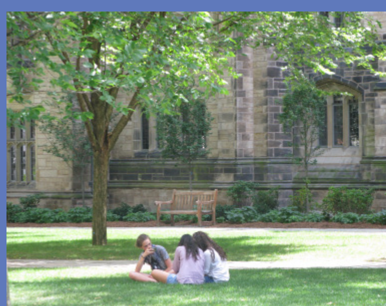
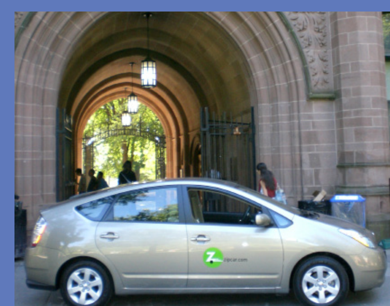
Yale's Greenhouse Gas Reduction Strategy





2010

Greenhouse Gas Reduction Strategy 2005-2010

Yale's Commitment

In keeping with its mission to advance and disseminate knowledge that sustains and improves society, Yale University is at the vanguard of sustainability and higher education. This commitment is evidenced by the University's pledge in 2005 to reduce greenhouse gas emissions 10 percent below 1990 levels by 2020 – a 43 percent reduction from 2005 levels.

Yale and the industrial world share the same difficult task: to drastically reduce emissions while also planning for future growth and development. We hope that by openly sharing our continued efforts, including our goals, lessons learned, strategies, and results, Yale's action will lead to similar commitments to greenhouse gas reductions by other institutions of higher learning at home and abroad.

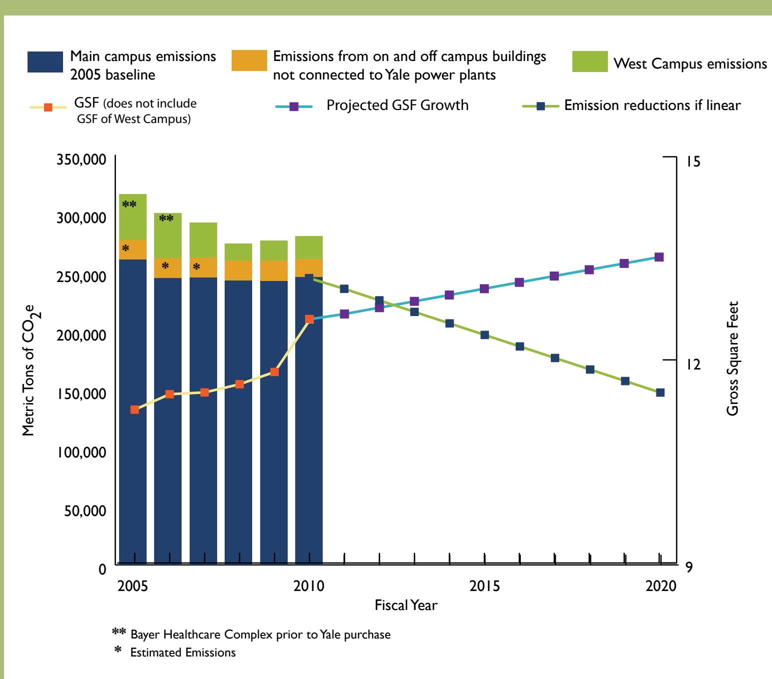
As a large institution with complex systems and operations, Yale recognizes its unique position to develop, test, and advance forward-looking, multidisciplinary climate activities. At the same time, Yale is a leading academic force on climate change research and education. Yale faculty members and researchers are developing and testing new technologies, exploring physical and social impacts, and advancing analytically rigorous policy and governance. Finally, Yale faculty, students, staff, alumni, and partners are an extraordinary network of influential thinkers, researchers, policy makers, and stakeholders who are responding to the unprecedented challenge of climate change.

Greenhouse Gas Reduction Strategy

Yale's fifteen-year plan to take responsibility for its emissions has focused on increasing the efficiency of on-campus energy production and distribution, energy conservation initiatives, testing renewable energy technologies, and requiring a LEED Gold minimum standard for new construction and large renovations. This reduction strategy has been designed to be responsive to both anticipated and unanticipated challenges. Yale's strategy must continually evolve to address these challenges in order to achieve the University's overall goal by 2020.

Yale reduced its campus emissions 6 percent from 2005 levels, despite a 12 percent increase in the main campus size. This represents a 1 percent increase in emissions from fiscal year 2009. This slight increase in emissions is primarily a result of large renovations and new buildings. We have recognized that our emission reduction path will likely not be linear over the course of the goal, but rather a combination of increases and decreases leading to an overall net reduction. For instance, in fiscal year 2010 a temporary increase in the use of oil occurred during the process of expanding the Central power plant to increase generation capacity. Conversely, in the coming year significant emission reductions will be realized with the conversion of the Medical Campus power plant to a co-generation facility. Yale's pursuit of its greenhouse gas reduction goal is a dynamic challenge that drives ongoing change and innovation.

Progress Toward Yale's 2020 Emissions Reduction Goal

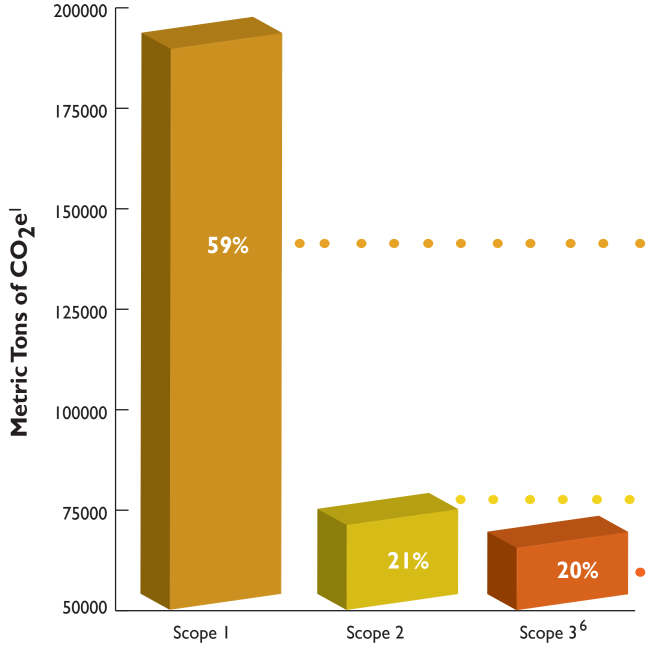


	2005	2010	Change
GHG emissions MTCO$_2$e of the Main Campus	260,700	244,560	6% decrease
students, faculty, & staff	23,273	25,862	11% increase
emissions per capita	11.2	9.4	16% decrease
gross square footage of the Main Campus	11,265,000	12,584,000	12% increase
emissions per 1000 sq. ft.	23.1	19.4	16% decrease
gross square footage of the Main Campus & West Campus	11,265,000	14,184,000	26% increase

To date, Yale University has reduced its greenhouse gas emissions 6 percent below the baseline emissions set in 2005. During this time both campus size and population have increased by over 10 percent. With additional plans to expand, the University will have to become increasingly innovative in order to achieve its 2020 reduction target.

Current information regarding Yale's progress can be found at www.yale.edu/sustainability.

Carbon Emissions by Scope



ON-SITE COMBUSTION	
Fuel Source	**Emissions ($MTCO_2e$)**
Natural gas	184,578
#2 oil	7,914
Gasoline & diesel for vehicles	2,621
Total	195,113

PURCHASED ELECTRICITY	
	Emissions ($MTCO_2e$)
Central Campus	24,644
Medical Campus	38,731
West Campus	8,469
Total	71,844

INDIRECT EMISSIONS (not included in emissions reduction goal)	
	Emissions ($MTCO_2e$)
Commuting	12,552
Air travel	51,589
Paper consumption	1,458
Total	65,599

Yale's 2005 greenhouse gas reduction commitment included emissions from the University's two power plants and purchased electricity. Since the adoption of the 2020 reduction target, Yale has incorporated emissions from West Campus and, beginning in 2009, emissions from fuel purchases for on and off campus buildings not connected to the Yale power plants.

What Is Included?

Based on guidance from the Greenhouse Gas Protocol,[2] Yale's emissions are divided into three categories called "scopes." Scope 1 encompasses direct emissions from sources owned or controlled by the University and includes emissions from mobile combustion, stationary combustion, process emissions, and fugitive emissions.[3] Scope 2 includes indirect emissions from purchased electricity and purchased co-generation for heating or chilled water. Scope 3 quantifies indirect emissions from all other sources that occur as a result of University operations but occur from sources not owned or controlled by the University, such as employee commuting, air travel, and paper consumption.

Yale's 2005 greenhouse gas reduction baseline included two on-campus power plants and purchased electricity for the Central and Medical Campuses.[4] Yale has now incorporated into its reduction efforts emissions from West Campus and fuel and electric purchases for on and off campus buildings not connected to the Yale power plants.[5] Emissions from the University fleet, commuting, and air travel are collected annually; however, inclusion of them in the University's reduction target is currently under analysis. As more accurate methodologies for accounting for Scope 3 emissions are developed, Yale may consider expanding its emission reduction target to include this wider scope.

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[1] Metric tons of carbon dioxide equivalent. This is the standard unit of measurement used to compare various greenhouse gases; emissions of gases other than CO_2 are translated into CO_2 equivalents using warming potentials.
[2] The Greenhouse Gas Protocol was developed by the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD) to standardize accounting and reporting methods for monitoring greenhouse gas emissions.
[3] Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and various other unintended or irregular releases of gases, mostly from industrial activities.
[4] Yale University operates two power plants, the Central power plant, a co-generation facility than can supply 18 megawatts of electricity, 340,000 pounds per hour of steam, and 14,600 tons of chilled water to the Central and Science Campuses; and the Sterling power plant, a thermal energy facility that can supply 350,000 pounds per hour of steam and 19,900 tons of chilled water to the Yale School of Medicine and the Yale-New Haven Hospital.
[5] West Campus, the former Bayer Healthcare Complex, is a 136-acre campus made up of 1.6 MM square feet of laboratories, offices, and warehouse space.
[6] Approximate total aggregate.

Testing New Technologies

One means of reducing campus carbon emissions is the adoption of renewable energy technologies. Energy generated from wind, solar, and hydro power emits zero to low emissions. Yale has launched a series of demonstration sites across campus to test a variety of emerging technologies. At each site Yale is assessing the technology's performance capabilities, ease of campus integration, short-and long-term costs (based on the technology's carbon reduction per capital dollar invested), and opportunities for student and public education. The information gathered will allow us to make informed technology selections that best fit the long-term needs of the University while also mitigating its greenhouse gas emissions.

Thin-Film Solar

Solar technology has existed since the 1950s, when it was first used to power space satellites and small items like calculators and watches. Today, more sophisticated systems are being used to power homes and businesses across the country.

Traditional solar photovoltaic cells are made from silicon, are flat-plated, and are typically bolted to the roof at an angle. Alternatively, thin-film solar cells are made from amorphous silicon or non-silicon materials such as cadmium telluride. This new technology is a few micrometers thick and can be adhered directly to the roof or facade of a building. Using fewer material resources in the manufacturing process, thin film is less expensive than traditional solar photovoltaic cells; however, the efficiency of thin-film solar ranges from 10 percent to 19 percent compared to 20-30 percent for its counterpart.

In the summer of 2009 the roof of a Yale dormitory was selected as a test site for the installation of a 24.5-kilowatt thin-film solar system. Initially expected to generate 20,000 kilowatt hours per year, the thin-film array has already produced 24,000 kilowatt hours in ten months. Our analysis shows that the thin-film system is outperforming the conventional photovoltaic system in place at the Yale Divinity School, as it is consistently producing at least twenty-five percent more energy per installed kilowatt.

Micro-wind Turbines

People around the world have been harnessing wind energy to pump water and grind grain for hundreds of years. Today, wind is captured using turbines that generate electricity that is used to power lighting and electronics in our homes and offices.

Standard wind turbines catch the wind's energy with propeller-like blades. As the wind blows, low pressure on the downside of the blade rotates the blade, causing the rotor to spin like a propeller. The rotor captures the kinetic energy of the wind and converts it into rotary motion to drive the generator, which produces electricity.

In the spring of 2009 Yale installed ten 1-kilowatt micro-wind turbines on the roof of the Becton Engineering and Applied Science Center. Built by AeroVironment, Inc., each turbine produces up to one kilowatt of clean energy to combine into a 10-kilowatt system. At 6.5 feet tall and weighing only 60 pounds each, the horizontal axis microturbines demonstrate an approach to wind harvesting that is ideal for urban areas. Their compact design generates little noise and requires a breeze of just seven miles per hour to produce electricity. The Units face almost due west, and can also self-rotate 30 degrees to the north or south, depending on wind direction, to maximize efficiency. To date, the turbines have generated 12 megawatt hours of electricity annually, reducing Yale's carbon dioxide emissions by 10,000 pounds.

Ten 1-kilowatt micro-wind turbines were placed on Becton Center in the spring of 2009.

Thin-film solar modules were installed on Yale's Swing dorm in the summer of 2009.