Transformation into a

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University campuses are often similar to small cities in the scope of services provided, such as housing, food, medical care, utilities, and transportation. Providing these services results in the generation of greenhouse gases (GHG), commonly expressed in terms of metric tons of carbon dioxide equivalent MT (CO_2e) or "carbon footprint." The University of Cincinnati (UC) is one of the largest employers in Cincinnati and accounts for approximately 6% of the city's overall GHG emissions.

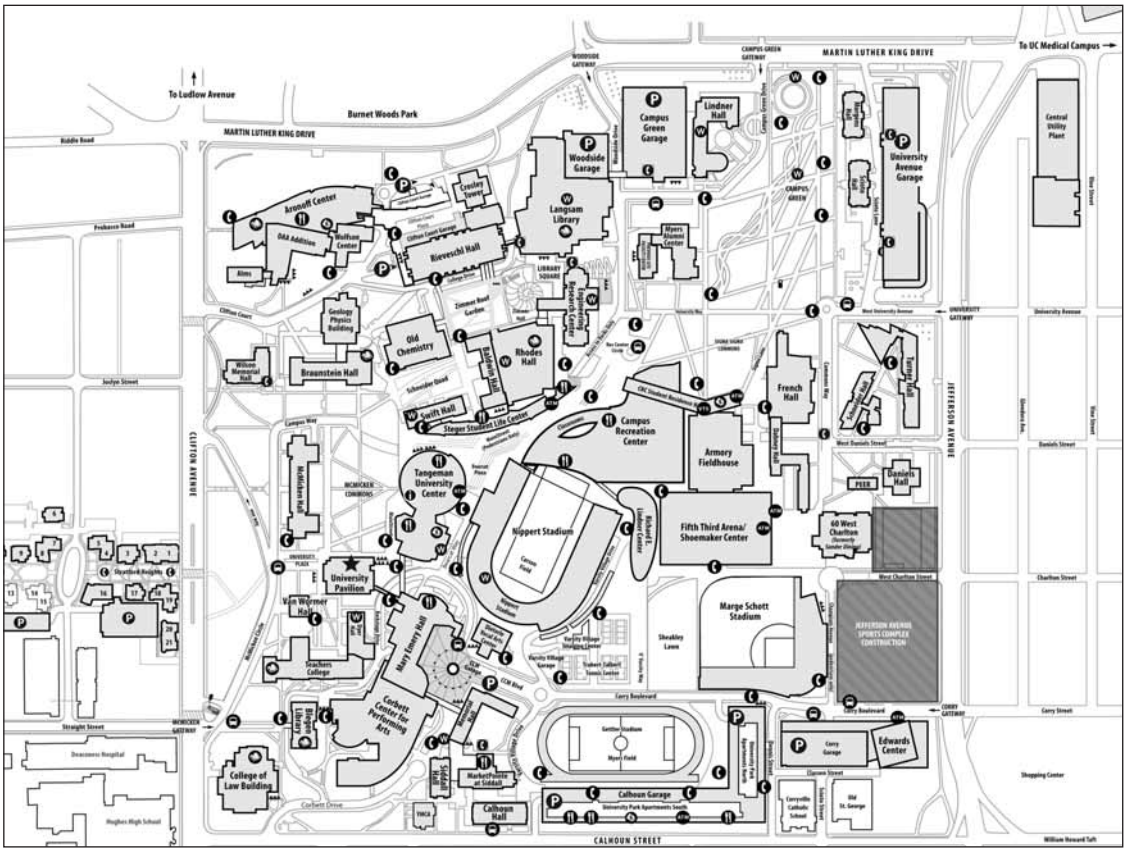
# of a University Climate Action Plan Sustainability Action Plan

Nearly 700 universities in the United States, including UC, are participants in the American College and University Presidents' Climate Commitment (ACUPCC). This commitment requires several actions, principally completing a biennial inventory of GHG emissions and defining a Climate Action Plan to achieve carbon neutrality. However, GHG emissions comprise only a portion of the scope of issues being considered by the UC President's Advisory Council on the Environment and Sustainability (PACES), and work is ongoing to update the university's decision-making tools to encompass more sustainability metrics.

This article discusses selection of metrics that will be included in the final framework and a sample comparison of results from a decision-making model applied to a subset of available data. The comparison showed that prioritizing actions through this broader sustainability lens resulted in a suite of actions with better economic performance and, surprisingly, more GHG emission reductions than when focusing on GHG emissions alone.

Background

UC was founded in 1819 and is a large urban research university with more than 41,000 students. Operations occur at four campuses and several satellite research facilities, all located within the Greater Cincinnati area in Southwest Ohio. The main or "uptown" campus is the focus of this work, and includes the West (Main) and East (Medical)



Map of Main campus at UC.

Table 1. Comparison of UC carbon footprint modeling results (MT CO_2e).

Reporting Year	Energy	Transportation	Solid Waste	Refrigerants	Other	Total Emissions
Original Modeling (FY 2008)	301,479	69,293	536	1,001	Not Addressed	372,309
Updated Modeling (FY 2010)	287,363	166,078	512	1,169	404	455,526

Campus. Together, these are home to 15 of the university's 17 colleges, several hospitals, and related facilities. UC joined the ACUPCC in 2007, completed its first GHG inventory in 2008, and defined a Climate Action Plan in 2009. But even prior to participating in ACUPCC, UC had adopted a Sustainable Design Policy in 2001, and construction of its first Leadership in Energy and Environmental Design (LEED)-certified building was completed in 2006. UC was designated as one of the nation's top green universities by *Princeton Review* in April 2010.

Carbon Footprint

The first carbon footprint for the UC "uptown campus" was generated in 2009 using the Clean-Air Cool Planet (CA-CP) Campus Carbon Calculator recommended by ACUPCC. The model computes emissions of six regulated GHGs in terms of CO_2 equivalents on the basis of their global warming potential (GWP). Results for UC showed energy to be the predominant component with transportation second, as shown in Table 1. Based on this initial modeling, a Climate Action Plan was created in 2009 that listed several hundred possible actions.[1]

Updated modeling using a newer version of CA-CP with modifications to was conducted for the ACUPCC 2010 biennial report. Results of the updated modeling (Table 1) showed transportation to be a much larger portion of the footprint, principally due to more accurate estimates of the amount of air travel actually conducted by university employees and students. Additional categories such as paper purchases were considered in 2010, further increasing the estimated GHG footprint. The change in GHG emission distribution between original and updated modeling suggested that the original Climate Action Plan needed to be updated. This was seen as an opportunity to explore a broader set of metrics and criteria for managing the university more sustainably.

Sustainability Footprint

To create a new model that captured more metrics and a broader range of potential actions beyond GHG, key sustainability metric systems were

analyzed. They included the Global Reporting Initiative (GRI),[2] United Nations Millennium Development Goals (UN MDGs),[3] United Nations Commission on Sustainable Development (UN CSD) indicators,[4] and U.S. Environmental Protection Agency (EPA) Report on the Environment (ROE) indicators.[5] Additional systems relating to universities were included, namely the Association for the Advancement of Sustainability in Higher Education Sustainability Tracking, Assessment & Rating System (STARS),[6] the Princeton Review Green Campus (GC) criteria,[7] the Sustainable Endowments Institution College Sustainability Green Report Card (GRC),[8] and the UC 2019 Strategic Plan.[9]

GRI, created by the World Business Council for Sustainable Development and the World Resources Institute, is a sustainability reporting system used by organizations in 37 commercial, governmental, and nonprofit sectors. The system comprises general reporting guidelines and special indicator sets. For this project, a combination of baseline performance indicators and sector indicators for electric utilities and public agencies were used.

UN MDGs exist to advance the state of humanity in eight core areas, including universal education and environmental sustainability. The CSD indicators focus on 14 themes across economic, environmental, and social topics and are intended to guide international agencies and individual countries in defining sustainability programs. EPA issued the ROE indicators to provide information on key national and regional environmental conditions and trends. The system also includes nine human health conditions, which could be biomarkers or health effects associated with exposure to environmental pollution.

AASHE STARS is a self-reporting framework created to guide universities in assessing and improving their sustainability performance according to weighted credits for specified activities. The GC report rates universities in 10 aspects of sustainability, while the GRC rates performance in a more extensive list of weighted criteria. The UC 2019 strategic plan sets forth goals in areas deemed critical to institutional success, including sustainability.

In total, 621 indicators were assessed. A comparison of the indicators by system is shown in Table 2. Looking across the indicators there was variability in the issues addressed by topic and by system. The only indicator listed in all seven systems was conducting a GHG inventory.

Notes for Table 2:

1. *GRI = Global Reporting Initiative Sustainability Reporting Guidelines, combination of G3, Electric Utility and Public Agency indicators.*
2. *UN MDG/CSD = United Nations Millennium Development Goals and Commission for Sustainable Development Indicators.*
3. *EPA ROE = U.S. Environmental Protection Agency Report on the Environment Indicators.*
4. *AASHEE STARS = Association for the Advancement of Sustainability in Higher Education Sustainability Tracking, Assessment & Rating System, Version 1.0*
5. *PR GC = Princeton Review Green College (GC) criteria. While the GC has only 10 criteria, the one on GHG is a compound indicator of computing a GHG inventory and having a reduction plan. These elements were counted separately for the assessment project.*
6. *SEI GRC = Sustainable Endowments Institute. College Sustainability Report Card 2011*
7. *UC 2019 = University of Cincinnati UC2019 Strategic Plan.*

Table 2. Comparison of indicator systems assessed.

Number of Indicators Assessed	GRI[1]	UN MDG/CSD[2]	EPA ROE[3]	AASHEE STARS[4]	PR GC[5]	SEI GRC[6]	UC 2019[7]	Total
Economic	34	23	0	18	2	22	25	124
Environmental	53	49	44	62	6	41	2	257
Social	74	43	10	58	3	17	35	240
Total	161	115	54	138	11	83	59	621

Table 3. Major themes addressed by UC Sustainability Framework. (*Note:* Many subsidiary metrics exist within each theme.)

Economic		Environmental		Social	
Financial performance of the university	R&D expenses and results	Disaster preparedness	Land use; tree cover	Physical safety	Anti-corruption
Productive employment/ wages	Market presence	Material use, Recycled content	Reduce transportation impacts	Health care	Sustainable housing, dining options
International impact	Affordability & access	Energy use intensity, fossil fuel, renewables	Material & Energy efficiency programs	Technology deployment	Adult learning, Employee training
Staff responsible for sustainability programs	Planned capacity and projected demand	Water use & efficiency	GHG inventory and reductions	Workforce composition, diversity, benefits	Sustainability curriculum offerings, research
Green purchasing	% local & preferred spending	Other air pollutant reductions	Indoor air quality	Employee & contractor health & safety	Student sustainability programs
Contractor management programs	Socially responsible fund options	Waste reduction, recycling	Source reduction	Community involvement and impacts	Privacy protection
Local investments	Endowment	Spills, discharges	Stormwater management	Public policy, lobbying	Stakeholder participation
Regulatory compliance					
Transparency					

Topics with highest numbers of related indicators were:

- minimizing transportation impacts (30),
- health status and risks (23),
- waste reduction (20),
- energy efficiency for buildings and equipment (19),
- economic performance (17),
- adult learning (15),
- sustainability curriculum (15),
- ambient air quality (14), and
- a tie between R&D, responsible investing and investment transparency, and sustainability policy and planning (12 each).

Indicators from all these systems were categorized into topic areas, and then assessed for potential applicability to the university setting according to:

- coverage across the spectrum of environmental, economic, and social factors;
- scope limitations relative to the University operations;
- data limitations – current sources for data or issues relating to developing data; and
- clarity and utility of output as management tools in the university setting.

The major themes in the customized sustainability metric set defined for UC are summarized in Table 3. The proposed sustainability framework addresses 87% of the assessed economic indicators, 72% of the environmental indicators, and 80% of the social indicators in a consolidated format that makes them more useful as a management tool. In total, the new sustainability footprint covers 78% of the

Table 4. Summary comparison of water saving actions.

	Cost of Actions ($)	Water Savings ($/yr)	Simple payback (yr)	Net Present Value ($)	GHG reduction (MT CO_2e)
Climate Action Plan	550,000	64,545	9	5,095	31
Sustainability Plan	539,964	353,656	2	1,980,048	170

assessed indicators and concentrates on those aspects that apply directly to the university. There was no existing metric set that covered all the relevant indicators. The best match was GRI, which addressed 69% of the content relevant for UC, and second was AASHE at 40%. Application of the entire set of indicators will require additional data collection efforts within the university and is part of ongoing work. However, data existed for a subset of the indicators relating to total utility consumption. These data were used to test the effect of broadening the model from GHG into sustainability focused.

Utility Consumption Test Case

Sustainability action planning, through analysis of total utility consumption, including all forms of energy and domestic water for each building, and use of an optimization model, led to targeting a different set of buildings than those indicated by the GHG-based Climate Action Plan. Because of data limitations, the only set of mitigation options that could be directly compared was water efficiency actions. Factors such as plumbing efficiency, building age, and water consumption were used as inputs to a simple linear algebraic optimization model. The model utilized a binary changing cell to represent doing (or not doing) each individual project in the water efficiency action set with the objective of maximizing net present value (NPV) under a constraint of maximum capital cost of $550,000. This value was chosen to match the projected cost of the actions suggested in the Climate Action Plan GHG-based list. The modeling output showed that the sustainability framework revealed a set of actions with shorter payback period, higher NPV and much higher GHG reductions, for slightly less capital outlay than the baseline CAP, as shown in Table 4.

Conclusion

Inclusion of a more broadly-based set of sustainability metrics in an institutional planning model may identify actions that reduce costs and payback periods and further reduce GHG emissions in comparison with actions that would be recommended based upon the CA-CP model alone. em

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Acknowledgments: *The authors gratefully acknowledge access to data provided by Mary Beth McGrew, Joe Harrell, and Maury DuPont from the University of Cincinnati, and funding provided through Research and Teaching Assistantships from the University of Cincinnati and a Fellowship from the National Science Foundation.*