THE UNIVERSITY OF CHICAGO

Greenhouse Gas Emissions Reduction Plan

FY2018–FY2025

March 2018

THE UNIVERSITY OF CHICAGO | Office of Sustainability

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EXECUTIVE SUMMARY

The University of Chicago is committed to creating a sustainable campus. To support this commitment, the **University has established a goal to reduce its greenhouse gas emissions by 20% by 2025**. The effort is part of a more comprehensive Sustainability Plan (sustainability.uchicago.edu/sp).

In 2016, the University released the results of a greenhouse gas emissions inventory in the Sustainability Plan. The inventory established a target base year for campus emissions, using a measure of carbon intensity (greenhouse gas emissions per square foot). As of February 2018, target base year emissions for scopes 1 and 2 are 16.5 kg eCO_2/sqft (kilograms carbon dioxide equivalent per square foot). Since the release of the Sustainability Plan in November 2016, the University Of Chicago greenhouse gas emissions inventory was updated to include fiscal years 2016 and 2017, and updated emissions factors from the Environmental Protection Agency.

To meet the 2025 goal, the University must reduce scope 1 and 2 greenhouse gas emissions to 13.2 kg eCO_2/sqft.

Grumman/Butkus Associates (G/BA), a firm of energy efficiency consultants and sustainable design engineers, was retained in 2017 to help the University analyze and prioritize strategies for reaching the emissions reduction goal. The focus is to reduce scope 1 and scope 2 emissions, to be achieved by reducing the energy (natural gas and electricity) used by University facilities. (Scope 1 emissions are emissions produced by on-campus combustion of fuels for heating and cooling of buildings; combustion of fuels to power campus-owned fleet; and off-gassing of fertilizers used on campus. Scope 2 emissions are emissions produced by off-campus combustion of fuels to produce electricity, steam, or chilled water for the campus.)

Since natural gas and electricity consumed in campus buildings contribute to nearly 70% of the University's greenhouse gas emissions, building energy efficiency is the primary focus of this emissions reduction plan.

After analyzing the greenhouse gas emissions inventory and other information about the campus and its energy use, such as campus growth potential, building energy usage, and previously completed energy efficiency projects, G/BA recommended various initiatives (see Table 1.1) for achieving the 2025 goal.

The plan includes purchasing Renewable Energy Certificates (RECs), Power Purchase Agreements (PPAs), or similar instruments supporting off-site renewable energy production to make up any gaps in emissions reductions, as allowed by the *World Resource Institute Greenhouse Gas Protocol Scope 2 Guidance*. **However, the intention is to reduce emissions as much as possible through facility-related energy savings projects.**

This report summarizes emissions-reduction actions already taken by the University, and provides a plan for reaching the 2025 goal.

TABLE 1.1: RECOMMENDED INITIATIVES FOR ACHIEVING THE 2025 GOAL

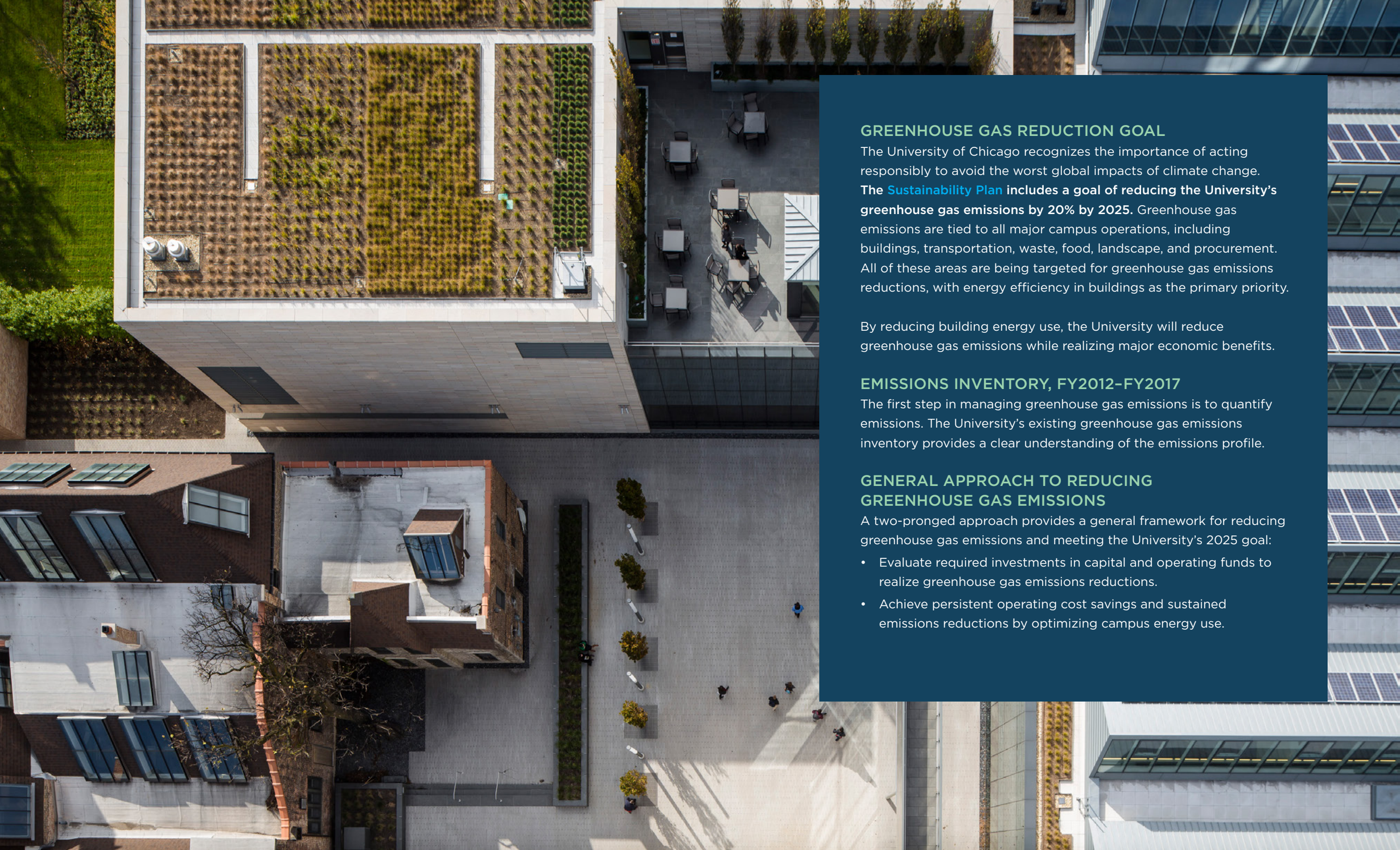
MEASURE TYPE	DESCRIPTION	GHG EMISSIONS REDUCTION CONTRIBUTIONS
Building Preventative Maintenance and Commissioning (PM+Cx)	Investigate the top energy consuming buildings on campus for operational improvement and energy conservation opportunities.	36.5%
Central Plant Efficiency Upgrades	Implement energy efficiency upgrades at the campus steam and chilled water plants.	28.7%
Building-level Capital Energy Efficiency Projects	Implement capital projects that are identified through the PM+Cx process.	10.4%
Lighting Upgrades	Indoor and outdoor lighting upgrades around campus.	2.0%
Off-site Renewable Energy	Purchase renewable energy credits for off-site energy production.	22.4%
TOTAL		**100.0%**

SUSTAINABILITY AND EXISTING EMISSIONS

SUSTAINABILITY AT THE UNIVERSITY OF CHICAGO

The University of Chicago is committed to creating a sustainable campus and addressing everyday issues related to resource stewardship, while seeking to understand the long-term impacts of today's decisions.

The University of Chicago Sustainability Plan (SP) includes goals in nine areas: Climate Change and Energy; High Performance Buildings; Multi-Modal Transportation; Waste Reduction; Food Systems; Green Space; Water Conservation; Environmentally Preferable Procurement; and Building Awareness and Partnerships. **Understanding and managing greenhouse gas emissions, as addressed in the Climate Change and Energy section of the SP, is the University's top strategic sustainability priority.**



GREENHOUSE GAS REDUCTION GOAL

The University of Chicago recognizes the importance of acting responsibly to avoid the worst global impacts of climate change. **The Sustainability Plan includes a goal of reducing the University's greenhouse gas emissions by 20% by 2025.** Greenhouse gas emissions are tied to all major campus operations, including buildings, transportation, waste, food, landscape, and procurement. All of these areas are being targeted for greenhouse gas emissions reductions, with energy efficiency in buildings as the primary priority.

By reducing building energy use, the University will reduce greenhouse gas emissions while realizing major economic benefits.

EMISSIONS INVENTORY, FY2012–FY2017

The first step in managing greenhouse gas emissions is to quantify emissions. The University's existing greenhouse gas emissions inventory provides a clear understanding of the emissions profile.

GENERAL APPROACH TO REDUCING GREENHOUSE GAS EMISSIONS

A two-pronged approach provides a general framework for reducing greenhouse gas emissions and meeting the University's 2025 goal:

- Evaluate required investments in capital and operating funds to realize greenhouse gas emissions reductions.
- Achieve persistent operating cost savings and sustained emissions reductions by optimizing campus energy use.

ENERGY PROJECTS, FY2010–FY2017

From FY2010–FY2017, the University of Chicago implemented numerous projects to reduce greenhouse gas emissions through facility energy savings. Strategies the University has used in projects that help reduce emissions are summarized below.

- Pursuing LEED Certification of facilities (new construction, major renovations).
- Leveraging energy project incentives from local utilities.
- Undertaking retro-commissioning of buildings (funded by ComEd).
- Piloting monitoring-based commissioning projects.
- Performing infrastructure improvements (central plant upgrades).
- Completing lighting upgrades, including installation of LED fixtures and lighting controls (for instance, occupancy sensors).

LEED PARTICIPATION

Fifteen buildings on the University of Chicago campus have achieved LEED certification since 2010. An additional three buildings are pursuing certification. The LEED rating system includes requirements for energy savings and credits for reducing energy use beyond the referenced standard. By pursuing credits for energy savings, the University helps to ensure that new construction and major renovation projects reduce the average energy usage intensity (EUI) of campus buildings.

Physics Research Center (shown)

- Construction completed: October 2017
- Renovation and addition to house physics research, including astrophysics and space research
- Area: 68,269 sqft
- Certified LEED Gold - LEED BD+C: Building Design + Construction v3 - LEED 2009
- Achieved 7 of 19 points for energy optimization

ENERGY PROJECT INCENTIVES

The University has also leveraged energy project incentives from ComEd, the University's electrical utility, and Peoples Gas, the natural gas utility. Completed projects ranging from lighting upgrades to new air-handling unit controls have already earned more than $2 million in utility incentives.

RETRO-COMMISSIONING

In addition, the University has leveraged ComEd's retro-commissioning program, which pays third-party service providers to analyze facility energy use and suggest low- or no-cost, short-payback measures for improvement. In exchange, the facility owner is required to implement energy savings measures recommended by the retro-commissioning analyst, within stated parameters for payback. The University has completed 12 retro-commissioning projects, yielding an estimated energy savings of $557,000 per year.

MONITORING-BASED COMMISSIONING

Three buildings have been engaged in a monitoring-based commissioning process. Monitoring-based commissioning is a systematic process that uses utility meters and a facility's building automation system to identify opportunities for energy savings or performance improvements.

INFRASTRUCTURE IMPROVEMENTS

Infrastructure improvements already made by the University include upgrades to the Steam Plant Power Plant. Stack economizers were added to recover heat from the boiler flue gases. This heat is now used to preheat feed water for the boilers, which reduces the natural gas used by the steam plant. Heat is also being recovered from the vents and blowdown. Thermal blankets were applied to steam valves and other steam accessories to help reduce the heat loss through those components and reduce natural gas use.

LIGHTING UPGRADES

Lighting in many campus buildings has been upgraded with higher efficiency equipment. Projects in 16 buildings and exterior lamp pole upgrades have been projected to save more than 1 million kilowatt hours (kWh) annually.

Harper Memorial Library (shown above) Lighting Project

- 67,233 sqft
- Replaced the lamps in over 1,400 luminaires
- Reduced peak electricity demand by 35 kW
- Estimated annual electricity savings of 106,600 kWh

EMISSIONS REDUCTION PLAN SUMMARY

To meet its greenhouse gas emissions reduction target—cutting emissions by 20% from the identified target base year by 2025—the University of Chicago has developed an emissions reduction plan focused on scope 1 and 2 emissions.

Reductions are primarily driven by **energy savings projects in campus facilities.**

Scope 1 and 2 emissions reductions for FY2018–FY2025 will primarily be achieved through energy savings projects implemented in FY2018–FY2025. Energy savings projects are grouped into four categories:

1. Preventative maintenance and commissioning (PM+Cx)
2. Building-level energy efficiency capital projects (medium-length payback)
3. Central plant efficiency upgrades
4. Lighting upgrades

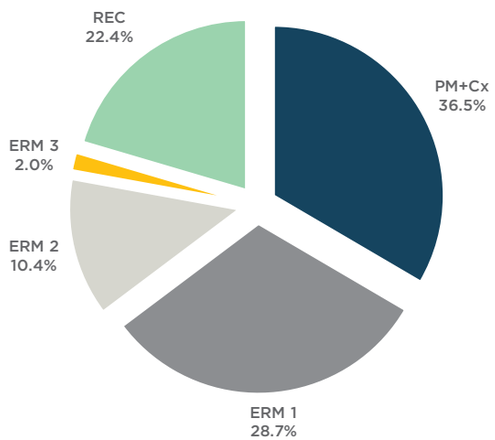
A substantial part of the savings will be realized through the **PM+Cx program**, which aims to achieve energy savings through equipment maintenance and implementing low- or no-cost, short-payback retro-commissioning measures. These projects will also identify additional energy savings measures involving **capital projects with a medium-length payback**. Projects at the campus central **steam and chilled water plants** have already been identified and will be completed throughout the time frame of this plan. **Lighting upgrades** that make use of rapidly evolving technologies will also contribute to campus energy savings.

TABLE 1.2: GHG EMISSIONS REDUCTION PLAN 2018–2025

MEASURE TYPE	DESCRIPTION	2018	2019	2020	2021	2022	2023	2024	2025
Building Preventative Maintenance and Commissioning	Investigate the top energy consuming buildings on campus for operational improvement and energy conservation opportunities.	■	■	■	■	■	■	■	■
Central Plant Efficiency Upgrades	Implement energy efficiency upgrades at the campus steam and chilled water plants.	■	■	■	■	■	■		
Building-level Capital Energy Efficiency Projects	Implement capital projects that are identified through the PM+Cx process.			■	■	■	■	■	■
Lighting Upgrades	Indoor and outdoor lighting upgrades around campus.	■	■	■	■				
Off-site Renewable Energy	Purchase renewable energy credits for off-site energy production.	■	■	■	■	■	■	■	■

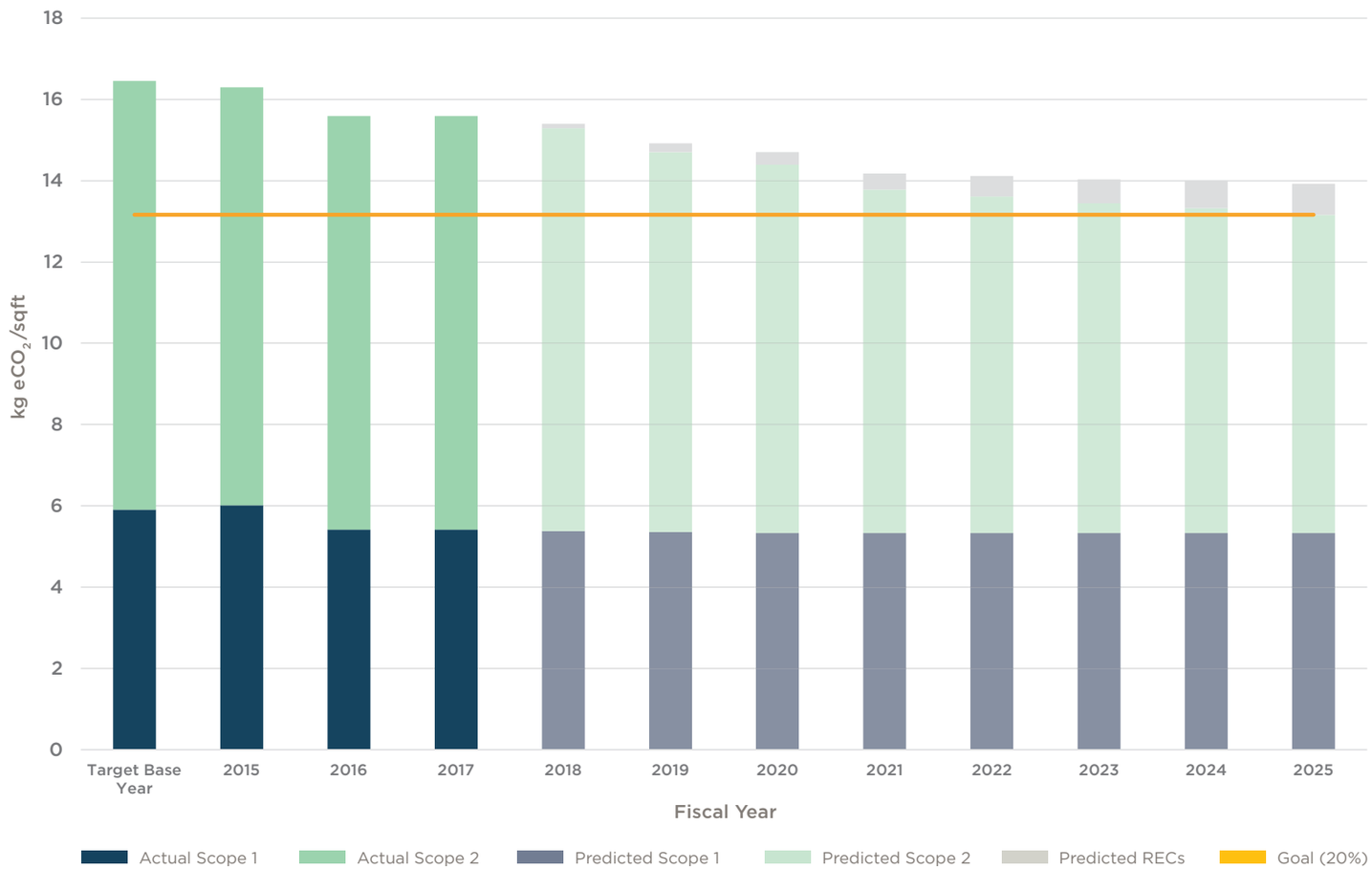
Figure 1.2 shows the actual carbon intensity for the target base year and FY2015–FY2017, and the predicted carbon intensity for FY2018–FY2025, for scopes 1 and 2. Also shown is the 20% emissions reduction goal. The emissions reductions in this figure are attributable to the projects identified in this plan. Figure 1.1 is a breakdown of the contribution each project type makes toward achieving the FY2025 GHG emissions reduction goal. Project types include PM+Cx plus other emissions reduction measures (ERM), including central plant efficiency upgrades, building-level energy efficiency projects, and lighting upgrades. Off-site renewable energy projects (REC) are also included.

FIGURE 1.1: GHG EMISSIONS REDUCTION CONTRIBUTIONS



	PM+Cx	Building Preventative Maintenance and Commissioning
	ERM 1*	Central Plant Efficiency Upgrades
	ERM 2*	Building-level Capital Energy Efficiency Projects
	ERM 3*	Lighting Upgrades
	REC	Off-site Renewable Energy
	*ERM	Emissions Reduction Measure

FIGURE 1.2: ANNUAL SCOPE 1 & 2 CARBON INTENSITY



IMPLEMENTATION PLAN, FY2018–FY2025

PM+CX

The University implemented the Preventative Maintenance and Commissioning (PM+Cx) process following the restructuring of the ComEd incentive program. The University no longer participates in the ComEd incentive program, due to recent legislation in Illinois that removed large electricity users from the program. Instead, the University manages its own energy auditing program with some modifications to the previous retro-commissioning process. The overall philosophy is that basic system operation should be tested and confirmed to be functioning properly before any optimization and advanced energy conservation measures are implemented.

The main objectives of the PM+Cx process are to identify HVAC operational issues, document existing equipment and control sequences, identify energy optimization opportunities, implement selected facility improvement measures, and develop a process to monitor building operation and achieve persistent energy savings.

The initial plan includes implementing this process in 38 buildings within the University of Chicago Organizational Boundary (defined in the *University of Chicago Greenhouse Gas Emissions Inventory Overview 2012–2017*).

Although more than 120 buildings are included in the emissions inventory, these 38 buildings are responsible for approximately 80% of the campus energy consumption. The high energy usage and cost of these buildings justifies dedicated focus to lower energy usage.

Figure 1.3 shows all campus buildings included in the *University of Chicago Greenhouse Gas Emissions Inventory Overview 2012–2017*. Buildings represented by green dots are included in the PM+Cx plan; orange are not included.

FIGURE 1.3: ANALYSIS OF BUILDING ENERGY USAGE FOR INCLUSION IN PM+CX

Each PM+Cx project is expected to identify **operational improvement measures, low- or no-cost measures, and capital projects**. The analysis for each building will provide a detailed path toward opportunities for improving building operation and reducing greenhouse gas emissions. Typical low- or no-cost measures that will be identified include the following:

- Seasonal setback adjustments
- Equipment scheduling
- Temperature reset
- Static pressure reset
- Simultaneous heating and cooling
- Economizer optimization
- Green Laboratory Program (energy efficiency in laboratory operations, such as a fume hood sash-closing initiative)

This plan recommends proceeding with this process in six or seven buildings a year for the next five years. That will allow the University to survey all 38 buildings by the end of fiscal year 2023. The University should then investigate the initial top 12 energy using buildings again in fiscal years 2024 and 2025. Since these 12 buildings are prioritized higher in the first round of building surveys, these second round surveys will likely occur four years after the buildings are initially surveyed.

A project already under way in **Searle Chemistry Laboratory** has identified each type of PM+Cx opportunity (operational improvements, no- or low-cost measures, and capital projects).

Operational Improvements

- Replace hydronic system expansion tank diaphragms that were identified as failed.
- Adjust cleanroom system chilled water temperature to satisfy relative humidity requirements in the end-users' space.

Low- or No-Cost Energy Savings Measures

- Reduce fume hood face velocity from 100 fpm to 80 fpm to reduce the supply and exhaust air demand in the laboratories.
- Change the supply air-handling unit filter type to reduce the air pressure drop and fan energy.
- Reset the air-handling unit supply air temperature during periods of low cooling load to reduce the building reheat energy load.

Energy-Saving Capital Projects

- Replace the heat recovery unit air damper pneumatic actuators with electronic actuators to reduce bypass air leakage through failed dampers.
- Convert heat recovery exhaust fans from constant speed to variable speed.

The recommended operational improvements and low- and no-cost measures would reduce the building's greenhouse gas emissions by an estimated 1,003 MT eCO_2 per year. Implementing the capital projects would further reduce emissions.

BUILDING-LEVEL ENERGY EFFICIENCY CAPITAL PROJECTS

In addition to identifying promising low- or no-cost, short-payback projects, the PM+Cx process will also identify projects with longer paybacks. These projects will require the investment of capital and may require additional design work. Simple paybacks will be in the four- to eight-year range.

At the completion of each PM+Cx project, the University will evaluate the additional measures recommended by the evaluating firm. Some projects may require further study so the University can fully understand the potential energy savings and project costs.

If a project looks viable, the University may add it to the list of energy efficiency capital projects planned for the fiscal year falling two years after the PM+Cx project. For example, projects identified through PM+Cx during FY2018 may be implemented in FY2020. This will allow sufficient time for budgeting, design, and construction.

A estimated budget of $500,000 per year for fiscal years 2020, 2021, 2022, and 2023 is included in the plan for implementing medium-payback capital projects. Many different kinds of energy savings projects will qualify.

Energy audits in 2011 identified more than $3 million in potential projects that would meet the four- to eight-year payback parameter. For instance:

- **Convert constant-volume pumping to variable volume**. Many chilled water and hot water pumping systems in University buildings operate at a constant water flow. The flow is sized for the peak system load, which may only happen a few times each year. At all other times, excess water is flowing. Savings can be achieved by reducing pump speed and, therefore, water flow. This tactic reduces the electricity required to operate pumps. To realize these savings, constant-volume systems must be converted to variable volume.
- **Convert constant-volume air-handling units to variable volume**. University facilities include many constant-volume air-handling units. Variable-volume systems save energy by providing only the airflow needed to meet space conditioning loads. A constant-volume system is sized for, and operates at, the peak design load at all operating hours. But actual peak loads are rare, so most of the time a constant-volume system delivers an oversupply of air, with a consequent overuse of electricity by fan motors. Because of fan power laws, decreasing the fan-driven airflow results in a larger decrease in electricity needed by the motor. A 10% airflow reduction correlates to more than a 25% reduction in electricity use.
- **Add energy recovery**. An energy recovery system reduces the energy required to condition outside air by using exhaust air, which has already been conditioned to the desired space temperature, to pre-condition incoming outside air. Energy recovery is especially good for systems that supply 100% outside air, such as air-handling units that serve laboratories. Energy recovery options include run-around loops, energy recovery wheels, and flat plate heat exchangers.

CENTRAL PLANT EFFICIENCY UPGRADES

Most campus buildings are served by the campus steam system, the campus chilled water system, or both. Boilers in the South Steam Plant and the West Campus Combined Utility Plant (WCCUP) serve the campus steam system. The chillers in Regenstein Library, the South Campus Chiller Plant, and WCCUP serve as the primary sources for chilled water for the campus chilled water system.

Because these plants serve a substantial amount of the campus heating and cooling load, energy savings projects involving this infrastructure will significantly reduce greenhouse gas emissions. Optimizing chiller operations and improving the temperature difference between chilled water system supply and return are examples of projects that will be included in the plan.

One project with particularly good emissions-reduction potential is the installation of a back-pressure turbine in the South Steam Plant (F02). The turbine would use the high-pressure steam produced by the plant to produce electricity. The plan calls for this measure to be implemented over two years. Emissions reductions will occur in the second year.

LIGHTING UPGRADES

Though the University has undertaken many lighting projects since 2010, additional locations will receive lighting upgrades as part of the Emissions Reduction Plan. Lighting technology, such as LED lamps, is rapidly evolving. Costs are falling, so additional lighting projects are becoming economically viable. The University will continue to evaluate and invest in cost-effective lighting projects. Exterior lighting is specifically targeted as part of this plan.

OFF-SITE RENEWABLE ENERGY

The University has several options for participating in off-site renewable energy projects. Renewable Energy Certificates (RECs), community solar projects, and power purchase agreements (PPAs)are all instruments that finance renewable energy projects. Refer to the Appendix for additional resources on off-site renewable energy.

RECs are a financial mechanism for reducing an institution's environmental impact outside the institutional boundaries. The REC is a tradable, non-tangible energy commodity, representing proof that 1 megawatt-hour (MWh) of electricity was generated from an eligible renewable energy resource. RECs incentivize carbon-neutral renewable energy by providing a production subsidy to electricity generated from renewable sources.

Community solar projects are solar photovoltaic projects that are located in the same utility region as their customers. Individuals, businesses, or institutions can either own shares (typically panels or Watts) of the projects or subscribe to the project. Ownership requires an up-front payment while a subscription involves periodic payments. The City of Chicago is working to encourage the development of these projects.

With a PPA, the University would contract with a renewable energy supplier to purchase electricity. The price of the power, which would include the REC, is negotiated between the supplier and purchaser. This electricity is then delivered to the purchaser. A PPA is one tool that renewable energy project developers can use to finance projects.

Regardless of the purchase option selected for off-site renewable energy, the University must maintain ownership of the REC to claim the carbon offset.

The intent of the University's Greenhouse Gas Emissions Reduction Plan is to reduce emissions as much as possible through facility-related energy savings projects. The plan includes investing in off-site renewable energy to make up any gaps in emissions reductions, as allowed by the *World Resource Institute Greenhouse Gas Protocol Scope 2 Guidance.*

MEASURES NOT INCLUDED IN THE PLAN

Several categories of energy savings projects are not included in the Greenhouse Gas Emissions Reduction Plan. They have been omitted because their high implementation costs translate to a low return on investment, and a high cost per MT eCO_2 (metric ton carbon dioxide equivalent) reduced.

Projects that fit into this category include building envelope upgrades, temperature controls upgrades, and on-site renewable energy projects. See Table 1.3.

Though these projects may not be good candidates for cost-effective emissions reductions, the University could still decide to pursue them for other reasons. For instance, on-site renewable energy projects may serve as a visible affirmation of the University's commitment to reducing greenhouse gas emissions.

Envelope. Many campus buildings currently have single-pane windows or little to no exterior insulation. To reduce air infiltration, the windows could be replaced with double-pane, high-performance, low-e coated glazing. Roofing changes can also be considered; high-reflectivity materials help reduce cooling loads, thus reducing electricity consumption. Green roofs (covered with vegetation) can be used to increase campus green space, as well as to increase roof insulation and storm water quantity control. Green roofs also serve as a visible symbol of environmental commitments.

Controls. Currently, temperature controls in some campus buildings are pneumatic, limiting the University's ability to implement energy efficiency strategies related to controls. Installing direct digital controls (DDC) would allow implementation of many additional energy efficiency measures, and would also facilitate collection of data that can be used to identify other potential areas for improvement. These upgrades may be recommended as part of larger renovation projects or to address temperature control issues, but would not be recommended solely as an emissions-reduction project.

On-Site Renewable Energy. The University may pursue adding renewable energy capacity by exploring new technologies, feasibility analyses, and small-scale demonstration applications. For instance, small-scale wind turbines or photovoltaic installations may be an option for some parts of campus.

Photovoltaic solar panels capture the sun's energy and convert it into direct-current electricity. This power must be converted to alternating current to be used in a building. A photovoltaic system consists of solar panels, inverters, wiring, and mounting. Small arrays of solar panels can be mounted on roofs around campus. Solar collectors that use thermal energy from the sun can pre-heat domestic water or supplement the hot water that is used to heat buildings. The University has previously implemented photovoltaic installations on some facilities.

TABLE 1.3: PROJECT COST PER MT eCO_2 REDUCED

MEASURE	ESTIMATED RANGE OF $/MT eCO_2 REDUCED	ESTIMATED COST TO MAKE SIGNIFICANT IMPACT*
Building Preventative Maintenance and Commissioning	$250–$750	$722,000–$2,165,000
Central Plant Efficiency Upgrades	$300–$600	$866,000–$1,732,000
Building-level Capital Energy Efficiency Projects	$800–$1,000	$2,309,000–$2,887,000
Lighting Upgrades	$300–$450	$866,000–$1,299,000
Off-site Renewable Energy (RECs)	$3–$7	$9,000–$20,000
Temperature Controls	$1,200–$2,600	$3,464,000–$7,506,000
Building Envelope Upgrades	$2,500–$3,000	$7,217,000–$8,661,000
On-site Renewable Energy	$4,000–$5,000	$11,547,000–$14,434,000

*A significant impact is 10% of the GHG emissions reduction goal

SOCIAL RESPONSIBILITY AND SCOPE 3 EMISSIONS

Reporting of scope 3 greenhouse gas emissions is optional reporting. The University reports emissions from scope 3, including business air and automobile travel; study abroad travel; solid (landfilled) waste; and scope 2 transmission and distribution losses. Business travel represents the third-largest source of the University's greenhouse gas emissions.

Greenhouse gas emissions from transmission and distribution losses are directly reduced as scope 2 electricity consumption is reduced. The University has programs in place to actively divert waste from landfills, and more information can be found in the Sustainability Plan.

To offset its scope 3 emissions, the University may pursue partnerships that reduce emissions, such as community renewable energy projects, land conservation, and tree planting.

One mechanism for offsetting scope 3 emissions, including emissions from business travel, is purchasing carbon offsets. A carbon offset is a credit derived from supporting a wide range of projects verified by a third party. Carbon offsets must represent real emissions reductions. They are subject to a standard, and they must represent emissions reductions that are measurable, permanent, and in addition to what was already being done. A wide variety of carbon offsets, for projects all over the world, can be purchased to offset greenhouse gas emissions.

OFFSETTING SCOPE 3 EMISSIONS

Explore the various types of carbon offsets available and choose options that align with the University's mission and research. The average price of carbon offsets in 2016 varied widely; see Figure 1.4 for carbon offset project types and average prices. Projects in the Midwest include:

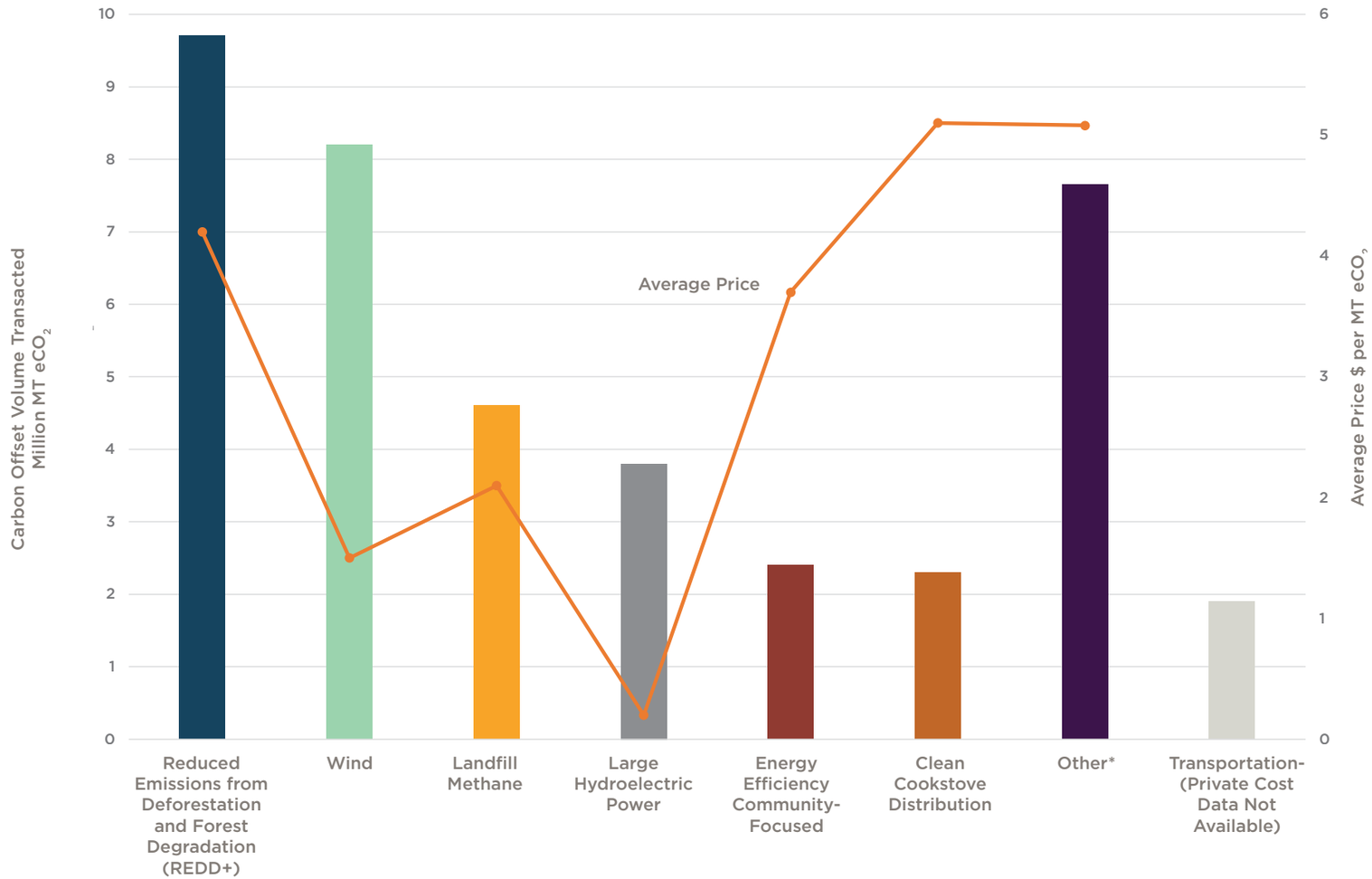
- Reforestation of agricultural land in Illinois
- Electricity production from biogas generated by Michigan dairy farms

Identify reputable organizations that sell these types of offsets.

- Green-e, a program of the Center for Resource Solutions (green-e.org/certified-resources), has a website that allows users to search for companies that sell the various types of offsets.

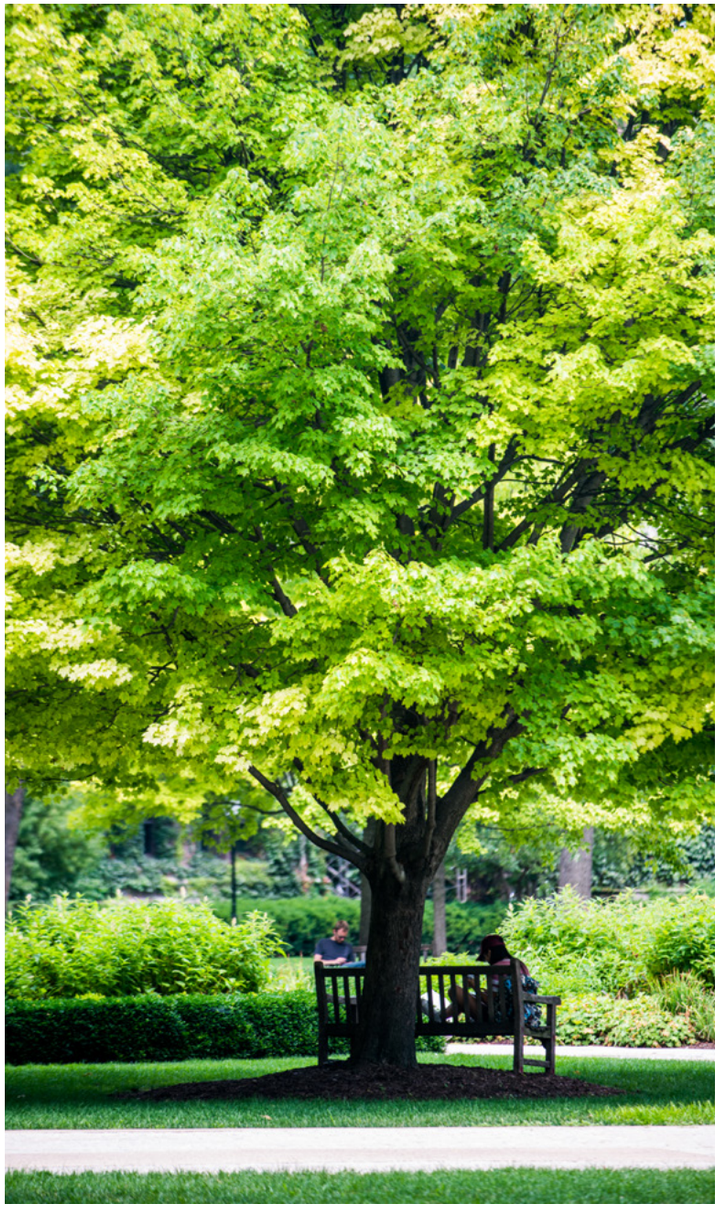
Purchase carbon offsets equivalent to 20% of the scope 3 target base year emissions, which is equal to 9,114 MT eCO_2. At an average price of $3.00 per MT eCO_2, the cost to purchase carbon offsets for 20% of the target base year emissions would be $27,342.

FIGURE 1.4: CARBON OFFSET MARKET SHARE AND AVERAGE PRICE BY PROJECT TYPE



***OTHER INCLUDES:**

- Afforestation/Reforestation
- Biogas
- Biomass/Biochar
- Improved Forest Management
- Water Purification Device Distribution
- Run-of-River Hydroelectric Power
- Solar



CARBON OFFSET PROJECT DEVELOPMENT PLAN

Another option is for the University to implement projects that offset emissions in collaboration with the local community. This strategy would involve the following steps:

1. Partner with the community to identify potential carbon emissions reduction projects on campus or in the community. Project ideas could come from research being performed on campus or from the needs of the community. Projects could include:
   - Tree planting in the City of Chicago
   - Affordable housing energy efficiency upgrades
   - Conservation of Illinois prairie

2. Determine if a proposed project should undergo an emissions reduction verification process. This would allow the University to sell or trade the carbon offsets. Certifying the offsets will add additional expense to the projects. **Items in this section could be done for social responsibility reasons, but do not necessarily qualify to be included in the greenhouse gas emissions inventory, as per greenhouse gas emissions protocols and referenced standards.**

3. If a project will have its emissions verified, identify an emissions reduction protocol or methodology that would apply to the project.
   - For tree planting, refer to Climate Action Reserve's Urban Tree Planting Project Protocol (climateactionreserve.org/how/protocols/urban-forest)

4. Complete the project to meet the guidelines of the identified protocol or methodology.

5. Verify and certify the carbon offsets with a third-party certification body.

6. Provide an opportunity for the larger University of Chicago community to support this effort.

Community projects will help create connections between varying entities to accelerate and grow social, economic, and environmental goals and accomplishments across the community. They will also serve as a driver for economic resilience through support of informed and integrated sustainable economic development.

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EMISSIONS REDUCTION PERSISTENCE

The goal of the greenhouse gas emissions reduction program is not simply to reach the 2025 goal, but also to ensure that the emissions reductions persist over time. Toward this end, the plan recommends several persistence strategies, including:

- Tracking building energy usage data
- Additional training for facilities engineering staff
- Central plant monitoring
- A steam trap maintenance program
- A general energy efficiency best practices program

BUILDING ENERGY USAGE DATA

To ensure that the University is on target to meet its greenhouse gas emissions reduction goal, **tracking building energy usage data** is essential. The University is installing an energy management information system (EMIS) that will facilitate utility data collection and analysis. The system will allow annual and monthly baselines to be established. Current utility data can be compared with the baseline data, and staff can be alerted to increases in energy use.

Energy use in buildings where emissions reduction projects are taking place must be tracked to verify that expected savings are being achieved. Measurement and verification (M&V) is important to ensure that an energy savings measure is having its desired effect and is reducing energy usage. M&V is the process of comparing energy usage before a measure was implemented with usage after it was put into place.

Implementation of an appropriate M&V strategy is an important part of each project identified through the PM+Cx process. The design process should identify appropriate parameters to measure, and additional metering equipment should be included if necessary. Tracking energy use will also help ensure that savings are being maintained over time.

As part of a monthly building check-up plan, staff will be provided with energy use data. Individual meter readings can then be reviewed, and any increases in monthly use can be more readily recognized and addressed.

FACILITIES STAFF TRAINING

As part of the PM+Cx process, the facilities staff will be trained on the implemented energy savings measures. Additional training focused on energy conservation for facilities engineering staff is recommended. The training is important to allow building operators to enhance skills that address comfort complaints, improve building systems' energy efficiency, and tackle operations and maintenance issues.

CENTRAL PLANT MONITORING

The University monitors campus chilled water usage and chilled water component energy usage to assess the chilled water system efficiency. Similarly, the campus monitors building steam usage and condensate return and boiler plant natural gas usage to assess steam system efficiency. The data is routinely reviewed to identify system inefficiencies.

STEAM SYSTEM MAINTENANCE

The University's steam system is large and distributed. Since 2014, the in-house energy management team has worked to repair or replace malfunctioning steam traps. This procedure reduces steam usage, thus reducing greenhouse gas emissions from natural gas combustion required to produce the steam. A steam trap maintenance program is in place to sustain these savings.

BEST PRACTICES

Finally, the following energy efficiency best practices should be implemented across campus to maintain campus greenhouse gas reductions:

Energy efficiency purchasing policy. Require that all University departments specify low-energy appliances when buying equipment. This includes computers, copiers, scanners, lab equipment, ultra-low temperature freezers, refrigerators, and vending machines. Many low-energy appliances are listed on the U.S. EPA's ENERGY STAR® website (energystar.gov).

Campus thermostat guidelines. Reinforce thermostat setpoint guidelines for summer and winter operation that will reduce energy usage. Existing service-level agreements (SLAs) with campus departments already endorse guidelines of 68°F to 72°F in winter and 70°F to 74°F in summer. This standard should be affirmed and maintained.

New construction design energy usage intensity (EUI) target. Include energy savings requirements for all new construction projects. Targets for EUI should be set based on building type. Pilot projects for this strategy have already been established for Campus North Residential Commons and Frank and Laura Baker Dining Commons, as well as David M. Rubenstein Forum.

Energy efficiency standards for renovation, repair, and replacement projects. Establish guidelines to ensure that facility improvement projects incorporate energy efficiency as much as practicable.

ENERGY EFFICIENCY UPGRADE OPPORTUNITIES FOR MAJOR RENOVATIONS

- ☐ Lighting fixture upgrades
- ☐ Lighting controls upgrades
- ☐ Temperature controls hardware and control sequences upgrades
- ☐ Heat recovery opportunities
- ☐ Airflow setbacks during unoccupied periods
- ☐ Constant-flow to variable-flow conversion (pump and fan)
- ☐ Demand control ventilation or modification of ventilation requirements

APPENDIX: ADDITIONAL RESOURCES AND ACRONYMS

ACRONYMS

CO_2	carbon dioxide
Cx	commissioning
DDC	direct digital control
eCO_2	equivalent CO_2
EF	emissions factor
EMIS	energy management information system
ERM	emissions reduction measure
EUI	energy use intensity
fpm	feet per minute
FS	Facilities Services
FY	fiscal year
GHG	greenhouse gas
kWh	kilowatt hour
M&V	measurement and verification
Mlb	1,000 lbs
MMBtu	1 MMBtu = $1x10^6$ Btu
MT	1 metric ton = 1,000 kg
MWh	megawatt-hour
PM	preventative maintenance
PPA	power purchase agreement
psi	pounds per square inch
REC	Renewable Energy Certificate
SLA	service-level agreement
SP	Sustainability Plan
UCMC	University of Chicago Medical Center

LINKS

The University of Chicago
uchicago.edu

Facilities Services
facilities.uchicago.edu

Office of Sustainability
sustainability.uchicago.edu

Sustainability Plan
sustainability.uchicago.edu/sp

Facilities Services Facility Standards (FS)2
facilities.uchicago.edu/about/partners/facilitiesstandards

Green-e
green-e.org/certified-resources

ENERGY STAR®
energystar.gov

SOURCES

Carbon Offset Market Information
Ecosystem Marketplace Unlocking Potential State
of the Voluntary Carbon Markets
cbd.int/financial/2017docs/carbonmarket2017.pdf

Climate Action Reserve Urban Tree Planting Project Protocol
Version 2.0
climateactionreserve.org/how/protocols/urban-forest

U.S. Department of Energy
A Guide to Community Solar: Utility, Private,
and Non-profit Project Development
nrel.gov/docs/fy11osti/49930.pdf

ACKNOWLEDGMENTS

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