	-	940,209	-
Morningside Campus CUIT							
	Undegraduate laptops tuned for power savings	136	0.07%	0.17%	\$ -	\$ 54,720	-
	Employee Desktops tuned for power savings	1,954	1.00%	2.48%	\$ -	\$ 752,309	-
Total		78,765	40%	100%	\$ 123,869,521	\$ 19,211,110	6.4
Reconciliation		78,765	40%	100%	\$ 123,869,521	\$ 19,211,110	6.4

As the overwhelming majority of the University's greenhouse gas emissions were shown to derive from buildings and their energy usages, the action plan focuses on strategies to reduce energy consumption in existing buildings and in central operations that supply the buildings within the Challenge. The action plan also focuses on strategies that will a) replace aging infrastructure with more efficient alternatives; b) produce the greatest greenhouse gas reduction for the cost; and c) have a reasonable payback period for the investment. All told, the current projects identified in Columbia's plan have an average payback period of 6.4 years.

The options considered were ones that have known financial returns from greater energy efficiency. This conservative approach, consistent with the City's assumed efficiency returns used to achieve City-wide reduction targets, has been adopted to ensure that the University's emission reduction projections are fairly estimated. Resource constraints may require modifications in the years to come and additional resources may be needed over time in light of changing economic conditions. Additionally, changes in the price of energy may require re-analysis of the data.

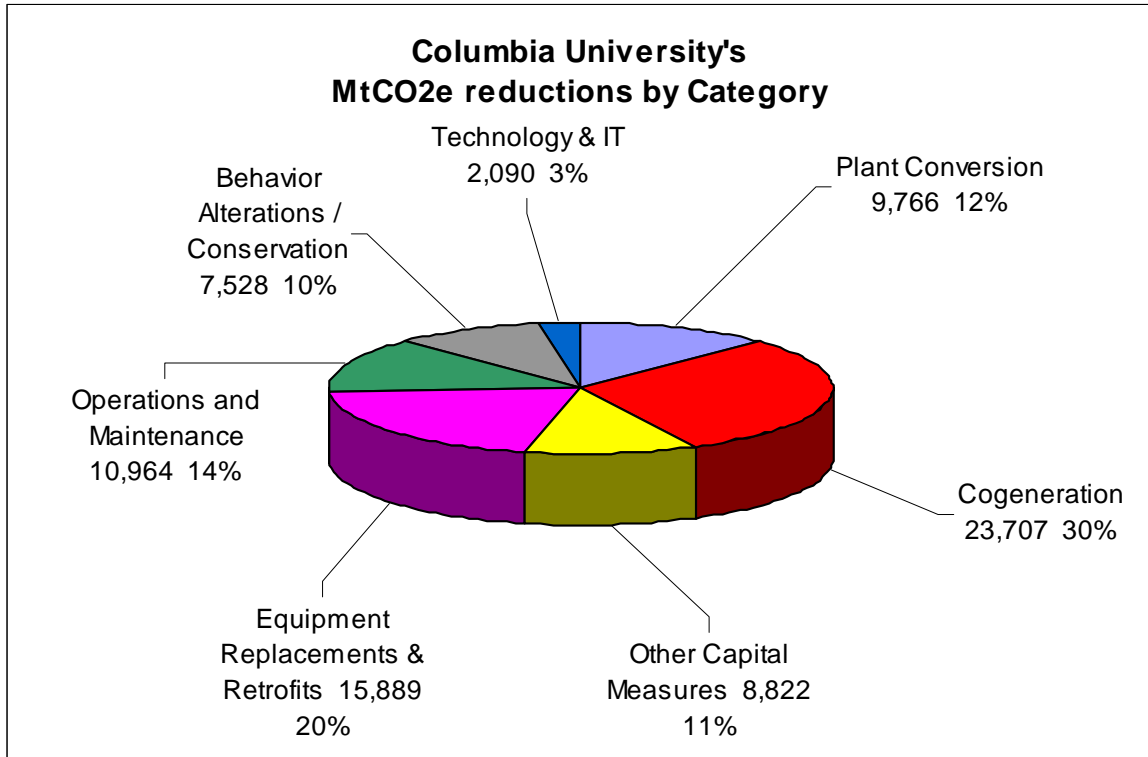
Consistent with the emphasis on gaining reductions in connection with existing space, the University's efforts focus on improving operations and maintenance, improving and expanding building management systems, replacing aging central plant equipment and retro-commissioning as part of our comprehensive strategy. Outreach and education to change behavior to conserve energy is another strategic initiative, but conservatively estimated due to uncertainty as to how to quantify results at this time. As transportation and solid waste made up a relatively small percentage of the University's emissions totals, specific strategies in this project addressing those issues are not included or quantified. They do, however, make up an important part of the University's overall commitment to environmental stewardship. Finally, in recognition that fume hoods, computers and data centers have high energy requirements, these sectors were specifically identified as targets of opportunity. Benefits will result from behavioral changes and investments in new equipment over time.

The assumptions underlying this analysis were based on standard industry data and cross-checked with the assumptions utilized by New York City in its *Long Term Plan to Reduce Energy Consumption and Greenhouse Gas Emissions of Municipal Buildings and Operations* (PlaNYC Energy Conservation Steering Committee, July 2008), as detailed by the City's consultants in meetings and memoranda. The team that developed the action plan anticipates that other strategies in the future not specifically identified at this time will be considered – including the use of alternative and renewable energy. For example, one building under renovation at the Morningside campus will include a new geothermal system.

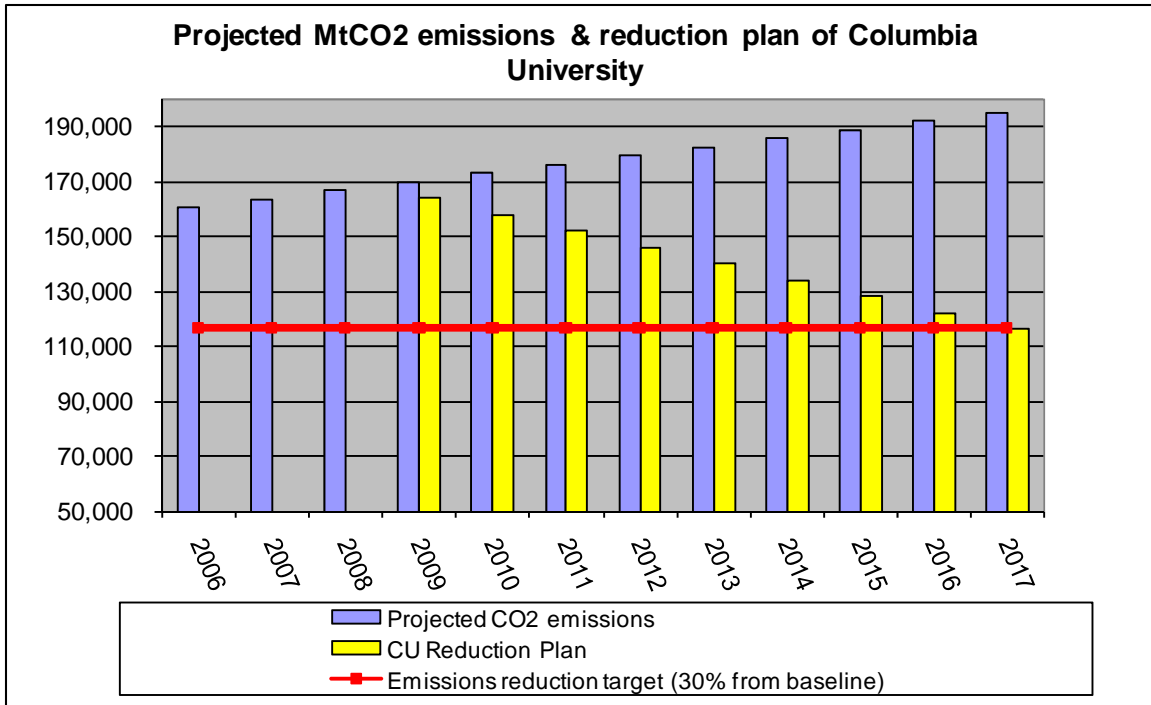
In addition, the University has four buildings in construction or undergoing renovation within the City that have been registered as LEED buildings with the U.S. Green Building Council, and the design and construction teams on those buildings have made energy efficiency a priority. The strategies employed in those buildings have not been included in the action plan

The internal team anticipates that as the ability to quantify results improves, additional strategies will be explicitly incorporated in the years to come. As noted above, however, the team chose to limit this plan to initiatives that would (i) have measurable and significant impacts on greenhouse gas emissions, and (ii) would likely be adopted and have already been shown to be effective in reducing greenhouse gas emissions and energy consumption given current costs and feasibility in New York City.

The pie chart below presents a summary of the percentage of Columbia's goals that will flow from each set of initiatives.



Not all of this progress will be made at once. The bar chart below suggests our best current estimates of the reductions that will be realized over time, and reflects Columbia's efforts to make progress throughout the time period and not wait for a last-minute intervention.



Below is a listing of the specific strategies that are included in the action plan, with a description of the projects to be undertaken and the percentage share of the total reduction goal to which they will contribute.

Projects	Description
Power Plant Chiller Replacement	Over the next three years we will be aggressively replacing three 45 year old chillers (Total 2000 tons) with a new state of the art chiller in addition we will correct some chilled water flow issues. With this replacement, including a new tower, and making improvements to our chilled water system we expect to reduce CO ₂ e emissions by 5%.
Cogeneration	We are currently evaluating installing a combined heat and power (cogeneration) system in our old power house. We are currently evaluating the size of the system, which we intend to use to meet our main campus' base load electric requirements. Upon implementation and operation we are expecting to reduce our CO ₂ e by 12.1%.
EMIS Implementation	Installation of an Energy Management Information System to monitor, control and trend energy usage campus wide. It is expected that with real time data on utilities use per building that we will achieve a CO ₂ e reduction of 2.9%
Lighting Upgrades	Upgrading of most of the public space lighting on campus to the most energy efficient technology available. We will switch out all T-8 to T-5 and LED were applicable in addition to adding Daylight controls and PV for powering exterior lighting. This initiative is expected reduce CO ₂ e by 1.6%.
VFD Upgrades	Installing Variable Frequency Drives on most larger sized air handlers, pumps and plant equipment. An engineering analysis was conducted that showed by installing VFDs electric usage will decrease, which will reduce CO ₂ e by 2.1%.
Steam Distribution & Insulation Repairs	Repair of steam system insulation and repair/upgrading of steam delivery equipment and piping. This operations and maintenance improvement to include preventive maintenance is expected to achieve an energy savings and reduce CO ₂ e by 1.5%.
Chilled Water System Repairs	Repair of chilled water system insulation and repair/upgrading of chilled water delivery equipment and piping. This operations and maintenance improvement to include preventive maintenance is expected to achieve an energy savings and reduce CO ₂ e by 1.6%.
Boiler, Burner & Hot water Repairs and Replacement	Repair and replacement of secondary hot water systems and burner systems where applicable. This operations and maintenance improvement to include preventive maintenance is expected to achieve an energy savings and reduce CO ₂ e by .9%.
Boiler Controls	Modernizing of the central plant boiler controls to provide more efficient use of fuel. The current system is 20+ years old with no ability to maintain the system. With modern controls and the ability to service the system we are expecting to save energy and reduce CO ₂ e by .3%.
Fan Coil Replacements	Replacing fan coils around campus to increase delivery performance and decrease repair costs. This aggressive initiative will replace over 400 fan coil units. Not only will it improve the working environment but it is expected to reduce electric consumption and reduce CO ₂ e by 1.6%.
Window Replacement	Replacing major windows on select campus building where they're needed most urgently. With most windows averaging around 18 years old, this improvement allows the University to upgrade the type of window and glazing, which will allow the University to achieve energy savings and reduce CO ₂ e by 1.6%.
Duct Cleaning	An annual program will be initiated to clean all duct work in select buildings. The initiative will improve airflow and the quality of the air. This initiative will achieve a reduce in CO ₂ e by .4%.
Air Handler Replacement	Replacing major air handlers in select areas where the replacement is most urgently needed. This initiative is currently underway. The University is focusing it's efforts on the oldest units. This effort is combined with retro-commissioning and duct cleaning efforts. It is expected that with these replacements electric consumption will decrease and reduce CO ₂ e by 1.6%.
Improve O&M Fan Coil Units	Establishing a comprehensive preventive maintenance program to increase equipment efficiency and life span. This initiative is expected to reduce electricity consumption and reduce CO ₂ e by 1.6%.
Retro-Commissioning	Annually the University will execute a program to retro-commission select buildings. The building's mechanical, electrical and plumbing systems will be evaluated for performance and inefficient systems or equipment will be repaired or replaced in order to bring the building back to a level of energy efficient operation. This program is expected to reduce CO ₂ e by .4%.
Purchasing Standards	Purchase all energy consuming assets to the highest efficiency standards available.