

2011

Greenhouse Gas
Reduction Strategy



Greenhouse Gas Reduction Strategy 2005-2011

Climate Change is one of the biggest challenges that society faces today and into the future. The concentration of carbon dioxide in the earth's atmosphere is at the highest levels in recorded history. The risks associated with the repercussions of our impact are high. As a result, Yale and the industrial world share the same difficult task: to **drastically reduce emissions while planning for future growth and development**.

In 2005, Yale University pledged to reduce its campus greenhouse gas emissions 43 percent below 2005 levels by 2020. This commitment is challenging Yale to develop a comprehensive but continually evolving strategy to reduce emissions while at the same time cope with plans to increase the campus size by 15 percent. In fiscal year 2011 **Yale has reduced its emissions 11.5 percent below its 2005 baseline emissions**. During this time campus size has increased by 11.7 percent and population has increased by 13.3 percent. Yale has achieved these reductions through the development of a comprehensive fifteen year plan that focuses on the following measures:

1. Increasing the efficiency of Yale's on-campus **power plants and distribution** of that energy;
2. Implementing **energy conservation initiatives** such as lighting retrofits, window replacements, installation of occupancy sensors, adjustment of energy set points and schedules;

3. Adhering to **sustainable construction and renovation** standards that require a LEED Gold minimum rating and Yale specified additional energy efficiency for all new construction and large renovations;
4. Utilizing new **renewable energy** technologies both on and off Yale's campus.

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.

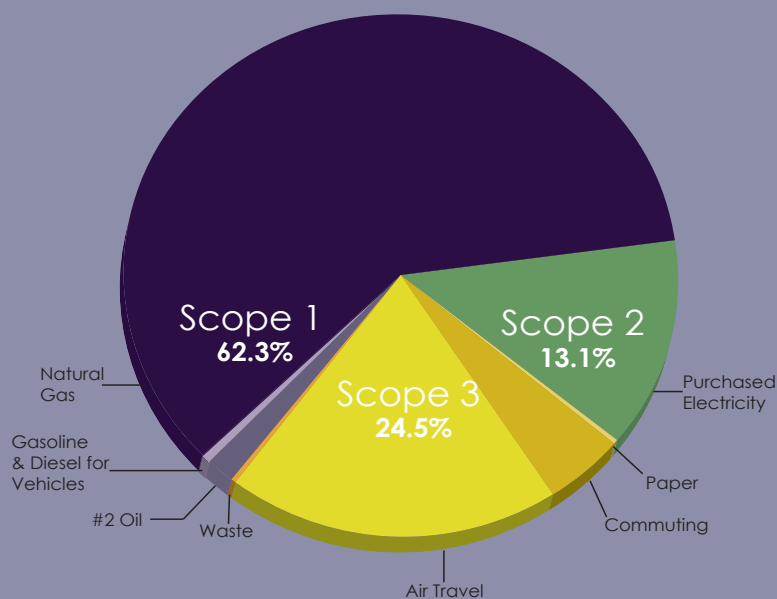
Contribution Toward 2020 GHG Goal

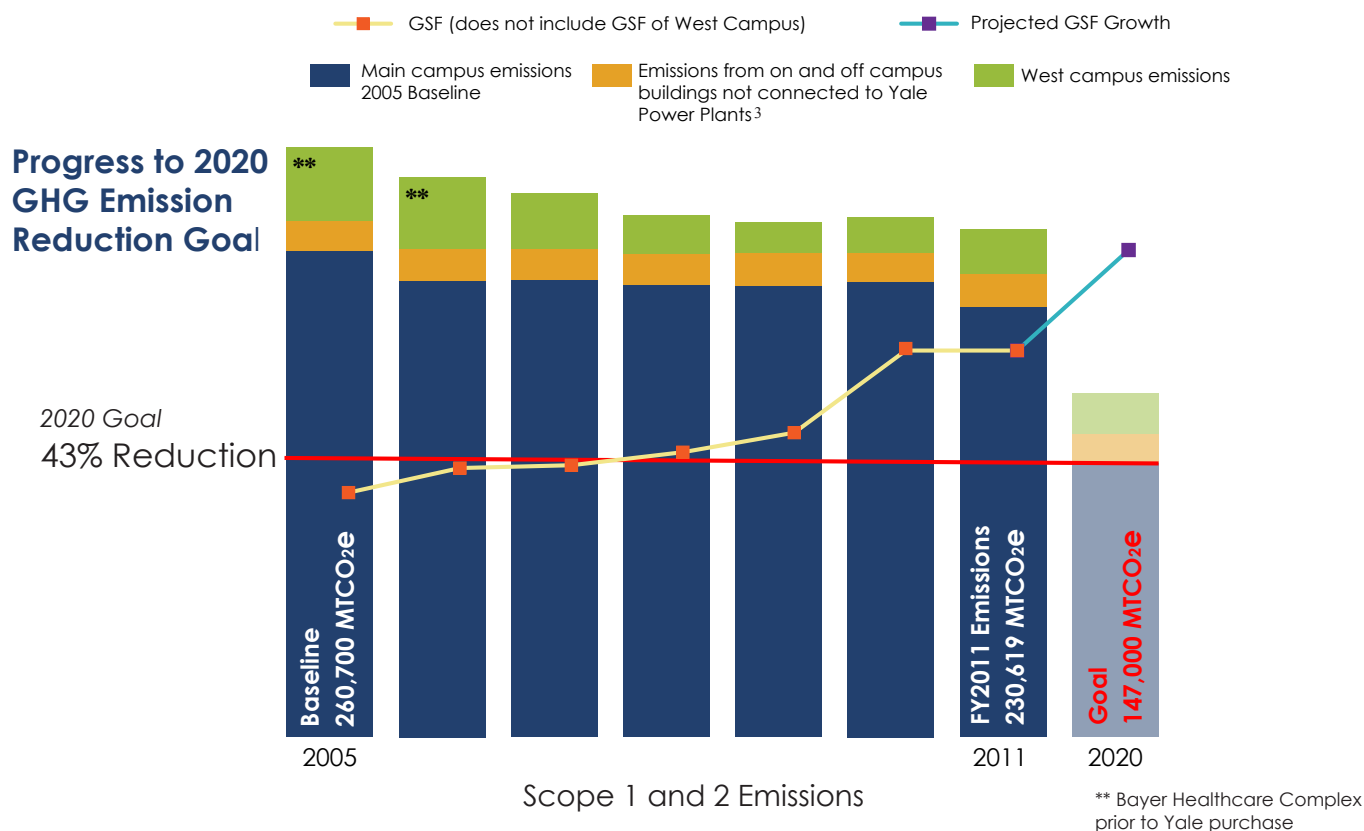
Measures	MTCO ₂ e change since 2005	Percent of total change
Power plant and energy distribution	↓ 15,000	13%
Energy conservation initiatives including behavior change	↓ 32,077	28%
Sustainable construction and renovation	↓ 2169	2%
Renewable Energy	↓ 1,145	1%
Increase in emissions due to campus growth	↑ 20,310	-18%

Scope of Emissions

Based on guidance from the Greenhouse Gas Protocol¹, 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 emissions².
- **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.





Greenhouse Gas Emission Sources

Yale is comprised of three campuses, (Central, Medical, and West) which amounts to over fourteen million square feet with a population of over twenty six thousand. The University's greenhouse gas emission reduction goal includes two on-campus power plants and purchased electricity for the Central and Medical Campuses. As a separate effort, Yale has also begun focusing on the reduction of emissions from West Campus and fuel and electric purchases for on and off campus buildings not connected to the Yale power plants.

Emissions from the University fleet, commuting, and air travel are collected annually; however, their inclusion 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.

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

	2005	2011	Change
GHG emissions for Yale's Main Campus	260,700 MTCO ₂ e ⁴	230,619 MTCO ₂ e	11.5% ↓
Campus population	23,276	26,380	13.3% ↑
Emissions per capita	11.2	8.7	22% ↓
Gross square footage of Yale's Main campus ⁵	11,265,000	12,584,300	11.7% ↑
Emissions per 1000 Sq. ft.	23.1	18.3	21% ↓
Gross square footage of Yale's Main Campus & West Campus ⁶	11,265,000	14,184,300	26% ↑

¹ 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.

² 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.

³ Yale University operates two power plants, the Central Power Plant, a co-generation facility that 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 15 megawatt co-generation system that generates steam, chilled water, and electricity to the Yale School of Medicine and the Yale-New Haven Hospital.

⁴ Metric tons of carbon dioxide equivalent. This is the standard unit of measurement used to compare various greenhouse gases; emissions of gases other than CO₂ are translated into CO₂ equivalents using warming potentials.

⁵ Gross Square footage of Yale's Main campus is only inclusive of buildings connected to the Central Power Plant and Sterling Power Plant. West Campus, the former

⁶ Bayer Healthcare Complex, is a 136-acre campus made up of 1.6 MM square feet of laboratories, offices, and warehouse space.

Making an Investment in Combined Heat & Power

Making a significant contribution to Yale's greenhouse gas reduction strategy is the conversion of Yale's Sterling Power Plant to a combined heat and power facility, also known as co-generation. Powering Yale's medical campus since 1923, the Sterling Power Plant was originally built as a coal burning steam plant but was converted to accommodate cleaner burning fuels over the last 88 years. More recently, using natural gas as its primary fuel source, it generated enough steam and chilled water to heat and cool the School of Medicine and Yale-New Haven Hospital while electricity was purchased from the local utility company.

As an initiative to reduce campus energy costs and greenhouse gas emissions, Yale's Sterling power plant was converted to a co-generation facility in 2010. The new 15 megawatt co-generation facility will now provide the medical campus with more efficiently generated steam, chilled water and electricity.

Co-generation of steam and power has been around for over 100 years. It was primarily used during the industrial revolution but as central power station facilities became fundamental to the country's broader distribution of electricity, the use of co-generation declined. In recent years it has become more prevalent on University campuses, and as a whole, co-generation facilities currently make up almost 9 percent of the U.S. total generating capacity.¹

A co-generation system produces both electricity and steam from the same input of fuel and as a result is a much more efficient way to generate power. During conventional electricity generation, only about a third of the fuel input is generated into usable energy due to heat losses.² Co-generation technologies recover that lost heat and use it to produce steam or hot water for heating and cooling. This improves our efficiency to generate power from 45% to as high as 80%.

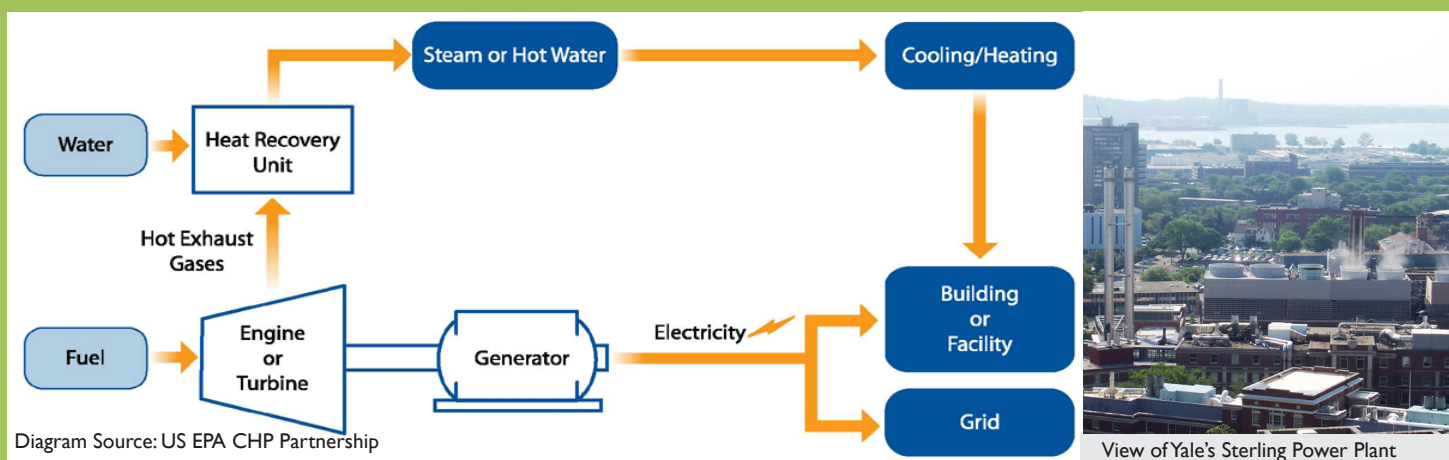
The new co-generation units at Sterling operate at about 79% thermal efficiency and the boilers operate at around 90% thermal efficiency. This increase in efficiency represents an estimated reduction of 15,000 metric tons of carbon dioxide equivalent per year, which is equivalent to taking more than 2,600 cars off the road.

Converting the Sterling Power Plant to a co-generation facility was an initial investment of seventy-five million dollars. Yale's predicted annual savings will be almost nine million dollars. This investment not only lowers annual costs, but reduces greenhouse gas emissions, increases power reliability and quality, and avoids distribution losses making it a sound investment for the University.

¹ 2008 Oak Ridge National Laboratory report

² American Council on an Energy-Efficient Economy CHP fact sheet

How does combined heat and power work?



Natural gas is used as the primary fuel source to run the gas turbine, which spins to generate electricity. The gas powered turbine holds energy which is exhausted into a boiler system to make steam for heating and cooling Yale's campus.