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April 5, 2018

Dr. Tallman Trask III
Executive Vice President
Duke University
203 Allen Building
Box 90027
Durham, NC 27708

RE: Duke University Plans for CHP – Institutional Peers

Dear Dr. Trask,

I am writing on behalf of the Board of Directors and the 2300+ members of the International District Energy Association (IDEA), a non-profit industry association founded in 1909 and based near Boston, MA. Among our members are many of the nation's leading research colleges and universities, including Duke University, for whom efficient, reliable and sustainable energy supply is of mission-critical importance. We commend Duke University for considering the integration of combined heat & power (CHP) into its district energy system and wanted to share a small sample of how other IDEA member institutions have utilized deployment of CHP to achieve environmental, economic and enhanced resiliency objectives.

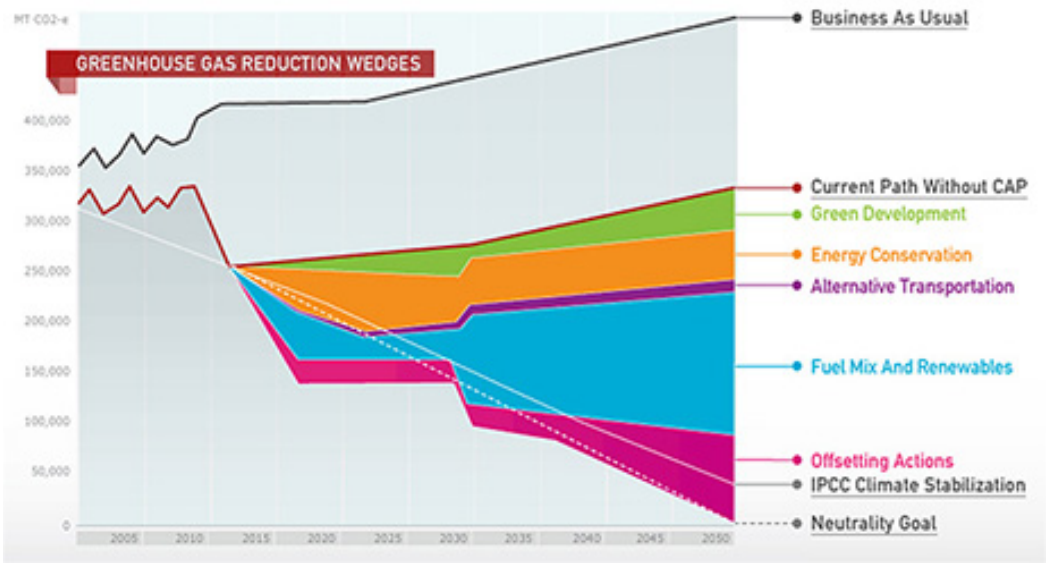
Duke University is a top-tier institution who can count prestigious names like Cornell, Harvard and Princeton among its peers. Duke is considered to be a leader in many areas from academics to athletics, and in the area of institutional sustainability and environmental stewardship, the administration might consider looking to its peers. For many of the top-tier universities in the US, combined heat and power has been a key component of their Climate Action Plans and has allowed them to lead the way toward cleaner, more efficient and more resilient campus energy systems.

All of the campuses below have diversified Climate Action Plans that look at a wide range of projects and initiatives that can help them to move toward carbon neutrality. They invest in renewable energy projects like solar PV, landfill gas, geothermal, or lake water cooling and keenly focus on energy efficiency in buildings, while also recognizing that district energy and CHP is a crucial foundation that makes the transition to low-carbon energy possible. By aggregating the energy needs of dozens of buildings, district energy as foundational infrastructure has made it possible for Harvard to meet its carbon reduction goals earlier than predicted, for UT Austin to use less fuel over the past 10 years despite a campus that has doubled in size, and for Princeton to maintain continuous operations through a devastating event like Super Storm Sandy.

Cornell University

In their 2009 Climate Action Plan, Cornell pledged to reduce their carbon emissions to zero by 2050. The plan identified 5 key areas where these reduction will come from and 42% of these savings are made possible by constructing the university's CHP plant. Because using CHP has the benefit of providing economies of scale in a campus energy system, things like equipment upgrades, converting to natural gas and biomass from coal, and integrating renewable energy sources are more economically feasible. Just the construction of the CHP plant, which came online in 2010, cut Cornell's carbon emissions "by a total of approximately 75,000 tons by 2012. This amount represents over 20% of the Ithaca Campus greenhouse

gas footprint."[1] The university also claims a host of other benefits from their CHP plant; "Improved energy efficiency; Enhanced environmental protection; Fuel flexibility; Ease of operation and maintenance; Reliability; Comfort and convenience for customers; Decreased life-cycle costs; Decreased building capital costs; Improved architectural design flexibility."[2]



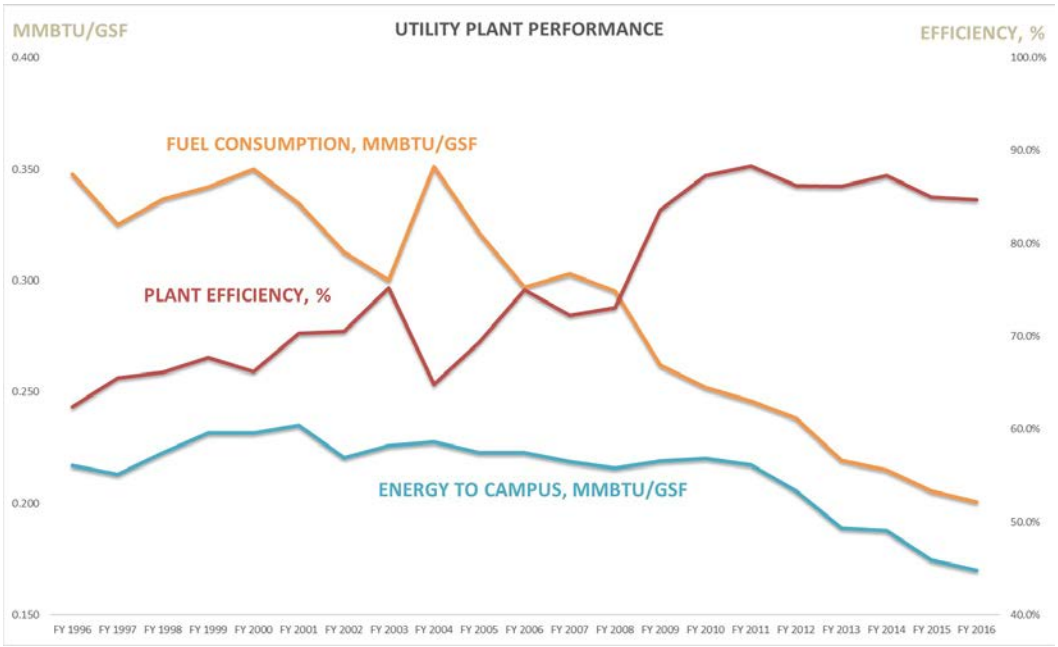
This graph shows the key areas where Cornell University plans to reduce their carbon emissions. 42% of their reductions are planned to come from the Fuel Mix and Renewables category which is largely made possible by their district energy/CHP system.

1: http://www.sustainablecampus.cornell.edu/initiatives/beyond-coal
2: http://www.sustainablecampus.cornell.edu/initiatives/district-energy-system
Other Resources: http://www.sustainablecampus.cornell.edu/initiatives/combined-heat-and-power; http://www.sustainablecampus.cornell.edu/energy; http://news.cornell.edu/stories/2009/09/cornell-unveils-its-climate-neutrality-plan

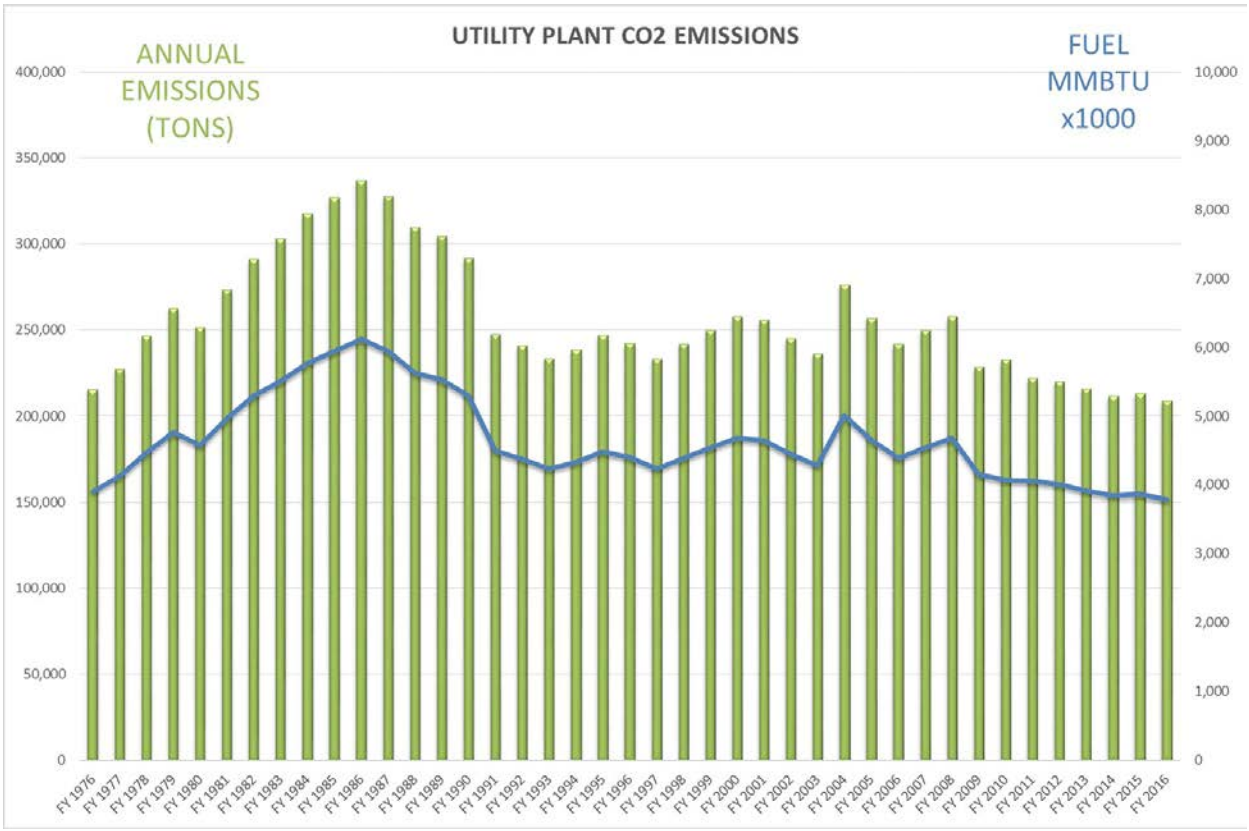
University of Texas at Austin

The University of Texas at Austin has the honor of calling itself "the most efficient university utility in the U.S."[1] They have earned that distinction because they operate a highly efficient campus energy system that includes district energy, microgrid capabilities, and combined heat and power. Natural gas is the primary fuel used at UT Austin and the university acknowledges that while natural gas is "considered one of the cleanest fossil fuels available, it is still a significant source of greenhouse gas emissions."[1] However, the incredibly high efficiencies reached by their CHP plant means that producing energy for the campus with CHP has "avoided the cumulative release of 862,000 tons of carbon dioxide since 1996, equivalent to taking nearly 164,630 cars off the road."[1] UT Austin is so successful at optimization and efficiency that their energy system "has helped the campus lower its CO2 emissions to 1977 levels, while the campus has grown by over 40 percent since then."[2] Meanwhile they also maintain reliability of 99.9998%[2] which is crucial for any facility that has mission-critical functions like valuable research that has high demand for uninterrupted energy.

UT Austin is able to reduce carbon emissions while growing their campus and maintain reliable energy to support their education and research mission because of their CHP plant. Juan Ontiveros, Associate Vice President of Utilities, Energy & Facilities Management at UT summarizes it best, "We've been able to produce twice the amount of energy, for twice the amount of square footage, with the same amount of fuel, for a 10-year period. Everyone could do that— I'm not the only one. These are all proven technologies that you can implement right now."



Carl J Eckhardt Combined Heating and Power Complex has dramatically reduced fuel consumption and improved efficiency while maintaining energy flows to a growing campus between 1996 and today



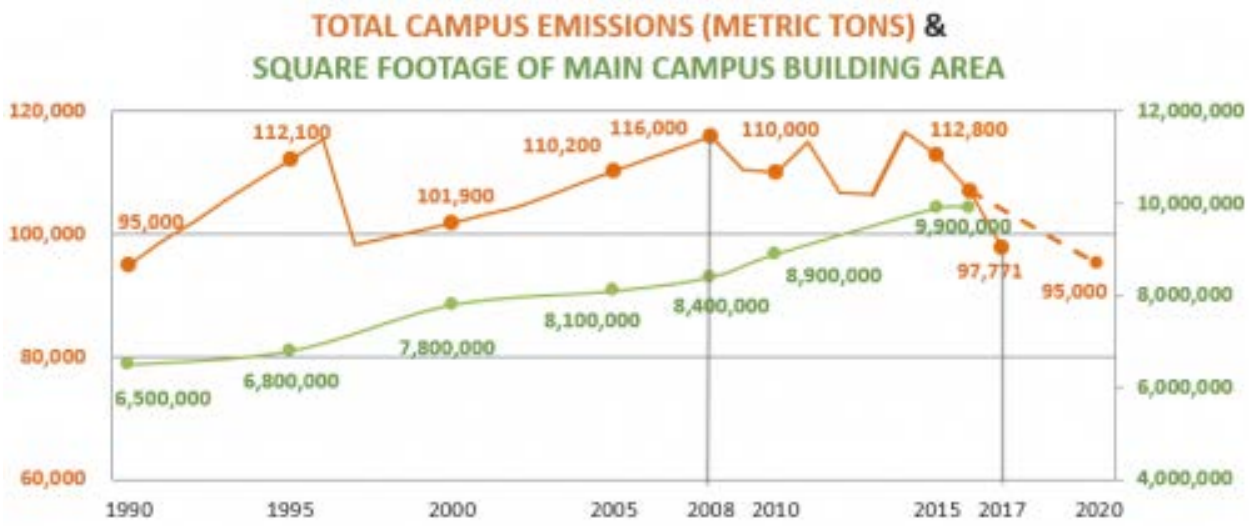
Carbon emissions today are equivalent to 1976 levels despite an increase in campus growth in terms of size and load.

1: https://utilities.utexas.edu/chp/about-carl-j-eckhardt-combined-heating-and-power-complex
2: http://www.southwestchptap.org/data/sites/1/documents/profiles/University_of_Texas-Project_Profile.pdf
Other Resources: https://utilities.utexas.edu/chp/about-carl-j-eckhardt-combined-heating-and-power-complex

Princeton University

If you mention Princeton in the district energy industry, most people will immediately think of how they were able to withstand Super Storm Sandy in October, 2012. The Combined Heat and Power plant maintained operations through the storm, keeping their campus and community supplied with electricity and heat even while the surrounding areas were left completely without power.[3] When Sandy hit they were able to keep the lights and heat on thanks to their CHP-based microgrid, even supporting area first-responders. If the next severe storm has its eye on North Carolina, will Duke be able to say the same?

Another benefit of using CHP at Princeton is fuel flexibility. The system is designed to use several inputs including "electricity, natural gas, diesel and bio-diesel fuel."[1] The plant's operations system includes various meters and controls which allow the plant operators to monitor metrics like energy demand from the campus and forward electricity prices to make decisions about real time operations to make or buy power from the grid on any particular day. Additionally, because they have aggregated the heating and cooling needs of 150 buildings into the central plant, Princeton has "the ability to switch from natural gas to bio-diesel as price or supply dictates"[1]. Their CHP microgrid enables the university to "pay lower prices for energy,"[1] saving them millions on energy costs each year. In addition to monitoring demand and price, "emissions are rigorously monitored"[1] as well and the emissions reductions generated by the CHP plant means that Princeton "is on track to reduce CO2 emissions to 1990 levels (95,000 metric tons) by 2020."[2] And like UT Austin, Princeton continues to achieve these emissions reductions even while their campus real estate grows. Energy efficiency through CHP is a critical advantage paying continuous dividends.

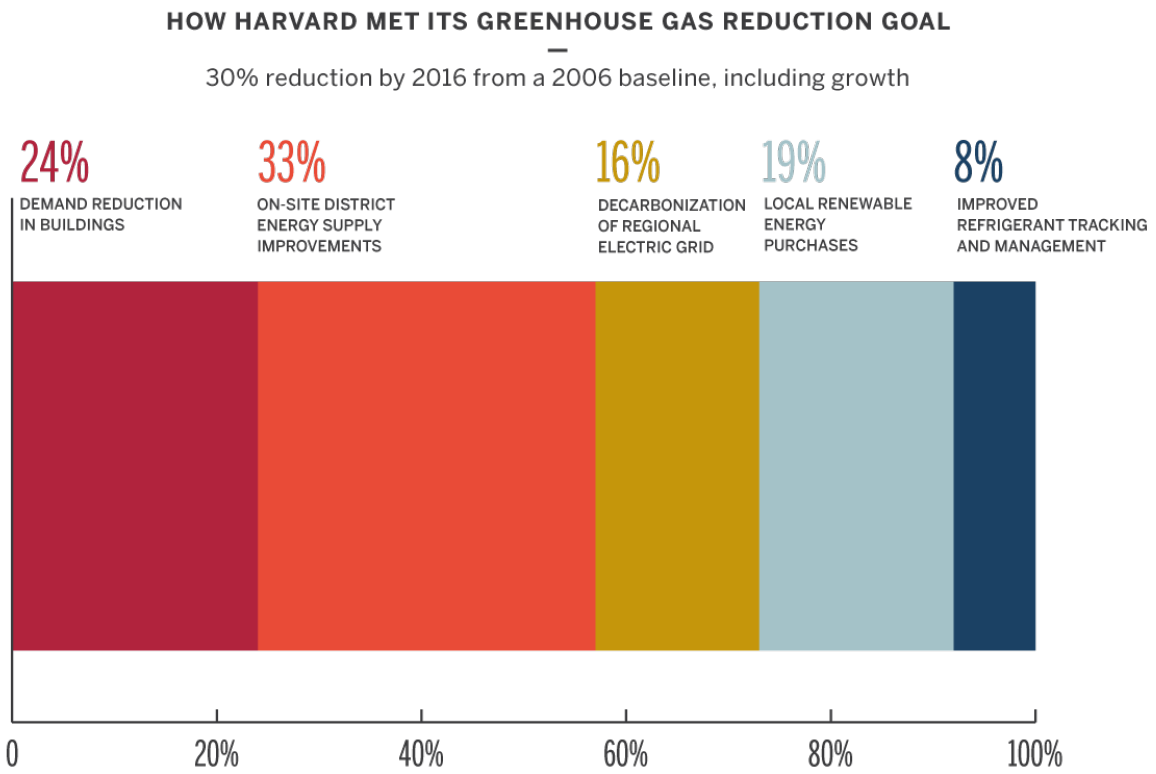


1: https://facilities.princeton.edu/news/the-princeton-energy-plant
2: https://sustain.princeton.edu/progress/energy https://facilities.princeton.edu/sustainable-campus/sustainable-energy
3: http://www.truebluenaturalgas.org/students-stayed-warm-hurricane-sandy-meet-princetons-natural-gasfired-cogeneration-plant/
Other Resources: http://www.centraljersey.com/opinion/solutions-finding-ways-to-save-money-and-power-through-environmental/article_5c5310a0-0bca-11e6-8728-6b7be6550d12.html

Harvard University

Harvard has been using district energy to supply resilient energy to its campus for "nearly a century"[1] and has been an early adopter in the age of sustainability, implementing a greenhouse gas emissions reduction plan in 2008 and entering in a long-term power-purchasing agreement for carbon-free wind energy in 2009. When the university met their emissions reduction goal early in 2016, they credited a reduction of "20,500 metric tons of carbon dioxide equivalent (MTCDE), equal to taking 4,300 cars off the road,"[2] to their combined heat and power system, "the largest portion of on-site emissions reduction."[1] Even now Harvard continues to demonstrate its global leadership in sustainability by modernizing and optimizing their district energy systems as a means to strengthen campus resiliency and reliability while simultaneously curbing their steam plant's carbon intensity by 22 percent.[3]

The most recent goals set forth by the University are "to be fossil fuel-free by 2050 and fossil fuel-neutral by 2026."[4] At the same time, the university is expanding with a new satellite campus in the Allston neighborhood of Boston. Harvard has chosen to construct a new district energy center with CHP in order to meet the new campus' energy needs and simultaneously work towards meeting those goals. The campus will be fueled by natural gas for now "because that's the dominant lowest carbon fuel source available for this scale of facilities," but flexibility provided by the energy center means that "As low and zero carbon technologies are tested and proven, they can be evaluated for incorporation"[4] into the campus energy system, as the university has done on its main campus where their district energy system has allowed them to utilize technologies like solar thermal, solar PV, and heat recovery.



Changes to energy supply and demand on campus accounted for the largest percentage of emissions reduction. Graphic by Judy Blomquist/Harvard Staff

1: https://green.harvard.edu/topics/climate-energy/2006-2016-climate-goal
2: https://green.harvard.edu/topics/climate-energy/renewable-energy
3: https://news.harvard.edu/gazette/story/2016/12/harvard-achieves-greenhouse-gas-reduction-goal/

4: https://green.harvard.edu/news/highly-efficient-energy-system-power-harvards-allston-campus
Other Resources: https://rentechboilers.com/case-studies/harvard/

Massachusetts Institute of Technology

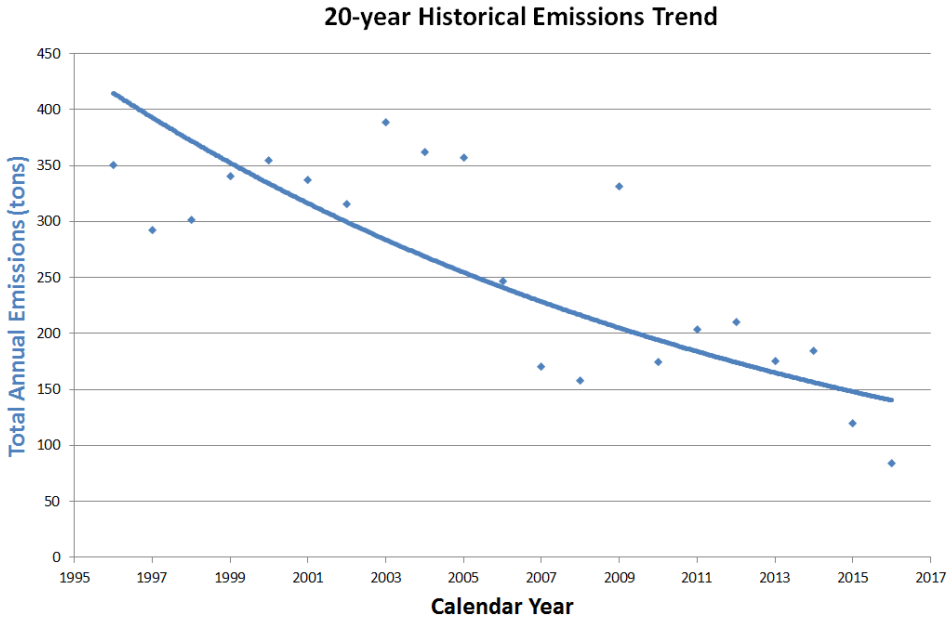
Like others in this list, MIT sees its Cogeneration plant as a "key component"[1] of their sustainability strategy, "crucial to supporting MIT's research and educational activities,"[2] and a "flexible power system that positions the Institute to explore emerging sustainability and efficiency measures."[3] Sustainability, reliability, resiliency, and energy efficiency are some of the main benefits of CHP and reasons why MIT has chosen to reinvest in its cogeneration system. Compared to a traditional campus energy system the existing plant at MIT has used "a third less fuel" and helped avoid "almost 1.3 million metric tons of GHG emissions"[4] in its lifetime. The newly upgraded plant will offset "a projected 10% increase in GHG emissions due to energy demands created by new buildings and program growth"[4] while still being able to maintain high reliability needed to "support its research and other world-changing activities."[5] Achievements like that can be attributed to a "substantial increase in energy efficiency"[2] reached by upgrading their CHP system from its current 22 MW capacity to 44 MW capacity.

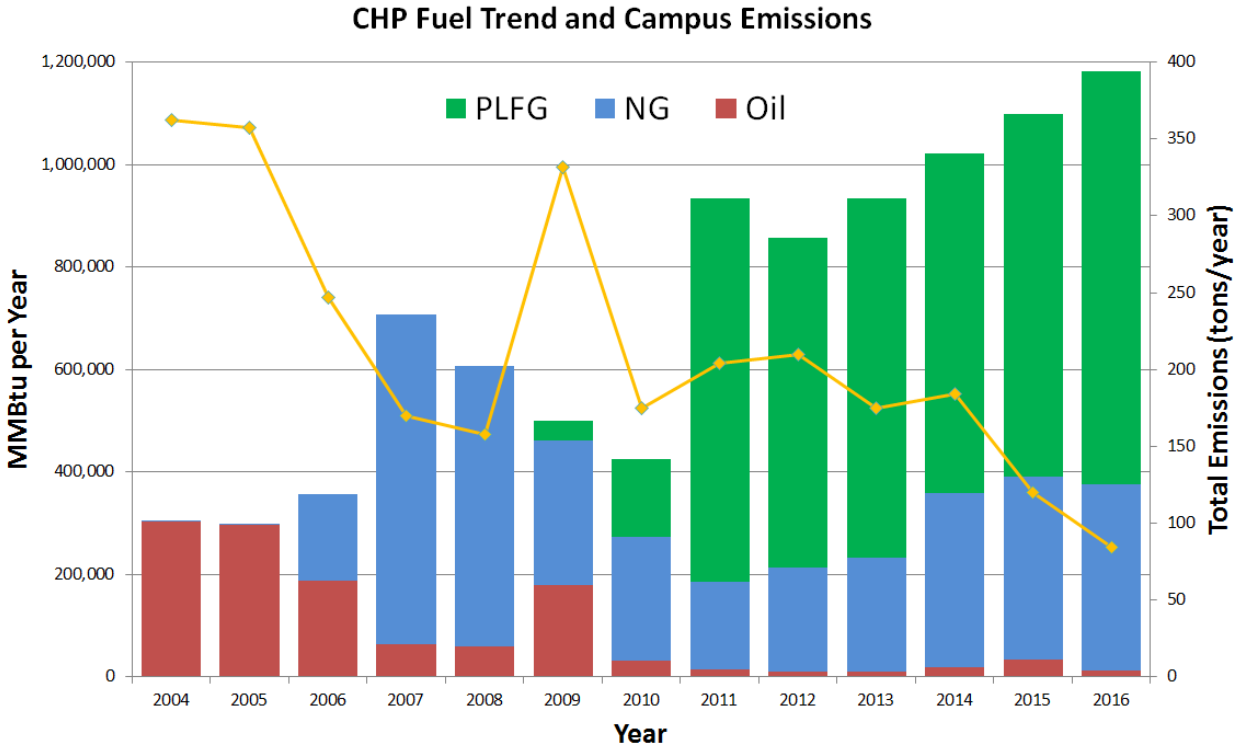
MIT has committed to "reducing greenhouse gas emissions at least 32% by 2030."[1] Perhaps the most important function of the CHP plant and district energy system at MIT is to serve "as an effective bridge to evolving energy technologies."[2] As critics point out, a natural gas-powered system is not an environmental holy grail, but due to the energy dense and mission-critical nature of many university facilities "a cogeneration plant powered by natural gas is one of the cleanest and most efficient proven options available today."[2] Ken Packard, MIT's Director of Utilities, says that "With this system MIT will be better positioned to explore additional sustainability and efficiency measures, and we'll be able to incorporate emerging energy technologies as they become available. We are collaborating with the Office of Sustainability on an energy strategy that defines our goals for the future, including at least a 32 percent reduction of campus greenhouse gas emissions by 2030. Cogeneration is the bridge that will get us there."

1: https://powering.mit.edu/project-faqs/cogeneration
2: https://powering.mit.edu/project-faqs/energy-strategy
3: http://news.mit.edu/2017/mit-upgrading-cogeneration-plant-to-improve-campus-resiliency-0807
4: https://powering.mit.edu/project-faqs/environmental-benefits
5: http://news.mit.edu/2015/cogeneration-bridge-future-1216
Other Resources: https://powering.mit.edu/cogeneration-sustainable-choice; http://www.mass.gov/eea/agencies/massdep/air/approvals/mit.html; https://powering.mit.edu/;

University of New Hampshire

At the University of New Hampshire in Durham, NH operating a cogeneration plant has made it economically feasible for the university to transition from fuel oil to natural gas to landfill gas, reducing their carbon emissions every step of the way and becoming "the first university in the country to use landfill gas as its primary fuel source."[1] Like UT Austin recognizes where natural gas falls short, UNH acknowledges that there are valid arguments against the use of landfill gas as their primary fuel source,[1] however "since we have only a decade in which to substantially reduce our greenhouse gas emissions to avoid the worst impacts of climate change, we need to explore renewable power sources like landfill gas."[1] And the combination of CHP and landfill gas has been extremely effective at reducing the university's emissions to meet their goals of "a 50 percent cut in greenhouse gas emissions by 2020 and an 80 percent cut by 2050,"[2] the cogeneration plant alone "resulted in an estimated reduction in greenhouse gas emissions of 21%."[2]

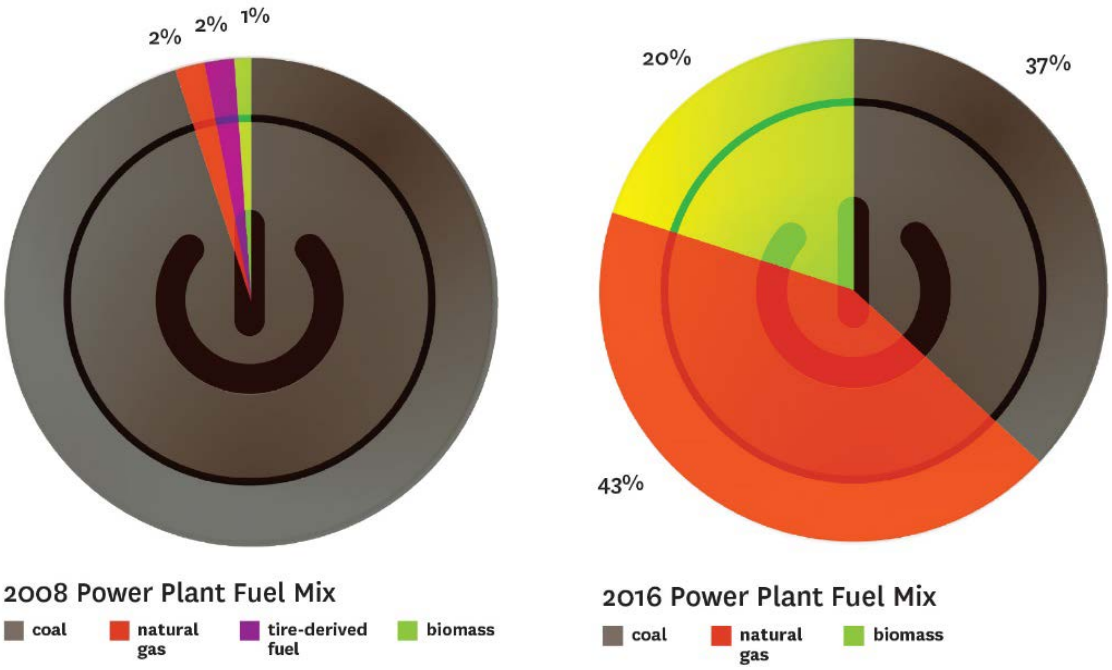




1: https://sustainableunh.unh.edu/ecoline
2: http://www.waste360.com/gas-energy/university-new-hampshire-teams-waste-management-pump-landfill-gas-energy
Other Resources: https://www.districtenergy.org/viewdocument/meeting-campus-emissions-requiremen https://www.unh.edu/facilities/unh-cogeneration-facility; https://www.unh.edu/facilities/energy-utilities; https://www.energyvortex.com/files/CHPprojectweec06confproc.pdf

University of Missouri

The University of Missouri is another institution that can claim a highly efficient campus energy system, thanks to CHP, which allows them to use "38 percent less fuel than a conventional plant of comparable size"[1] and "cut greenhouse gas emissions by 43 percent."[2] Not only has combined heat and power allowed Mizzou to use less fuel, it has also enabled them to integrate biomass into their fuel mixture and they "now generate more renewable energy on [their] campus than any other university in the country."[2] Overall the efficiency and fuel flexibility provided by the CHP plant has helped the university reduce "emissions of carbon dioxide by 107,000 tons, the equivalent of almost 18,000 passenger vehicles, [and reduce] energy use by 10 percent and greenhouse emissions by 12 percent since 1990, which translates into a savings of $6.6 million a year for the university."[1]



1: http://biomassmagazine.com/articles/5490/missouriundefineds-cogeneration-powers-biomass-production
2: https://mizzoumag.missouri.edu/2016/05/aiming-for-zero/
Other Resources: https://www.youtube.com/watch?v=HAp8oGZeO1I; https://www.cf.missouri.edu/cf/em/renewable; https://www.cf.missouri.edu/cf/em/eff

University of California Los Angeles

Like the University of New Hampshire, the University of California Los Angeles has also used a combination of natural gas and landfill gas to power their cogeneration plant and reduce campus emissions.[1] UCLA recognizes the CHP, "with its emphasis on efficiency and use of more environmentally friendly gases"[1] has been key to the emissions reductions they have been able to achieve so far. They also recognize that having a district energy/CHP system makes future reduction strategies more technically and economically feasible. Nurit Katz, Sustainability Coordinator at UCLA describes the cogeneration plant as "the foundation of reduction that we are building on."[1]

1: http://dailybruin.com/2009/04/09/co-gen-helps-ucla-go-green/
Other Resources: https://www.facilities.ucla.edu/services/utility-distribution; http://www.scsengineers.com/scs-project-case-stu/co-generation-combined-heat-power-university-of-california-at-los-angeles/

In closing, IDEA commends Duke University for considering the adoption of CHP as part of a long term sustainability strategy to support the core mission of the University – educating tomorrow's leaders. I hope this information is helpful on how other IDEA member institutions have achieved important environmental objectives while balancing the critical economic, energy and resiliency needs of world-class university campuses.

We stand ready to assist the Duke Administration and Staff in this endeavor and welcome any inquiries on the material provided and if desired, contact information at the respective institutions. Please feel free to contact me at +1-508-366-9339 or rob.idea@districtenergy.org.

Sincerely,

Robert P. Thornton
President & CEO, IDEA
www.districtenergy.org

cc. Mr. Vincent E. Price, Office of the President
IDEA Executive Committee and Board of Directors

Other Resources

https://www.epa.gov/chp/chp-benefits
https://www.energy.gov/sites/prod/files/2017/06/f35/CHP%20Financing%20Primer%206-16-17%20Final.pdf