# PRESIDENT'S COMMISSION ON CARBON NEUTRALITY

UNIVERSITY OF MICHIGAN

## Draft Report and Recommendations

December 17, 2020

## PCCN COMMISSIONERS

**Stephen Forrest, Co-Chair**
Peter A Franken Distinguished University Professor of Engineering, Paul G Goebel Professor of Engineering, Professor of Electrical Engineering & Computer Science, Material Science & Engineering, and Physics, U-M

**Jennifer Haverkamp, Co-Chair**
Graham Family Director, Graham Sustainability Institute, Professor from Practice, Law School, and Ford School of Public Policy, U-M

**Henry Baier**
Associate Vice President for Facilities and Operations, U-M

**Andrew Berki**
Director, Office of Campus Sustainability, U-M

**Valeria Bertacco**
Vice Provost for Engaged Learning, and Arthur F. Thurnau Professor of Computer Science and Engineering, U-M

**T. Anthony Denton**
Senior Vice President and Chief Operating Officer, U-M Health System, Michigan Medicine

**Austin Glass**
Doctoral Candidate, Climate and Space Sciences and Engineering, U-M

**Brandon Hofmeister**
Senior Vice President of Governmental, Regulatory & Public Affairs, Consumers Energy

**Gregory Keoleian**
Director, Center for Sustainable Systems, Peter M. Wege Professor of Sustainable Systems, School for Environment and Sustainability, Professor of Civil & Environmental Engineering, U-M

**Larissa Larsen**
Associate Professor of Urban & Regional Planning, A. Alfred Taubman College of Architecture & Urban Planning, U-M

**Jonathan Overpeck**
Samuel A. Graham Dean and Professor, William B. Stapp Collegiate Professor, School for Environment and Sustainability, Professor of Climate and Space Sciences and Engineering, and Earth and Environmental Sciences, U-M

**Barry Rabe**
J. Ira and Nicki Harris Family Professor of Public Policy, Arthur F. Thurnau Professor of Environmental Policy, Gerald R. Ford School of Public Policy, U-M

**Camilo Serna**
Vice President Regulatory Affairs, DTE Energy

**Anna Stefanopoulou**
William Clay Ford Professor of Technology, Professor of Mechanical Engineering, Professor of Electrical Engineering and Computer Science, and Director, Energy Institute, U-M

**Missy Stults**
Sustainability & Innovations Manager, City of Ann Arbor

**Logan Vear**
U-M Undergraduate Alumna, 2020

**Lisa Wozniak**
Executive Director, Michigan League of Conservation Voters

## PCCN STAFF

**Liz Barry**
Special Counsel to the President, Office of the President, U-M

**Andrew Horning**
Administrative Director, PCCN, and Managing Director, Graham Sustainability Institute, U-M

**Griffin Reames**
Facilitator, PCCN; and Chief Operating Officer, Kidney Epidemiology and Cost Center, U-M

**Lydia Whitbeck**
Project Coordinator, PCCN, U-M

# IMPORTANT CONTEXT FOR THIS DRAFT REPORT

This draft report includes a wide range of **preliminary draft recommendations and context** from the University of Michigan President's Commission on Carbon Neutrality, which President Schlissel charged with recommending sustainable, scalable and transferable pathways for U-M to reach carbon neutrality across all three campuses: Ann Arbor (including Michigan Medicine), Dearborn, and Flint.

To inform its final recommendations, the Commission invites interested students, staff, faculty, alumni, community members, and others to **contribute feedback and ideas through its public comment portal through January 22, 2021**. The Commission welcomes comments from all who desire to share them and is particularly interested in gaining perspective on how the draft recommendations may impact the daily lives and experiences of U-M community members, and the extent to which these draft recommendations fulfill the elements of the charge that provides the terms of reference set forth by President Schlissel.

The Commission encourages those submitting public comments to reference specific line numbers in the report when submitting. **The Commission will review and consider every public comment,** all of which will be essential toward formulating final recommendations that are comprehensive, responsive, bold, accessible, and equitable.

The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

**This draft report does not represent the Commission's final recommendations, nor does it represent that the commissioners unanimously support each recommendation.**

Finally, reports from internal and external analysis teams, which the Commission tasked to inform its work, were invaluable toward the completion of this draft. While the Commission references these throughout the document, this draft also, in large sections, includes language taken directly from those respective analyses.

# LAND ACKNOWLEDGEMENT

*The University of Michigan is located on the territory of the Anishinaabe people. In 1817, the Ojibwe, Odawa, and Bodewadami Nations made the largest single land transfer to the University of Michigan, ceded through the Treaty of Fort Meigs, so that their children could be educated. We recognize the history of displacement of Native communities that facilitated the founding of the University of Michigan. We acknowledge the sovereignty of tribal lands, and we reaffirm contemporary and ancestral Anishinaabek ties to this land as well as the profound contributions of Native Americans to this institution.*

# TABLE OF CONTENTS

*"Human influenced global climate change is the defining scientific and social problem of our age."*

*— University of Michigan President Mark Schlissel*

# INTRODUCTION

This past year has been among the most tumultuous in modern history. A pandemic rages while the world awaits an accessible vaccine, a resulting economic downturn causes millions to lose their jobs and shutter their storefronts, U.S. civil society reckons with a history and legacy of systemic racism, and once-strong political institutions stand vulnerable amidst polarization, demagoguery, and misinformation.

In the face of 2020, it may be easy to forget that the greatest crisis of all — the climate crisis — is no longer just looming. It is here.

Glaciers and permafrost are melting at accelerating rates. Wildfires and hurricanes are becoming more frequent and more severe. Plant and animal biomes are shifting as long-held ranges become literally uninhabitable. And for humanity, climate change is threatening to worsen existing humanitarian emergencies and spark one of the greatest migration crises in history.

In 2018, the Intergovernmental Panel on Climate Change (IPCC) reported that even larger catastrophes can be avoided, both for humanity and for the natural environment, if global warming were limited to 1.5 degrees Celsius above pre-industrial levels.[1] The IPCC, a global network of scientists tasked by the United Nations to analyze trends in climate science, explained that reining in climate change to this extent would require reducing human-caused carbon emissions to 45 percent below 2010 levels by 2030, and to net-zero by 2050. All carbon emissions from then on would need to be balanced by the removal of an equivalent amount of carbon dioxide from the atmosphere.

The organization warned, however, that achieving a 1.5 degree goal would require "rapid and far-reaching transitions in land, energy, industry, buildings, transport, and cities."

Universities reach into all of these areas – convening a large residential community, facilitating medical care, and spurring groundbreaking research across disciplines are all carbon-intensive processes and have contributed to the problem of the climate crisis. At the same time, public

[1] IPCC. (2018). "Summary for Policymakers." *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C.Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy,T. Maycock, M. Tignor, T. Waterfield (eds.)]. Retrieved from: https://www.ipcc.ch/sr15/chapter/spm/

universities, in addition to being hubs for cross-sector research, endeavor to fulfill broader missions of serving the public and educating and equipping the next generation of scientists, policy makers, and business and social sector leaders. As climate change remains among society's most pressing issues, universities exist as literal training grounds for new approaches, and accordingly, have a unique opportunity to lead.

In February 2019, the University of Michigan President's Commission on Carbon Neutrality was convened to leverage the resources and expertise of the entire university to recommend a plan for U-M to reach net-zero (carbon neutral) emissions.

The Commission acknowledges U-M's history in sustainability and environmentalism; including its role in the first-ever Earth Day celebration, its pioneering of the environmental justice discipline, its 20-year record in carbon accounting, and its continuing progress toward its current greenhouse gas reduction goal (25 percent below 2006 levels by 2025) for the Ann Arbor campus. History, however, is not enough. Climate change is not a problem that can be solved and then walked away from. Sustainability requires continual collective and institutional action. And the scientific consensus demands that it all be done with great urgency.

So, from its inception in February 2019, the Commission sought to go beyond previous U-M efforts, both in scope and geographic reach. Its analysis accounts for: Scope 1 emissions, resulting from on-campus sources; Scope 2 emissions, resulting from purchased power; and Scope 3 emissions, resulting from indirect sources such as commuting, university-sponsored travel, and food procurement.

Though the Ann Arbor campus is the largest of these, comprising 388 buildings across 2,997 acres, U-M's footprint, and indeed its leadership on climate action, reverberates far beyond Ann Arbor. Analyses cover emissions from the Ann Arbor, Dearborn, and Flint campuses, which vary greatly in their size, access to energy and resources, and engagement with their respective surrounding communities. Analyses also encompass emissions from Michigan Medicine, a leading regional health care system where patient care and cutting-edge research are paramount. Through the inclusion of the entire university in its scope of work — over 40 million building square footage across the three campuses — the Commission has developed an array of recommendations that can be effective in markedly different community and geographic settings.

The Commission has strived to design solutions aligned with U-M's core missions of research, education, scholarship, service, health care, and reflecting the principles of diversity, equity, and inclusion. It has also crafted recommendations that aim to be scalable and transferrable, so that they can be applied by like-minded institutions of all sizes and sectors, near and far from Flint, Dearborn, and Ann Arbor. For climate actions to reverberate beyond campus, the university must leverage existing partnerships with communities surrounding U-M campuses as well as develop new ones around the State of Michigan and the world toward achieving mutually shared goals.

The Commission recognizes that the climate crisis poses the most harm to communities that are historically and unfairly disadvantaged and disenfranchised. Each proposed university action

brings with it a different set of environmental justice considerations. Accordingly, environmental justice must be comprehensively interwoven throughout U-M's climate action plan, rather than added as a supplementary step.

With that said, U-M and like-minded partners in sustainability will have to conduct much more meaningful and intentional engagement to best address equity and justice issues at U-M's three campuses, around the region, and globally. The best ideas often come from those who have the most at stake.

At the same time, U-M is a renowned public university and such institutions, in developed countries, have significant legacy emissions. As developing countries begin to tackle their response to climate change, they will rely on developed countries and their educational institutions for approaches and leadership. In light of this global context, U-M has an outsized responsibility to mitigate its own emissions and lead the way for others.

Furthermore, a university is only as sustainable as the community it comprises. Though much of the work toward carbon neutrality is technical, the Commission expects U-M's ultimate climate plan to emphasize opportunities to also engage faculty, students, staff, alumni, donors, patients, and visitors. High-level, institutional change is crucial to a cultural shift necessary to achieve these goals over several decades into the future. So too is giving U-M community members the agency and responsibility to make their own significant contributions toward carbon emissions reductions both on and off campus. There must be buy-in at all levels, from the central administration to the individual.

Consistent with this framing, the President's Commission on Carbon Neutrality is pleased to present its **preliminary draft recommendations**. Proposed actions delve into many topics crucial toward achieving net-zero emissions, including: heating and cooling infrastructure, purchased electricity, transportation, energy consumption policies and pricing, campus culture, carbon offsets, and more. Through the steps outlined in this report, the Commission has identified a bold pathway that, if adopted, could enable U-M to:

- Reach carbon neutrality for Scope 1 emissions across all three campuses by 2025 (inclusive of carbon offsets) and eliminate Scope 1 emissions entirely by 2040;
- Achieve carbon neutrality for Scope 2 emissions across all three campuses by 2025, and;
- Establish, by 2025, carbon neutrality goal dates for Scope 3 emissions categories that are set no later than 2040.

In presenting the following draft recommendations, the Commission owes a number of teams and individuals its collective gratitude and would like to acknowledge them here.

First, the Commission thanks the many U-M community members who continue to advocate for climate action; whether by submitting comments to the Commission's public comment portal, organizing and making their voices heard at Regents' meetings and other public gatherings, or convening independent discussions and seminars. The Commission has received 164 public comments to date through its public comment portal, and also welcomes future engagement, both in its progress toward final recommendations, and pertaining to broader U-M sustainability

work. Activism and advocacy were crucial to the Commission's establishment, and will be critical toward ensuring the U-M meets its carbon neutrality commitment in the years ahead.

The Commission thanks the various students, staff, faculty, alumni and community members who provided their candid perspectives on various phases of the work. In particular, the Commission is grateful to the members of the Student Advisory Panel, who provided invaluable guidance on what the campus community prioritized. Recommendations must reflect realities on the ground in order to be successfully deployed and resonant within the U-M community and beyond.

The Commission thanks the various internal analysis teams, internal sub-groups, and external consultants (Integral Group and SmithGroup) for their robust research and engagement around a number of distinct issues, each critical toward defining and working on ways for U-M to reach carbon neutrality. Teams focused on: bio sequestration, building standards, campus culture and communication, carbon accounting, commuting, energy consumption policies, external collaboration, food procurement systems, heat and power electrification, mobility electrification, and university-sponsored travel.

The Commission thanks administrators and staff from U-M Ann Arbor Facilities and Operations (Architecture, Engineering and Construction; Grounds and Waste Management; Logistics, Transportation and Parking; Office of Campus Sustainability; Real Estate Office; and Utilities), the Graham Sustainability Institute, MDining, Michigan Medicine, Michigan Publishing Services, the Office of Diversity, Equity and Inclusion, the Office of the President, the Office of the Vice President for Communications, U-M Dearborn Facilities and Operations, and U-M Flint Facilities and Operations, as well as the City of Ann Arbor for their assistance in knowledge and data-sharing.

Finally, the Commission thanks you for reading this draft report and taking the time to submit public comments. Your feedback and engagement will be crucial toward making carbon neutrality at U-M real, and the Commission invites you to stay engaged and stay tuned.

# PROCESS OVERVIEW

## President's Charge

University of Michigan (U-M) President Mark Schlissel launched the President's Commission on Carbon Neutrality (PCCN) in February 2019 with the mission of contributing to a more sustainable and just world. President Schlissel charged the Commission with recommending timelines, pathways and approaches for U-M (Ann Arbor, Dearborn, and Flint campuses) to achieve carbon neutrality that:

- Are environmentally sustainable;
- Involve the regional community;
- Create scalable and transferable models;
- Include the participation and accountability of all members of the university community, and;
- Are financially responsible in the context of U-M's mission of education, research and service.

Read President Schlissel's full charge to the Commission here.

## Defining Key Terms

The charge issued by President Schlissel to the PCCN includes several criteria for the Commission to meet as it develops its recommendations. These, and other key terms, are listed below along with working definitions that the Commission developed over the course of its work.

***Carbon neutrality*** means, at a global level, having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. At the level of an institution such as U-M, it means that all quantifiable greenhouse gas emissions (GHGs) attributable to that institution's activities are eliminated or offset by investments in carbon credits or sequestration projects.

***Carbon offsetting*** occurs when an organization counter-balances its direct emissions by investing in, or purchasing credits associated with, verifiable emissions reduction or sequestration efforts somewhere on the planet. Until an organization eliminates all GHG emissions associated with its activities, it cannot achieve carbon neutrality without using carbon offsets to counterbalance its remaining emissions. Due to the complexity and controversial nature of carbon offsetting, there are divergent views on the merits of various approaches and how they should be used as part of U-M's carbon neutrality strategy.

***Financially responsible*** determinations should be made in the context of U-M's mission of education, research, health care, and service. Determining what is financially responsible will ultimately require trade-offs that should be made explicit. Achieving carbon neutrality will require a shift in priorities for U-M that resonates, and gains favor among the U-M community at large. Associated investments should reflect our responsibilities to achieve carbon neutrality without

placing an undue burden on students or the diverse communities that the University serves, and in a manner consistent with its broader mission.

***Sustainable*** solutions meet the needs of present generations without compromising the ability of future generations to meet their own needs. Methodologies and approaches pursued to achieve carbon neutrality must reflect the interdependence of environmentally, socially and economically beneficial outcomes. Solutions should provide positive benefits over the long term, while challenging the status quo of current systems that are unsustainable.

***Regional community involvement*** means that U-M should leverage existing partnerships and develop new, inclusive partnerships across relevant sectors throughout the State of Michigan. New efforts should include significant engagement with Flint, Dearborn and Ann Arbor, and the counties surrounding these cities, while being respectful of the expectations and potential resource limitations within these communities. Pathways, timelines, and strategies should be responsive to, and reflective of, the regional communities with whom we engage.

***Scalable and transferable*** solutions are those that have broad applicability beyond U-M's three campuses, reaching organizations and communities of all sizes and sectors. Though some solutions will be unique to U-M, scalability and transferability are important criteria for prioritizing recommendations. External engagement should be integral to how U-M manages its transformation to carbon neutrality, with data and information being shared in accessible and transparent ways.

***Science-based Targets*** reflect the global GHG emission reduction trajectory required to meet the International Panel on Climate Change (IPCC) guidance for holding global warming to 1.5°C above preindustrial levels.

***Scope 1 Emissions*** are greenhouse gas (GHG) emissions produced by sources that are owned or controlled by the University of Michigan, such as the Central Power Plant, building boilers, and buses.

***Scope 2 Emissions*** are GHG emissions that are created at utility-scale electricity generation plants away from the U-M campus, which correspond to the electricity that is sold to and used by the university.

***Scope 3 Emissions*** are all other off-campus GHG emissions associated with U-M's activities (upstream and downstream), such as commuting, university travel, and purchased goods and services.

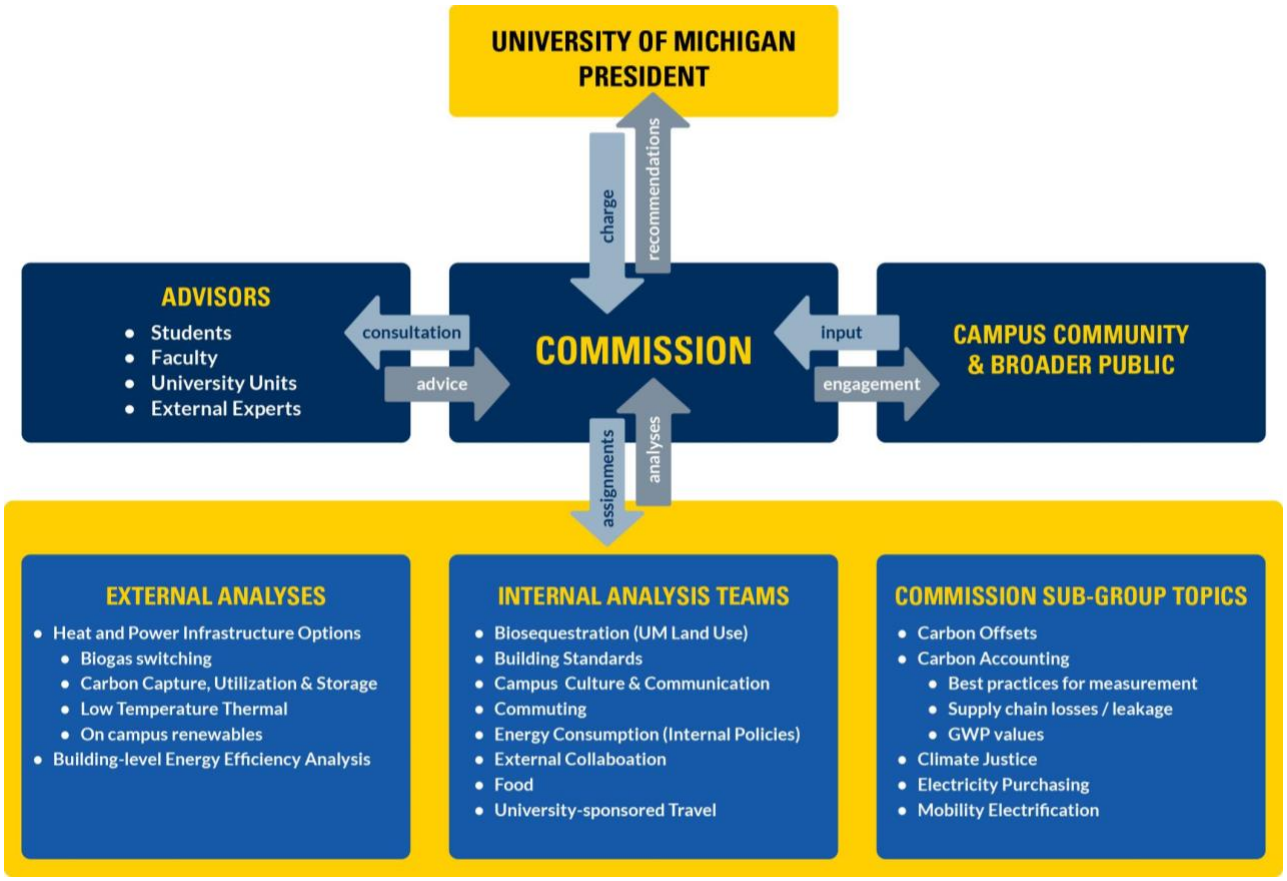
***U-M community participation and accountability*** requires multi-directional linkages and robust networks, which are facilitated by organizational structures that enable and require shared responsibility. In addition to U-M faculty, students, staff, alumni, patients, and visitors, the U-M community includes many affiliated groups that should also develop plans and have responsibility for achieving carbon neutrality goals aligned with U-M.

## Commission Structure

The Commission includes 17 members who collectively developed the recommendations included in this report to transform U-M and achieve carbon neutrality in accordance with the President's charge. In developing this plan, the Commission tasked specialized teams to conduct distinct analyses, as illustrated and described below.

The PCCN involved many coordinated groups (including the commissioners), internal and external analysis teams and subgroups focused on specific topic areas, the campus community, and broader public. In addition, students, faculty, university administrators, and external experts served as formal and informal advisors during the process. Throughout the course of the work more than 200 people have contributed to the process in various ways.

The following diagram illustrates the PCCN structure:



## Formal Analyses Completed

A wide range of teams completed analyses including internal analysis teams led by U-M faculty and staffed by U-M students, two external consulting firms, and three subgroups which included commissioners, U-M students, faculty and staff. These analyses included contributions from more than 50 U-M undergraduate, graduate and doctoral students across the Flint, Dearborn and Ann Arbor campuses, 17 faculty members from the Flint and Ann Arbor campuses, and dozens of staff members from the Flint, Dearborn and Ann Arbor campuses who worked with the various analyses groups. Overall, the Commission's analyses included and engaged individuals from over 45 units across the Flint, Dearborn and Ann Arbor campuses.

Analysis teams submitted their final reports and associated recommendations in spring 2020 and subsequently engaged with the Commission to discuss their reports in more detail. These reports were invaluable toward the completion of the Commission's draft recommendations. While the Commission references the analysis team reports throughout the document, the draft report, in large sections, includes direct language from those respective analyses.

| Topic | Category | Scope of Work |
|---|---|---|
| Heat & Power Infrastructure | Scope 1 Emissions | Pathways for evolving U-M's heating and power generation infrastructure, including natural gas, toward carbon neutrality across all three U-M campuses. |
| Mobility Electrification | Scope 1 & 3 Emissions | Strategies for converting internal combustion engine vehicles to battery electric vehicles (EV) and for encouraging EV commuting. |
| High-Efficiency Building Retrofits | Demand-side Management | Deep-dive retrofit analyses of two distinct buildings on U-M's campus to inform what would be required to reduce building-level emissions as far as possible. |
| Building Standards | Demand-side Management | Best practices regarding the adoption, implementation, and long-term efficacy of building codes to achieve carbon emissions reductions. |
| Internal Energy Consumption Policies | Demand-side Management | Potential budget & finance mechanisms to decrease energy usage across U-M's campuses. |
| Commuting | Scope 3 Emissions | Carbon impact of the commute to the U-M campuses and strategies to reduce the commute's footprint. |
| University-Sponsored Travel | Scope 3 Emissions | GHG emissions associated with university-sponsored travel and approaches to reduce the carbon intensity. |

| | | |
|---|---|---|
| Food | Scope 3 Emissions | Approaches to decrease the GHG footprint associated with food consumption on U-M's three campuses. |
| Campus Culture | Behavior & Collaboration | Structures and strategies to raise awareness, enhance personal investment, and change behaviors related to carbon neutrality. |
| External Collaboration | Behavior & Collaboration | Opportunities and strategies for collaborations focused on scaling and replicating high-impact solutions. |
| Environmental Justice | Behavior & Collaboration | Social equity impacts arising from potential recommendations and how these may be addressed. |
| Bio sequestration | Offsets | Approaches for potential large- and small-scale bio sequestration projects on and off-campus. |
| Carbon Accounting | Measurement | Model targets and timelines, energy demand reduction and supply decarbonization strategies, emission permits/offsets, and implications of carbon prices. |

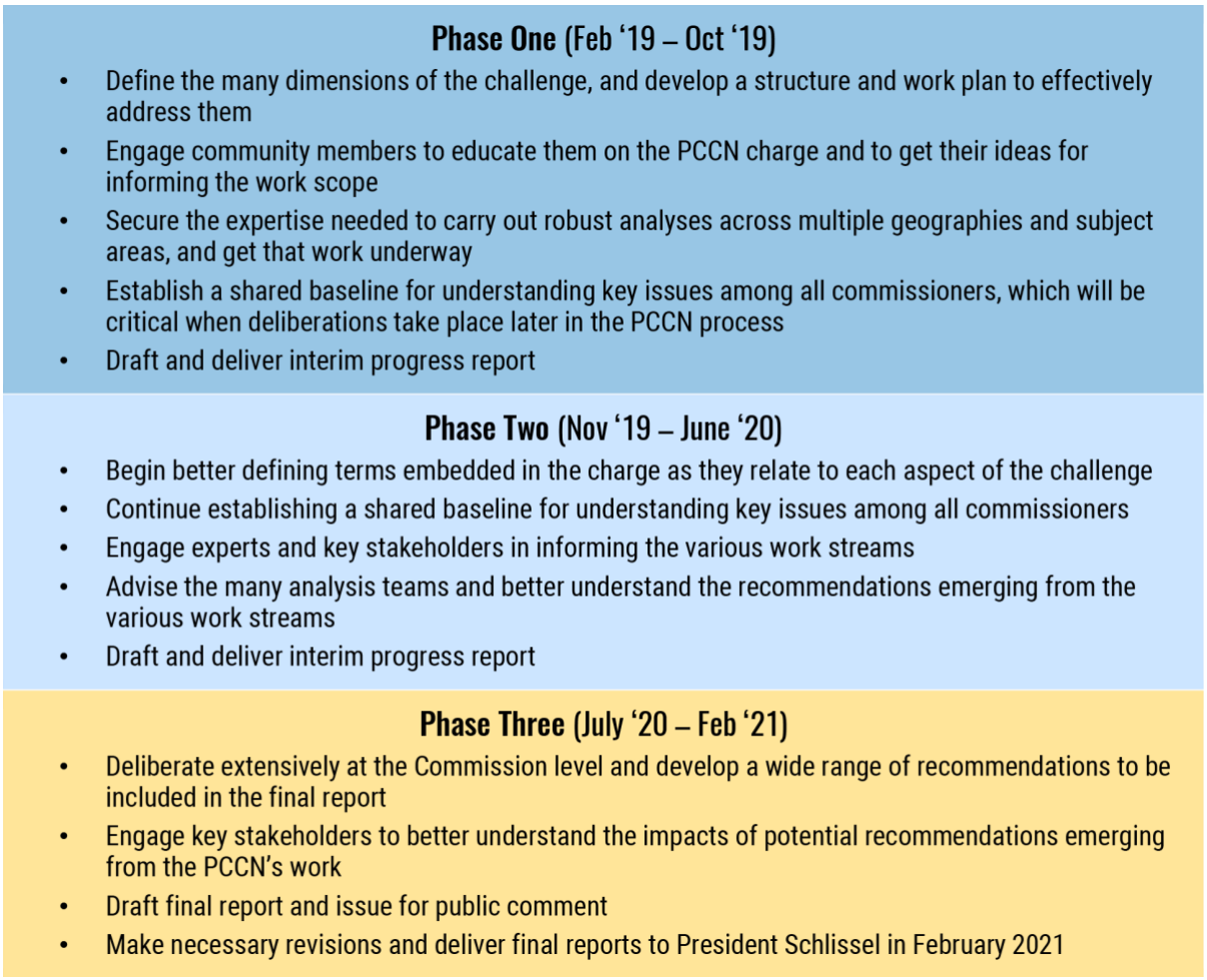
## Phases of Work

Phase One work, which took place from February 2019 through October 2019, focused on defining the dimensions of the challenge, developing a structure and work plan to effectively address them, securing the expertise needed to carry out robust analyses across multiple geographies and subject areas, and beginning analyses. For more information on Phase One work, refer to the Fall 2019 Interim Progress Report.

Phase Two work, which took place from November 2019 through June 2020, involved a range of technical analyses which informed the Commission's recommendations. Commission meetings focused on establishing a shared baseline for understanding of key issues among all commissioners. This shared knowledge informed feedback to analysis teams and continued to be helpful for deliberations which took place during the PCCN's third and final phase of work. For more information on Phase Two work, refer to the Spring 2020 Interim Progress Report.

Phase Three began in July 2020 and provided commissioners time to review the various analyses, engage in deep deliberations, develop draft recommendations, write the draft report, and publish it for public comment. This period also involved consultations with a wide range of advisors to explore potential ramifications associated with the various recommendations. Following the release of this draft report, Phase Three will continue through February 2021, with a focus on stakeholder engagement, further deliberations and report revisions reflecting community input prior to delivering a final report to President Schlissel.

The following diagram summarizes the three phases of the PCCN's work:




## Community Engagement & Communications

Since its establishment, the Commission has maintained a public comment form on its website where community members are welcome to share their ideas, suggestions and concerns with the Commission. All ideas received are summarized and published on the PCCN website. More detailed ideas and comments have been, and will continue to be, shared with the Commission and the relevant analysis teams throughout the process. To date, the Commission has received 164 comments through the public comment form. The Commission also received many other public comments via direct email, engagement events and targeted engagement.

During Phase One of its work, the Commission hosted several engagement activities designed to educate the community on the PCCN's activities and to gather input and ideas from a wide range of university stakeholders. This included three public community forums on the Ann Arbor campus. Each forum involved a question and answer session with the Commission co-chairs and small table break-out conversations around specific topics. All comments, suggestions and recommendations were noted. There were 397 total registrations across the three events.

During Phase One and the beginning of Phase Two of the commission's work, the PCCN co-chairs visited the UM-Dearborn and UM-Flint campuses where they shared the commission's work with faculty, staff and students at each campus, and provided opportunities for the Dearborn and Flint communities to get involved. The co-chairs also met with city government representatives, facilities and operations staff, deans and faculty experts on the Flint campus.

The Commission's eight internal analysis teams and subgroups hosted various engagement events and shared surveys across all three U-M campuses throughout the 2020 winter term. The purpose of these events was to gather input and inform the analysis team recommendations. In total, analysis teams hosted ten in-person public engagement events. Four teams also hosted surveys across all three U-M campuses to reach those unable to attend their in-person events.

During the third phase of work, the Commission published the IAT reports for public comment and feedback, and focused on engaging specific stakeholders to understand the impacts of potential recommendations resulting from the internal and external analyses. The Commission sought feedback from key stakeholders and experts on the Flint, Dearborn and Ann Arbor campuses. The commission received comments from seven key stakeholders on the Flint campus, and from twenty key stakeholders on the Dearborn campus. Stakeholders from U-M Architecture, Engineering and Construction, Ann Arbor Facilities and Operations and the Office of Campus Sustainability also submitted a significant number of comments on the analysis team reports.

The Commission co-chairs met with the PCCN's Student Advisory Panel at key points during the process to gather feedback. The co-chairs also met with the Student Sustainability Coalition (SSC) to gather their thoughts and concerns with the analysis team recommendations that informed the Commission's recommendations. During this time, SSC has been posting summaries of each analysis team report on its Instagram profile.

Throughout its process, the Commission worked with communications personnel from the Office of the Vice President for Communications (OVPC) and the Graham Sustainability Institute to inform the public of the PCCN's progress and public engagement opportunities. These activities include placing stories in U-M publications and channels, fielding media inquiries, and assisting in convening Commission events.

The Commission's draft report will be out for public comment through January 22, 2021. During this time, the SSC will be hosting two student conversations in mid-January, and the Planet Blue Ambassadors program will be hosting two "Staff/Faculty/Community Member Conversations on Carbon Neutrality." Refer to the Commission website for a list of upcoming engagement events.

**See Appendix B for a full list of PCCN public engagement events to date.**

# COMMISSION RECOMMENDATIONS

## Principles for Goal-Setting and Strategies

The President's charge tasked the Commission with recommending timelines, pathways and approaches for U-M to achieve carbon neutrality that reflected several key criteria. The terms below outline those criteria, and the accompanying bullets reflect key principles associated with the criteria, which were developed through Commission discussion. It is important to note that each of the recommendations in this draft report satisfy each of these criteria to different degrees.

Appendices at the end of this report seek to provide detail on how each recommendation relates to each of these criteria. However, this guidance should be considered preliminary and additional work will be required to flesh out and refine the details to inform implementation. With regard to the criteria of financial responsibility, it is important to note that several recommendations, particularly those that are the most capital-intensive, were informed by significant financial analysis to determine preliminary, high-level cost estimates. However, other recommendations were not analyzed in depth from a cost or financial perspective. More in-depth financial analysis and costing would be needed for all recommendations as a next step moving forward.

***Carbon neutral***

- Seeks a goal and trajectory (set of strategies) to accelerate emissions reductions and minimize cumulative U-M greenhouse gas emissions (GHGs)
- Ultimately eliminates all quantifiable $CO_2$ and other significant GHGs, or offsets them by investments in carbon credits or removal/sequestration projects

***Sustainable***

- Meets or exceeds IPCC 1.5 degree Celsius global targets (carbon neutrality by 2050 and 45 percent below 2010 by 2030)
- Includes Scopes 1, Scope 2, and Scope 3 categories that can be accurately measured and tracked
- Aligns with or enhances U-M's core missions of education, scholarship, service, health care and the principles of diversity, equity, and inclusion

***Equity & Justice***

- Addresses equity and justice issues among our three campuses, regionally, and globally
- Recognizes our position within society and particularly within the State of Michigan
- Acknowledges that institutions in developed countries have significant legacy emissions and that developing countries have less responsibility for causing the climate crisis and fewer resources to address it

***Regional community involvement***

- Collaborates with communities surrounding our campuses (Ann Arbor, Dearborn, and Flint) toward achieving mutually shared goals

- Engages more broadly in southeast Michigan and throughout the state

***Scalable and transferable***

- Seeks a range of solutions that collectively have broad applicability beyond U-M's three campuses, reaching organizations and communities of all sizes and sectors
- Prioritizes the sharing of relevant information in accessible and transparent ways

***U-M community participation and accountability***

- Emphasizes and promotes opportunities to engage faculty, students, staff, alumni, donors, patients, and visitors in carbon neutrality efforts
- Pursues efforts focused on having U-M community members take individual responsibility for helping U-M achieve its goals, and establishes mechanisms to facilitate that objective
- Identifies, pursues, and promotes education and research to make significant impact on carbon reductions
- Provides a feasible plan with administrative/governance guidance, establishing mechanisms to track progress and assure accountability across the campuses
- Emphasizes mechanisms to embed aspects of the plan within units so that there is buy-in at all levels of university leadership

***Financially responsible***

- Recognizes that U-M will need to plan within physical, logistical, administrative, and financial realities
- Minimizes capital cost and maximize operational cost benefits & savings
- Seeks pathways and solutions that positively impact our core missions of education, scholarship, service, health care and the principles of diversity, equity, and inclusion

# Scopes 1 & 2 Emissions

This section provides background information on U-M's GHG emissions for Scopes 1 and 2, as well as recommended timelines, pathways and approaches for achieving carbon neutrality

## Carbon Neutrality Goal Summary

The following are preliminary draft recommendations for establishing carbon neutrality goals for Scope 1 and 2 emissions. They do not represent the Commission's final recommendations. nor do they represent that the Commission unanimously supports each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

| | |
|---|---|
| Scope 1 Emissions | Commit to the goal of carbon neutrality (inclusive of offsets) for Scope 1 emissions across all three campuses by 2025.[2,3] |
| Scope 1 Emissions | Prioritize direct emissions reductions for Scope 1 by setting a goal of eliminating them across all three campuses by 2040, and exceeding science-based targets via direct emissions reductions (i.e., without offsets) along the way. |
| Scope 2 Emissions | Commit to carbon neutrality for Scope 2 emissions across all three campuses (i.e., Ann Arbor, Dearborn, and Flint) by 2025 or earlier. |

## Boundaries and Baselines

Scope 1 emissions are generated from the combustion of natural gas in distributed boilers, the North Campus Research Complex (NCRC) power plant, and the Central Power Plant (CPP) on the Ann Arbor campus; the Central Steam Heating Plant on the Dearborn campus; the Central Energy Plant on the Flint campus; as well as combustion of transportation fuels in fleet vehicles (buses and other U-M owned vehicles). Scope 2 emissions are those associated with electricity purchased from DTE and Consumers Energy (and suppliers of smaller UM facilities such as Camp Davis). These emissions depend on the mix of fuels used by the electricity generators.

[2] Refer to Carbon Offsets and Sinks section for additional context

[3] When preceding a goal date within a recommendation, "by" means that the goal should be achieved before the end of that calendar year.

## Recent Scope 1 Emissions Profile

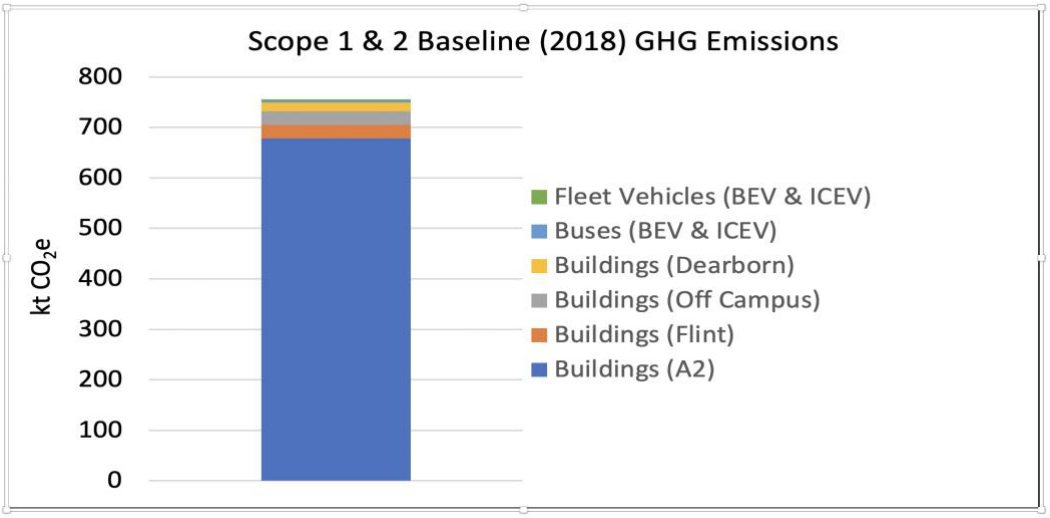
| | FY2017 | FY2018 | FY2019 | FY2020 |
|---|---|---|---|---|
| ***Ann Arbor Campus Scope 1 Emissions*** *($MTCO_2$)* | | | | |
| Natural Gas | 280,000 | 280,000 | 270,000 | 270,000 |
| Transportation fuel | 7,300 | 7,300 | 7,300 | 6,200 |
| | **287,300** | **287,300** | **277,300** | **276,200** |
| ***Dearborn Campus Scope 1 Emissions*** *($MTCO_2$)* | | | | |
| Natural Gas | 7,000 | 7,200 | 5,900 | 5,500 |
| Transportation fuel | 170 | 170 | 200 | 170 |
| | **7,170** | **7,370** | **6,100** | **5,670** |
| ***Flint Campus Scope 1 Emissions*** *($MTCO_2$)* | | | | |
| Natural Gas | 7,000 | 7,500 | 7,500 | 7,000 |
| Transportation fuel | 240 | 230 | 210 | 180 |
| | **7,240** | **7,730** | **7,710** | **7,180** |
| ***U-M Scope 1 Emissions Total*** *($MTCO_2$)* | **301,710** | **302,400** | **291,110** | **289,050** |

## Recent Scope 2 Emissions Profile

| | FY2017 | FY2018 | FY2019 | FY2020 |
|---|---|---|---|---|
| ***Ann Arbor Campus Scope 2 Emissions*** *($MTCO_2$)* | | | | |
| Purchased Electricity | 360,000 | 340,000 | 370,000 | 320,000 |
| ***Dearborn Campus Scope 2 Emissions*** *($MTCO_2$)* | | | | |
| Purchased Electricity | 17,000 | 17,000 | 15,000 | 13,000 |
| ***Flint Campus Scope 2 Emissions*** *($MTCO_2$)* | | | | |
| Purchased Electricity | 21,000 | 22,000 | 20,000 | 17,000 |
| ***U-M Scope 2 Emissions Total*** *($MTCO_2$)* | **398,000** | **379,000** | **405,000** | **350,000** |

## Scope 1 and 2 Emissions Baseline

Figure 1. Scope 1 & 2 baseline (2018) GHG emissions including: fleet vehicles, buses, Dearborn campus buildings, off-campus buildings, Flint campus buildings, and Ann Arbor campus buildings.



## Goals, Timelines and Interim Targets

**Preliminary Draft Recommendation:** *Commit to the goal of carbon neutrality (inclusive of offsets) for Scope 1 emissions across all three campuses by 2025.*

**Preliminary Draft Recommendation:** *Commit to carbon neutrality for Scope 2 emissions across all three campuses (i.e., Ann Arbor, Dearborn, and Flint) by 2025 or earlier.*

The University of Michigan should set these aggressive and ambitious goals to address the urgency needed to achieve carbon neutrality. These goals demonstrate our commitment to addressing the local, regional, and global equity and justice challenges associated with carbon neutrality, and to engaging our campus communities, alumni, and public and private sector partners in that mission. The Commission recognizes that in light of the timeline for reducing direct emissions, the 2025 neutrality goals will have to be achieved with carbon offsets.

**Preliminary Draft Recommendation:** *Prioritize direct emissions reductions for Scope 1 by setting a goal of eliminating them across all three campuses by 2040, and exceeding science-based targets[4] via direct emissions reductions (i.e., without offsets) along the way.*

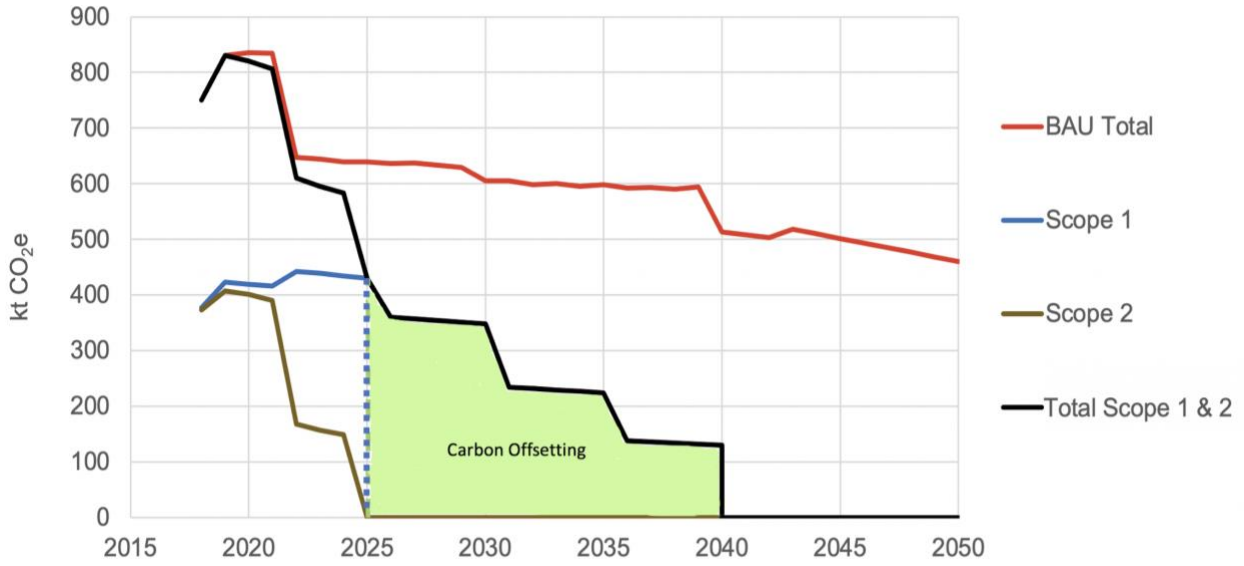
An offsets-based goal, alone, is insufficient to spur the transformation of technology, policy, markets, and behavior — worse, if it becomes the sole focus of the University's efforts, it allows and incentivizes the de-prioritization of crucial work to directly mitigate the University's Scope 1 emissions. To inspire research, education, and leadership on the technologies and solutions necessary to achieve global neutrality, therefore, the Commission recommends that the University pursue technological neutrality as soon as possible and no later than 2040, achievable through the plans articulated by its external consultant (Integral Group), with modest additional assumptions about technological advancement in the coming decades.

Figure 2 illustrates U-M emissions trajectories for Scopes 1 and 2 beginning with a 2018 baseline and continuing until 2050. The red line reflects a business-as-usual scenario for total Scope 1 and 2 emissions, taking into account actions that U-M already has underway, including the Central Power Plant upgrade, recent renewable power purchase agreement with DTE Energy, and energy conservation measures on campus. The “business as usual” (BAU) case includes changes to the electricity fuel-mix at DTE and Consumers Energy that are projected to take place between now and 2050. The remaining trajectories include the same assumptions as the BAU case but reflect the Commission’s recommended goals and strategies for mitigating Scope 1 and 2 emissions and achieving carbon neutrality across both scopes by 2025.

[4] See Key Terms section for definition

The brown line represents Scope 2 emissions, which are fully mitigated in 2025 when the Commission recommends that all of U-M's purchased electricity come from renewable sources[5]. The blue line represents Scope 1 emissions and becomes the black line (sum total of Scope 1 and 2 emissions) in 2025 when Scope 2 emissions are fully mitigated. Scope 1 emissions decrease more gradually over time, mostly attributable to the strategies outlined in the Heat & Power Infrastructure section and additional technological advancement assumptions made by the Commission. The green area under the curve represents the projected emissions that would need to be offset to achieve carbon neutrality for Scope 1 emissions for each year between 2025 and 2040. As Scope 1 direct emissions decrease, fewer carbon offsets will be required over time to maintain carbon neutrality.

Figure 2. Scopes 1 and 2 emissions trajectories[6]




## Strategy Recommendations Summary

The following are preliminary draft recommendations for mitigating and accounting for Scope 1 and 2 emissions. They do not represent the Commission's final recommendations, nor do they represent that commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

The table below seeks to provide generalized comparisons of the draft recommendations in terms of Financial Investment, GHG Levels, and Culture Shift. These are subjective judgments based on best available information and are for illustrative purposes only.

[5] The procured electricity generates Renewable Energy Certificates (RECs) that are retired by U-M or on its behalf.
[6] Refer to the Carbon Accounting Modeling Project report for additional information on the accounting model and emissions reduction scenarios.

| Preliminary Draft Strategy Recommendations | Financial Investment | GHG Levels | Culture Shift |
|---|---|---|---|
| Embark upon a phased, district-level approach to converting U-M's heating and cooling infrastructure to be fossil fuel-free, beginning with electrified systems centered on geo-exchange with heat recovery chiller technology, and with the flexibility to pivot to other proven technological solutions as they emerge. | $$$$$ | ↓ ↓ ↓ ↓ ↓ | Low |
| Issue a Request for Proposals (RFP) to procure all purchased electricity for U-M's three campuses in a manner that generates Renewable Energy Certificates that are retired by U-M or on its behalf, and aligns with the principles outlined by the Commission. | $$ | ↓ ↓ ↓ ↓ | Low |
| Engage with the cities of Ann Arbor, Dearborn, Detroit, and Flint, and other entities that are, or could be partners in, advocating for renewable electricity policy changes in the State of Michigan to better understand their perspectives, conduct necessary due diligence, and potentially partner in advocacy efforts that reflect mutually-shared objectives, as well as actively explore ways to partner directly in pursuit of carbon neutrality goals. | $ | n/a | High |
| Establish best-in-class $CO_2$ emissions targets across 9 building types for all new construction and major renovations. | $$$ | ↓ ↓ ↓ | Med |
| Convert U-M's entire vehicle fleet — automobiles, trucks and buses — and all maintenance equipment to electric power. | $$ | ↓ ↓ | Low |
| Create a Revolving Energy Fund on each of U-M's three campuses. | $ | ↓ ↓ ↓ | Med |
| Establish a carbon pricing system at the organizational unit level across U-M where revenue flows to the REF for new energy conservation measures. | $ | ↓ | High |

## Scope 1 Emissions Reduction Strategies

### Heat & Power Infrastructure

At the onset of its work, the Commission issued a request for proposals seeking an engineering firm with deep expertise and experience in developing concept studies for large and complex institutions to evaluate potential pathways for evolving heat and power generation infrastructure toward carbon neutrality. After a competitive process, the Commission selected the Integral Group to conduct this analysis. The consultants identified and evaluated multiple options, and recommended optimal strategies for the various campus locations and facility types based on technical feasibility, greenhouse gas emissions reduction potential, capital and operating costs, disruptions to campus activities, and other risks and uncertainties. Integral's summary and full report are available here and their comparative summary of various technology options can be found in Appendix C.

**Preliminary Draft Recommendation:** *Embark upon a phased, district-level approach to converting U-M's heating and cooling infrastructure to be fossil fuel-free, beginning with electrified systems centered on geo-exchange with heat recovery chiller technology, and with the flexibility to pivot to other proven technological solutions as they emerge.*

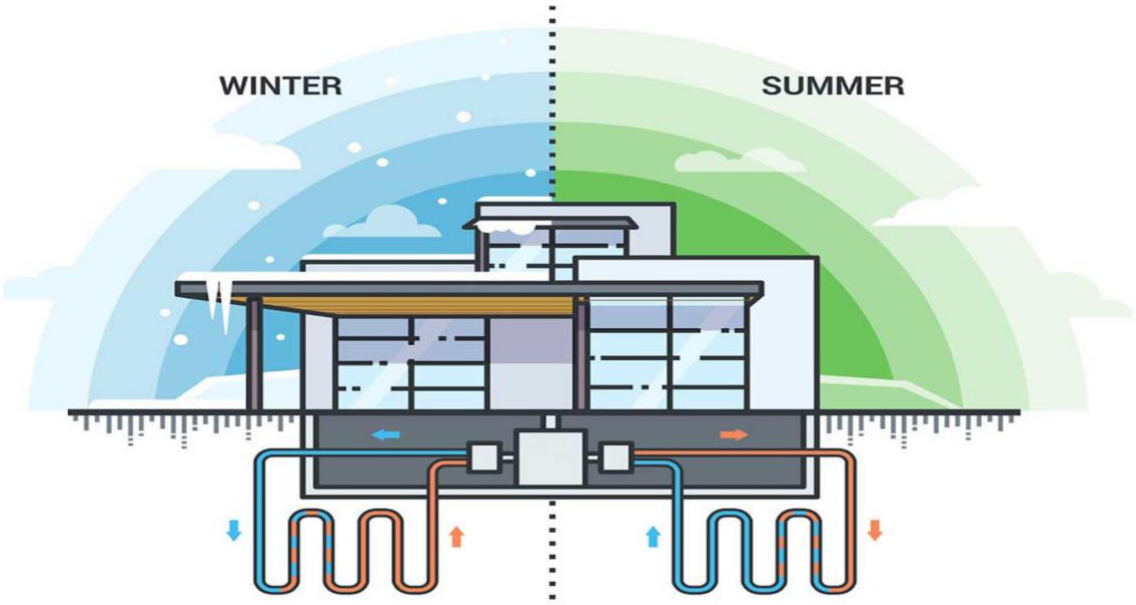
The Commission endorses the overarching conclusions reached by its external consultant, Integral Group, for U-M to electrify and decarbonize its heat and power infrastructure using a highly energy efficient geo-exchange (GHX) system and heat recovery chiller technology to support campus thermal needs, with the system being powered by renewable electricity (see Scope 2 recommendation below). This option requires an eventual campus-wide conversion from steam distribution to medium temperature hot water (MTHW) distribution, as well as the construction of new cooling distribution networks. This also requires the conversion of high temperature building heating systems to accommodate MTHW.

Geo-exchange is a process that leverages the earth's constant temperature to improve the efficiency of thermal energy systems. According to the Integral Group report:

> *Geo-exchange (GHX) systems use the natural ambient temperature of the ground as a free low-grade energy source. The system is relatively low temperature and is normally equal to the annual average air temperature of the region, meaning it can be used as either a heat sink (for heat rejection), or as a low- grade heat source (for heat extraction). GHX systems consist of either "open-loop" wells using groundwater in a non-consumptive manner as a heat source or sink, or a "closed-loop" system typically constructed of a buried closed-loop high-density polyethylene (HDPE) piping network within an array of boreholes drilled hundreds of feet deep.*
>
> *The advantage of a GHX system is that it is extremely efficient compared to a traditional plant with boilers and chillers providing heating and cooling separately. Heat Recovery Chillers (HRCH) essentially move heat around the district from where it is being rejected to where it is being consumed, rather than running boilers and chillers simultaneously to*

*both remove heat from the buildings and reject it via a cooling tower, while continuing to burn fossil fuels to generate more heat. This is particularly relevant for a district consisting of varied building typologies (i.e. science laboratory vs. residence) with diverse demand types. This means there are some buildings that need cooling at the same time as others need heating.*

Figure 3. Geoexchange system

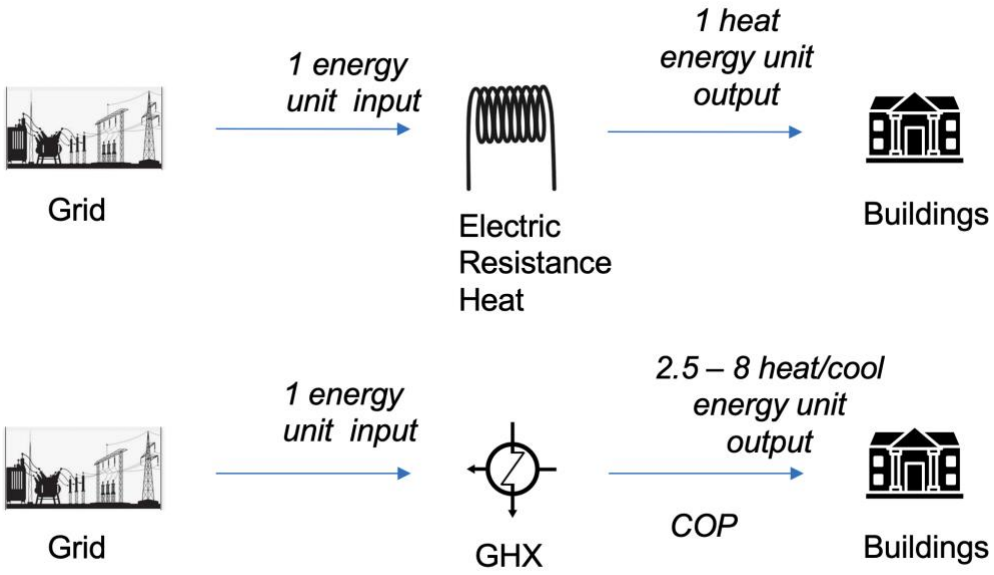



Geo-exchange is a demonstrated and proven solution that is compatible with U-M's three campuses. The Integral Group report summarizes the benefits, limitations/risks, and long-term outlook for many decarbonization options to support their proposal in Appendix C. A phased, district-level approach will allow U-M to learn as it goes, and if other viable and acceptable technological alternatives emerge during the transition period, U-M will have the option to modify the design of future phases accordingly.

For each of the six campus districts (Central/Medical; Athletic; East Medical; North Campus; Dearborn; and Flint), the Commission recommends geothermal heat exchange with heat recovery chiller technology; in some cases, paired with complementary technologies as described in the Integral report. This option requires an eventual campus-wide conversion from steam distribution to medium temperature hot water distribution networks, which requires the conversion of existing high temperature building heating systems. For all campus districts, the proposed strategy involves integrating, reusing and extending the existing chilled water networks as part of the new systems. All campus buildings are currently heated by steam and will require upgrades to their heating systems to be able to accept medium-temperature hot water. Each campus will also require a new centralized geothermal heat exchange and heat recovery chiller plant that ties in to a new and nearby geo-field. Each campus's size and thermal load will shape the scale of the geo-field boreholes and piping. In total, the consultant's analysis estimated nearly 20,000 boreholes, with most going below ground roughly 600 feet.

The transition to geothermal heat exchange with heat recovery chiller technology will increase the campuses' thermal efficiency for two main reasons. First, thermal efficiency is higher; heat recovery chillers are approximately 300 percent efficient, while combustion technology, which is currently in use, is approximately 80 percent efficient. Second, the geothermal heat exchange with a heat recovery chiller plant efficiently moves heat around a campus, thus optimizing the movement of thermal energy from where it is generated to where it is needed. As is shown in Figure 4 below, geoexchange with medium temperature hot water also makes for much more efficient use of electricity as compared to heating facilities with electric resistance heating.[7]

Figure 4. Electric resistance heat efficiency vs geoexchange system efficiency




The Commission recognizes the magnitude of this endeavor, which, if completed in its entirety, would be the largest university geo-exchange project in the world. For comparison, Ball State University's geothermal district system is the largest operational geothermal district system in the U.S. with 3,600 boreholes. This is approximately five times smaller than the proposed U-M project and slightly smaller than the North Campus portion of the project, estimated to require 4,600 boreholes. With this in mind, the Commission recommends that U-M phase the implementation of the infrastructure improvements over a 20-year timeframe. This timeline is more aggressive than the preliminary guidance provided by the Commission's external consultant and reflects the Commission's belief that new technological solutions will emerge in the coming decades. A phased approach will allow for modifications in response to more economical technologies that will likely be introduced during that time frame.

This infrastructure transformation will require substantial investments over multiple decades. As part of their analysis, Integral worked with U-M to develop a life cycle cost assessment (LCCA) reflecting both Integral's experience with projects of this type and U-M's experience with large capital project costs, which is available in Appendix D. Table 1 below summarizes high-level cost estimates for a project of this magnitude. Actual costs may vary greatly based on a wide

[7] Carbon Accounting Subgroup, 2020

range of factors and would not be known with greater certainty until detailed engineering studies are completed.

Table 1. High-level cost estimates for heat and power infrastructure recommendation. *Note: Electric infrastructure costs are not included in these estimates and could be substantial.*

*(dollar figure in millions and in 2020 dollars)*

| Campus | Central | Athletic | East Med | North | Dearborn | Flint | TOTAL |
|---|---|---|---|---|---|---|---|
| **Thermal Systems** | $1,101 | $332 | $50 | $680 | $99 | $77 | **$2,339** |
| **Solar PV** | $31 | $41 | $24 | $102 | $64 | $35 | **$297** |
| **Bldg Conversion** | $406 | $61 | n/a | $122 | $21 | $122 | **$732** |
| **TOTAL** | **$1,538** | **$434** | **$74** | **$904** | **$184** | **$234** | **$3,368** |

In the Integral Group's own words:

> *"While the proposed energy system transformation would result in lower utility costs for each campus, the upfront capital costs of the prospective transaction are massive. Seen through a traditional lens with standard assumptions, the payback is long. Using traditional analysis, the nominal payback period would be 61 years; the 30-year NPV is ($2.01B)."*

Given the massive investment and the potential for new technological solutions to emerge, the Commission also recommends that the decarbonization of U-M's heat and power infrastructure be done in stages across the six campus districts. The Integral Group report provides guidance on a phasing approach. However, the choices made for phasing should ultimately be governed by a clear set of principles that include such factors as the relative carbon intensity of current electricity sources (e.g., Central Power Plant vs. DTE), U-M's project management capacity; design/tendering/construction timelines; campus and community disruption; local impacts on the affected populations; and existing equipment or building retrofit timelines. U-M may want to prioritize a stand-alone campus option that could serve as a pilot for the rest of the project.

Table 2 provides guidance from the Integral Group with regard to "potential sequencing that seeks to minimize concurrent campus projects. As there is no interdependency between campuses related to thermal infrastructure, the campuses can be sequenced in any order that works best for U-M."

Table 2. Integral Group guidance on campus transformation sequencing

| Campus | Timeline | Comments |
|---|---|---|
| North Campus | Years 1 - 15 (15 yrs) | Initial implementation project: North Campus Academic Core |
| U-M Dearborn | Years 1 - 10 (10 yrs) | Can achieve onsite net zero emissions with parking lots and rooftop solar PV |
| Central Campus | Years 5 - 25 (20 yrs) | Gradual phase-out of CPP as new systems are built out |
| Ross Athletic | Years 10 - 20 (10 yrs) | Quick timeline difficult, given sensitivity to onsite disruptions (e.g. parking for football games) |
| East Medical | Years 15 to 20 (5 yrs) | Small campus, short timeline, starting in year 15 after North Campus is completed |
| U-M Flint | Years 15 - 25 (10 yrs) | 10 yrs likely required because of demands from three concurrent projects from years 15-20 |

Implementing a project of this magnitude is an extraordinary endeavor. This project will involve an urgent call to action and concurrent phasing of multiple campuses. This will require a significant amount of people power, management, organization and funding across the 20-year time frame. U-M Ann Arbor's Architecture Engineering and Construction (AEC) department is confident that it possesses the project management capability in-house for a project of this magnitude. The Flint campus has conveyed that engaged and involved plant operations team members throughout the system design and construction process would ensure an effective transition with an educated staff and front-line buy-in to the new system. To be effective, the university must plan and budget for this immediately.

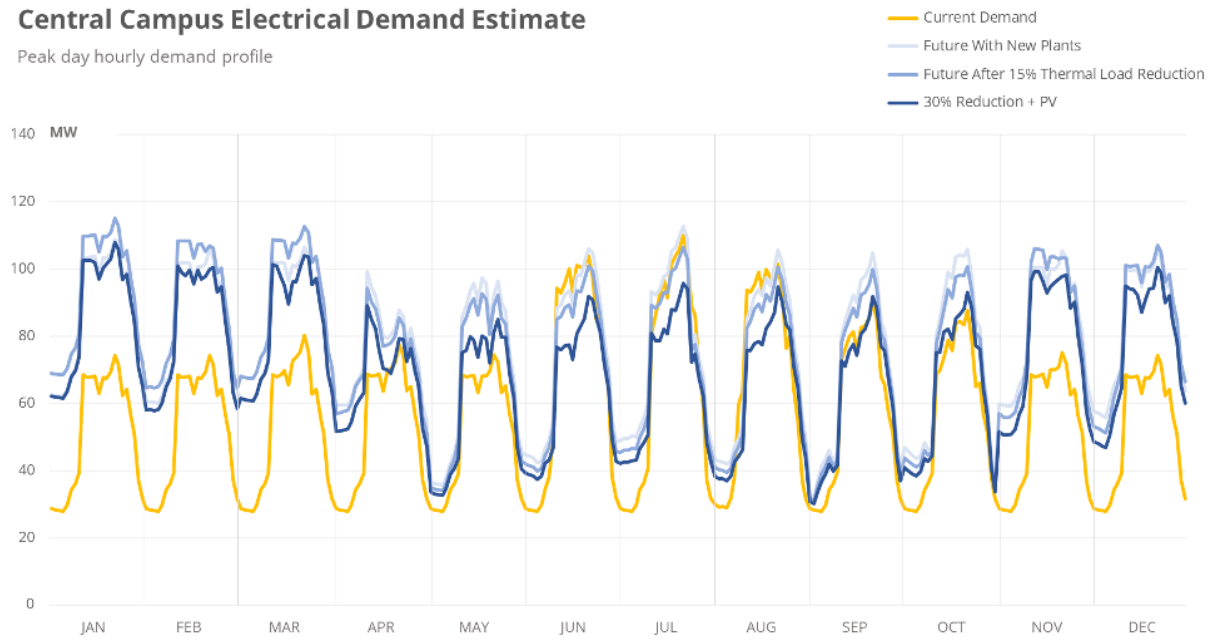
Availability and cost of capital will also be significant considerations that could accelerate or slow implementation. For example, if significant external sources of capital become available (e.g., government subsidies, philanthropic support) then the university should consider accelerating the timeline to the degree possible. Furthermore, changes in government policy such as a carbon tax may increase the attractiveness of moving more quickly.

A phased approach to this project also provides the university flexibility to reassess strategies and technologies as alternative options evolve over time for heat and power infrastructure decarbonization. This way, the university is not tied to any one strategy if a more cost-effective solution materializes. The Commission recommends that U-M reassess the feasibility of other emerging technologies at least every five years throughout the multi-decade implementation timeframe to ensure that potential alternative technologies are fully considered as they emerge.

Among the uncertainties with a project of this magnitude are additional costs attributable to upgrading and expanding the transmission and distribution (T&D) capacity of the local and regional electricity grid. While the Integral Group analysis suggests that the new system will demand significantly more electricity over the course of a year once it is fully operational, U-M's peak loads should not exceed current peaks, but they would shift from summer to winter as

shown in Figure 5, and at the time U-M retires its central plant, additional peak demand may potentially need to be met by the transmission and/or distribution utilities.

Figure 5. New proposed heat and power system: Central Campus electrical demand estimates




The Integral Group analysis did not evaluate the effects of U-M's increased electricity demand on the local transmission and/or distribution grid, however, a number of variables could determine whether incremental peak demand on the electric system will trigger upgrade costs. One critical variable will be the timeframe over which the change occurs — the longer the time frame, the more options the utility will have to meet incremental loads. Another critical variable will be the interplay with incremental load for other customers served by the same substation.

If the new system substantially increased peak loads, then T&D expansion costs could be substantial, and U-M would bear these costs if it was the only beneficiary of the upgrades. U-M should consider the overall load patterns in the City of Ann Arbor as those create potential contingencies (or not) to handle incremental load at the U-M campus. The Commission recommends that U-M work with its utility providers and regulators (e.g., Michigan Public Service Commission) to identify campus districts that are the least stressed in terms of capacity constraints to help inform a phased approach to building out the project. As emphasized in the Demand-Side Management section below, improving building standards and increasing the energy efficiency of existing buildings are extremely important. Taking these actions will lower electricity demand, and peak loads in particular, which is a critical factor in keeping the physical footprint and associated costs of a geoexchange system as low as possible.

**Refer to Appendix E for more specific evaluation criteria related to this recommendation.**

## University-Owned Vehicles and Maintenance Equipment

**Preliminary Draft Recommendation:** *Convert U-M's entire vehicle fleet — automobiles, trucks and buses — and all maintenance equipment to electric power.*

In addition to stationary sources throughout the campuses, U-M's Scope 1 emissions include a variety of non-stationary sources, including: the campus bus service fleets; light and medium-duty trucks and utility vehicles used for operations and maintenance; cars, vans, and other vehicles available to university units for rental; as well as non-vehicular maintenance equipment (e.g., lawn mowers, leaf blowers). The Commission recommends that U-M convert its entire vehicle fleet — automobiles, trucks and buses — and all maintenance equipment to be electric powered.

U-M's vehicle fleet is a highly visible, mission-critical operation for the university, with high reliability and safety being essential. All three campuses will require adequate and equitable support as they transition to an electric vehicle fleet.

*Ann Arbor Campus*

On the Ann Arbor campus, the BlueBus fleet provides transportation around the campus for faculty, staff and students seven days a week. As of 2019, the U-M Ann Arbor fleet accounted for roughly three percent of U-M Ann Arbor's total Scope 1 emissions. The U-M BlueBus fleet contributes the largest portion of fleet emissions for the Ann Arbor campus, making it an ideal point of focus for reducing emissions from U-M Ann Arbor. In line with the mobility electrification analysis group's recommendation, the Commission recommends U-M transition the BlueBus fleet to all-electric buses.

*Dearborn Campus*

The UM-Dearborn campus shuttle service moves faculty, staff and students around campus. This bus system is much simpler than that of the Ann Arbor campus. The Dearborn shuttle system has three buses serving three routes from 7:40 am to 9:50 pm each weekday. The Commission recommends U-M also transition the UM-Dearborn shuttle buses to electric power.

*Flint Campus*

The Flint campus does not currently have a campus bus or shuttle service.

*Inter-Campus Transit*

U-M has discontinued the Detroit Connector; the shuttle bus service connecting the Detroit Center, Dearborn campus, and the U-M Ann Arbor Central Campus Transit Center (CCTC). If U-M were to begin a new inter-campus bus service, the Commission recommends that U-M utilize electric buses.

*Other Campus Vehicles*

In addition to electrifying university buses and shuttles, the Commission recommends U-M transition light and medium-duty trucks; utility vehicles; and cars, vans, and other vehicles available to university units for rental to electric vehicles. This recommendation is applicable across all three U-M campuses. The timeline for transitioning smaller vehicles on all campuses

will be dependent on timelines for building out associated vehicle charging infrastructure on those campuses.

The Commission recommends that U-M make this transition as quickly as possible, recognizing that engineering studies will need to be completed to determine infrastructure needs. Early movement by U-M could accelerate broader uptake of these technologies in the region and the speed of U-M's transition will be influenced by a variety of factors, including:

- The political landscape and associated incentives;
- Partnerships with other key stakeholders in the region (e.g., cities, utilities, auto industry) to optimize transit solutions at the local and regional level;
- On-campus and local utility infrastructure capacity, and;
- Opportunities to partner in the deployment of charging infrastructure with DTE, Consumers Energy, local communities, and third party charging station companies.

U-M can track progress on this recommendation by monitoring: the number of electric buses acquired, annual GHG reduction, annual electricity usage and diesel fuel savings, up-front costs of the electric buses and charging, housing and maintenance infrastructure investments, and the achieved cost savings relative to the diesel bus costs.

The Commission recommends that U-M develop action plans in parallel for the Ann Arbor campus connector system (see Scope 3 strategies), optimal bus routes, charging infrastructure, battery capacity, a hybrid fleet of buses and/or shuttles; and a plan to electrify the truck and vehicle fleet across all three campuses. As U-M develops these plans, it should work closely with the City of Ann Arbor in pursuit of design solutions that optimize the relationship between U-M's transit system and other local/regional systems.

**Refer to Appendix F for more specific evaluation criteria related to this recommendation.**

## Scope 2 Emissions Reduction Strategies

### Purchased Electricity

**Preliminary Draft Recommendation:** *Issue a Request for Proposals (RFP) to procure all purchased electricity for U-M's three campuses in a manner that generates Renewable Energy Certificates that are retired by U-M or on its behalf, and aligns with the principles outlined by the Commission.*

The Commission has concluded that sourcing 100 percent renewable electricity from the grid is among the least complex and lowest cost near-term options for U-M to significantly reduce its greenhouse gas emissions. DTE Energy and Consumers Energy — the electric utilities serving U-M's campuses — have established public goals to fully decarbonize their electricity supplies by 2050 and 2040, respectively, but the Commission recommends that U-M accelerate that timeline in accordance with the goal stated above.[8] As a point of reference, the Science-Based Targets Initiative (SBTi) recommends an 80 percent decarbonization by 2025 and a 100 percent decarbonization by 2030 for purchased electricity.[9]

Electricity derived from renewable sources has historically made up a very small percentage of U-M's electricity purchases. However, that is on schedule to change in 2021 as a result of U-M (Ann Arbor) power purchase agreement for 75MW of wind energy through DTE's large customer MIGreenPower program, which supplies renewable energy from designated facilities in the State of Michigan. Under this regulated tariff, U-M will pay a price premium of approximately 1.5 cents per kWh above its standard rate and will receive credits over time from sales of the output in the energy and capacity markets. This agreement will supply approximately 200,000 MWh of renewable electricity annually, or approximately 40 percent of the Ann Arbor campus's current annual electricity buy. This will represent more than 50 percent of the Ann Arbor campus's purchased electricity once the expansion to the university Central Power Plant is complete in 2021. With the current DTE fuel mix, 200,000 MWh of renewable energy would result in an annual GHG reduction of nearly 110,000 $MTCO_2$.

According to the International Renewable Energy Agency (IRENA), the electricity generation costs from new renewables is increasingly less expensive than the generation costs associated with building new fossil fuel plants. Specifically, solar photovoltaics (PV) show the sharpest cost decline over the past decade (82 percent), while onshore wind decreased by 40 percent, and offshore wind fell by 29 percent. Given these trends, the Commission believes that electricity from renewables will continue to become increasingly cost-effective in the years to come.

Mitigating the remaining emissions associated with electricity purchases for U-M's three campuses will require additional investments in sourcing renewable electricity. There are

[8] DTE Energy. (2020, January 1). *DTE Clean Energy*. DTE Clean Energy. Retrieved December 2, 2020, from https://dtecleanenergy.com/; Consumers Energy. (2020, February 24). *MI Clean Energy Plan*. MI Clean Energy Plan. Retrieved December 2, 2020, from https://micleanenergyplan.com/

[9] Science Based Targets. (2020, April 1). *SBTi Criteria and Recommendations*. Science Based Targets. Retrieved November 30, 2020, from https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf

various ways of accomplishing this; each with potentially different levels of attractiveness across the three campuses. Currently available options within the State of Michigan include:

- Increasing existing subscription levels to regulated renewable electricity options like DTE's MIGreenPower program. With this subscription, U-M would pay a levelized subscription fee for the assets supporting the enrollment and would receive a partial credit reflecting the value of the energy and capacity from these assets. The subscription fee cannot increase over the life of the contract, while the credits will reflect market rates, which are expected to increase over time. The incremental renewable projects, which would most likely be solar, will be constructed in Michigan. DTE would retire the Renewable Energy Credits (RECs) on behalf of U-M, and DTE would not count them toward their own goals.

- Entering into a Virtual Power Purchase Agreement (VPPA), which is a financial contract where U-M would purchase electricity output from a new utility-scale renewable energy project located anywhere in the US from a third-party project developer at a pre-agreed price. The project developer would sell this electricity into the grid for the market price at the time the electricity is sold. If the market price is greater than the fixed VPPA price, U-M would receive the difference. If the market price is less than the fixed VPPA price, U-M would pay the project developer to make up the difference. Under a VPPA, U-M would continue to source its actual electricity from its utility partners (DTE and Consumers) at their contractual rate. VPPAs have some similarities to programs like DTE's MIGreenPower, in that the electricity flows into the grid and not directly to the customer, yet there can be differences in how RECs are handled. For example, within the MIGreenPower program, the RECs are retired by DTE on behalf of the customer, whereas in a VPPA, the customer typically takes ownership of the RECs, though a RFP could set an expectation that RECs be retired on behalf of the customer. While U-M could enter into a VPPA linked to an out-of-state project, the Commission recognizes that there are reasons why in-state projects may be preferred.

- Entering into a Power Purchase Agreement (PPA) with an electricity provider to develop behind the meter renewable energy projects on campus where the project would be owned and operated by the project developer, but both the electricity and associated RECs would flow to the university. The City of Ann Arbor is exploring a version of this where the developer would own the asset up front, and the City would have the option of buying it back at a reduced rate in the future. Grid connected PPA projects in front of the meter are not currently available under State of Michigan law. Behind the meter generation requires an interconnection agreement with the connected utility provider. The regulated utilities levy a MSPC approved "standby" charge on electrical power generated behind the meter.

- Installing U-M owned and operated, behind the meter, renewable energy projects on various structures and lands within U-M's campuses to reduce the amount of electricity that would need to be purchased from the electric utilities. Projects could potentially be integrated within building design or on greenspace within the campus boundary (e.g., 150 acres between Green Rd. and Huron Pkwy.). These projects are required to be

sized to not exceed the demand of the respective location as all energy is consumed onsite, if participating in DTE's Distributed Generation Rider tariff. DTE has other tariff and contracting options for U-M that would allow for larger sized installations, but with different economics (i.e., credits for outflows into the grid). The Commission expects such decisions will depend on a variety of factors, including project phase-in timelines on the three campuses, life cycle costs, availability of capital, land availability, and staffing capacity, which may change over time. With regard to on-campus behind-the-meter projects, U-M should consider whether or not energy storage should be included in the plan, given the intermittent nature of renewables. Electrochemical (i.e. battery) storage prices are dropping rapidly. Including storage systems can help stabilize the grid and improve reliability in the communities surrounding our campuses. The cost impact will be less damage to sensitive laboratory equipment due to system failure, as well as more stable operations of the medical and educational campuses. While university structures are already in place to facilitate electricity purchasing options from energy providers, investments in U-M owned and operated photovoltaic systems may require additional staffing capacity and deeper exploration of partnership potential with surrounding communities.

U-M should actively explore all current and potential strategies to determine which strategy, or combination of strategies, will best serve its goal of sourcing 100 percent renewable electricity in a manner that optimizes university priorities, in alignment with principles outlined by the Commission. The Commission recognizes that other options for sourcing renewable electricity could emerge in the years ahead and that U-M could play an active role in helping to shape those options.

**Refer to Appendix G for more specific evaluation criteria related to this recommendation.**

**Preliminary Draft Recommendation:** *Engage with the Cities of Ann Arbor, Dearborn, Detroit, and Flint, and other entities that are, or could be partners in advocating for renewable electricity policy changes in the State of Michigan to better understand their perspectives, conduct necessary due diligence, and potentially partner in advocacy efforts that reflect mutually-shared objectives, as well as actively explore ways to partner directly in pursuit of carbon neutrality goals.*

As U-M pursues options to achieve 100 percent renewable production, it is appropriate to consider not only available options, but also to support potential policy changes if they align with U-M's goals in pursuit of carbon neutrality. For example, the City of Ann Arbor's A$^2$ZERO plan seeks to enact Community Choice Aggregation (CCA) legislation in the State of Michigan.[10] A CCA enables a local government to pool the electricity demand of customers within its jurisdiction to procure power from an alternative supplier at a competitive price, while the electric utility continues to provide transmission, distribution, and billing services. Other options being advocated include microgrids, community solar, solar gardens, which many believe are important to address concerns regarding accessibility and equity. The Commission

[10] City of Ann Arbor, Sustainability and Innovations. (2020, April 1). *Sustainability and Innovations*. City of Ann Arbor. Retrieved November 30, 2020, from https://www.a2gov.org/departments/sustainability/Pages/default.aspx

recommends that U-M engage with potential partners and conduct due diligence with regard to renewable electricity options in the State of Michigan to determine whether, and how, it wants to advocate for additional options through potential policy changes at the state level.

For all options, the Commission recommends that, to the extent possible, the university pair investments in renewable electricity with research and education opportunities for U-M faculty and students. In addition, the university should allocate ongoing funding to support advanced systems research related to energy generation from building applied and building integrated photovoltaics, solar thermal electricity generation, waste heat generation, building installed wind power, energy storage, grid architecture and management, and other carbon neutrality solutions (see Research and Education recommendations). U-M should actively seek funds from government agencies, particularly the Department of Energy, the Department of Defense and the National Science Foundation, and donors to help support investment in these projects in a coordinated and intentional way.

**Refer to Appendix G for more specific evaluation criteria related to this recommendation.**

## Demand-Side Management Strategies

This section focuses on strategies the university can pursue to reduce energy demand in its buildings, thus reducing Scope 1 and 2 emissions. Demand-side management can include a wide range of strategies such as building envelope design, technological energy conservation measures, and policy mechanisms to incentivize behavioral change. Demand-side management and reduction strategies should be prioritized in the near-term. Doing so will ultimately reduce the amount of renewable energy the university needs to procure. Reducing peak demand for electricity will reduce the number of geoexchange boreholes required to transform U-M's heat and power infrastructure, thus lowering the overall project costs.

### Revolving Energy Fund

A revolving energy fund (REF) is a well-established financial instrument for funding energy conservation and carbon reduction projects at large institutions and cities across the United States.[11] The goal of the REF is to support carbon neutrality as quickly as possible by prioritizing projects with the lowest cost of emissions reductions.

**Preliminary Draft Recommendation:** *Create a Revolving Energy Fund (REF) on each of U-M's three campuses.*

Investments in Energy Conservation Measures (ECMs), such as light emitting diode (LED) lighting and equipment upgrades, can often be cost-effective ways to reduce the energy consumption and associated emissions of individual buildings. For example, the energy consumption policies (ECP) analysis team found that over the past 13 years, ECMs in U-M General Fund buildings (i.e., units primarily supported by tuition, state appropriations, and

[11] The Billion Dollar Green Challenge encourages institutions to participate in a revolving energy fund. For a full list of the participating institutions, see here: http://greenbillion.org/participants/

indirect costs of research), had a median return on investment (ROI) of 22.67 percent. The ECMs that realized 20+ percent ROI did not involve renovation or construction to complete. More involved/complex ECM projects that require building renovation and construction have much higher capital costs, and subsequently longer payback periods. These results show that greenhouse gas reductions from certain types of ECM's make good business sense for U-M. Moreover, based on the analysis team's data, there is no sign that U-M has picked all of the "low-hanging fruit," as the ROI of projects over the past 13 years shows no sign of decreasing over time, which suggests that U-M is underinvesting in ECMs.

While the ECP recommendations suggest there are many ECMs yet to develop with simple paybacks of 4 years or less, additional ECM work with paybacks of 10 years or longer will be required to achieve a 25 percent reduction. The Office of Campus Sustainability (OCS) estimates that an average ECM payback of 8 years or less is only achievable for projects (such as lighting retrofits) that do not require construction or renovation activity. More intensive energy reduction work/ECM's require construction/renovation work which add significant capital costs to the project and much longer payback periods. Refer to Appendix B of the ECP analysis report for the details of the data and financial calculations.

Following the recommendation of the ECP analysis team, the Commission recommends accelerating ECM work at U-M by establishing an REF on each of U-M's three campuses (Ann Arbor, Dearborn and Flint). The REF policy will empower the leaders and staff of individual units to foster emissions reductions at the building level through energy conservation measures.

Due to different budget models across different campuses and divisions, U-M should also consider whether to create multiple REFs within each campus to account for different budget models (e.g., general fund vs. auxiliary). Doing so would foster greater buy-in at the unit level and prevent unintended consequences such as academic units subsidizing athletics. Each REF would function as a separate fund. U-M units would submit project proposals to the REF with quantified energy and financial savings estimates. If approved, the campus-specific REF would provide the unit with a loan to cover the upfront capital expense. The loan is repaid to the fund through utility bill savings from the resulting reduction in energy consumption. Managing the mechanics of the REF program would require additional staff effort, which could be significant depending on the process involved to solicit, review, and select projects.

A significant benefit of the REF is that it provides a long-term and stable mechanism for consistently funding ECM work, which is not affected by changes in short-term policy and budget priorities. The REF model provides the opportunity to seek additional funds from alternative sources, such as federal subsidies and utility energy efficiency programs. In the case that a project receives funds from both the REF and an external source, the external funds will offset a portion of the loan from the REF.

*Ann Arbor Campus*

Based on the ECP analysis estimates, the REF on the Ann Arbor campus is expected to reduce U-M Ann Arbor Scope 1 and Scope 2 emissions by 25 percent through energy conservation projects over 10 years. After 10 years of operation, annual emissions are projected to be 104,727 $MTCO_2e$ less than they were at the start of the 10-year period, though OCS estimates

that it would likely take longer due to the complexity of individual projects and the challenge of sequencing. The Commission recommends that U-M provide the U-M Ann Arbor campus with at least $25 million in seed funding for the REF. The ECP's sensitivity analysis suggests that this approximate level of funding would facilitate the most cost-effective project investments, and that project paybacks would gradually decline at higher funding levels. In other words, higher funding levels would not necessarily result in a concomitant level of efficiency gains, because efficiency improvements are limited by the remaining opportunities available in the facilities being renovated and retrofitted. To provide adequate expertise across the Ann Arbor campus to fully utilize the REF and achieve the desired emissions reductions, the Commission recommends that U-M increase the size of the current energy management team to adequately meet the additional implementation and accounting demands. Currently, DTE provides three on-site energy managers to help U-M Ann Arbor identify and develop new energy efficiency opportunities. An increase with the level of activity might require bringing on additional DTE resources and staff. More information can be found in the ECP analysis report, Appendix D.

An implementation challenge for the REF on the Ann Arbor campus is the decentralized nature of the university, which extends to budgets and budget models. The Commission recommends that U-M focus on optimally implementing REFs in auxiliary units, such as the Michigan Medicine, Athletics, and Student Life (University Unions and Housing).

*Dearborn & Flint Campuses*

The UM-Dearborn and UM-Flint campuses do not track carbon emissions by building, and unlike the Ann Arbor campus, utility bills are paid centrally on those campuses. These characteristics make the decentralized REF policies proposed for the Ann Arbor campus unsuitable for the Dearborn and Flint campuses as they are presently structured. Nevertheless, the Commission recommends the use of a dedicated REF by the central administration for the Dearborn and Flint campuses. Consistent with the ECP analysis team recommendations, the Commission recommends $2.5 million in seed funding for each of the Dearborn and Flint campus REFs. The Commission recommends hiring at least one energy management staff member to assist with identifying and executing energy efficiency projects on each of these two campuses. On the Flint campus specifically, Consumers Energy would be willing to explore a model similar to the relationship between DTE's energy managers and the Ann Arbor campus. If adequate funding could be allocated, UM-Flint Facilities and Operations staff are eager to implement an REF system, which they think would be a game changer to bolster the campus' energy efficiency and carbon reduction efforts.

If REFs were implemented, it is estimated that REF programs will result in a 25 percent emissions reduction over 10 years on the Dearborn and Flint campuses. Due to incomplete data from the Dearborn and Flint campuses, the Commission recommends U-M begin by expanding the data collection capabilities at these campuses.

*Implementation and Next Steps*

In line with the ECP analysis suggested implementation timeline, the Commission recommends the following timeline to implement REFs across the three campuses:

*First Year* — Determine where the seed funding is coming from and create a new business account for the REF. Allocate funds. Conduct broad engagement and information sharing on the upcoming opportunities.

*Second Year* — Hire and train regional energy managers (once assigned to buildings, regional energy managers will need six to nine months to get familiar). Inform and educate units on the opportunity.

To track progress on this recommendation, the Commission recommends that U-M track emissions reductions from the energy conservation measures, the annual cost savings, and the number of energy conservation measures completed with the REF. Current U-M metric and verification practices are inadequate to support the efforts of carbon neutrality and must be significantly expanded for the REF to function effectively and sustainably. Proposed alternative practices are available in the ECP analysis report, appendix D.

In agreement with the ECP analysis recommendation, the Commission recommends the following priority actions to catalyze the implementation of an REF on all three U-M campuses:

- Perform additional analysis and consultation with relevant auxiliary units and campus leaders to determine the logical way to integrate the REF on the Ann Arbor campus.
- Make the necessary emissions accounting upgrades and adjustments for the REF.
- Hire the energy management staff necessary to meet the program goals.
- Allocate funds and create new business accounts for the REF at all three U-M campuses.

**Refer to Appendix H for more specific evaluation criteria related to this recommendation**

## Carbon Pricing

A carbon price is a cost applied to the use of fossil fuels linked to the climate damage that they cause. It increases the overall cost of energy and thereby creates a financial incentive to reduce both production and use of fossil fuels. The idea of a carbon tax or carbon pricing equivalent via cap-and-trade has been embraced by a large and diverse set of economists in the United States and around the world and the 2018 Nobel Prize in Economics was awarded to one of the world's leading scholars in this arena, Yale's William Nordhaus.[12]

The World Bank reported in 2020 that more than 60 nations employ some form of a carbon price, with leading models including those from the European Union, Canada, and a growing number of Asian nations.[13] In the United States, twelve states have adopted some version of a carbon price, the most recent being Virginia in 2020. Such policies can be highly complementary with a range of other policies, creating strong incentives to reduce fossil fuels

[12] Metcalf, G. E. (2018). *Paying for Pollution: Why a Carbon Tax is Good for America*. Oxford University Press. 10.1093/oso/9780190694197.001.0001

[13] World Bank. 2020. State and Trends of Carbon Pricing 2020. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/33809 License: CC BY 3.0 IGO.

and thereby supporting other efforts that expand the availability of energy alternatives or promote greater energy efficiency.

A growing global trend has been to use revenue from a carbon price to finance the transition to a low-carbon economy. This is perhaps most evident in the United States in the eleven-state Regional Greenhouse Gas Reduction Initiative,[14] which generates substantial revenue to support related programs, and the emerging Green Deal initiative in the European Union. In the absence of federal or state carbon pricing mechanisms, individual institutions are experimenting with putting a price on carbon within their organizations. In higher education, for example, carbon pricing has emerged as a central component in carbon neutrality strategies adopted at such institutions as Yale, Cornell, Smith College, and Swarthmore College.

**Preliminary Draft Recommendation:** *Establish a carbon pricing system at the organizational unit level across U-M where revenue flows to the REF for new energy conservation measures.*

Following the recommendation of the PCCN's ECP analysis team, the Commission recommends that U-M establish a carbon pricing system that would charge each organizational unit according to its carbon footprint. Carbon pricing aligns incentives by internalizing the impact of emissions into economic decisions through a price on greenhouse gases. The Commission believes that linking a carbon pricing system with a REF to fund energy conservation measures presents an opportunity to show leadership among universities while driving down emissions and sending a clear signal to units about U-M's priorities.

As stated by the ECP analysis team, in the absence of external emissions pricing systems, internal pricing provides an opportunity to:

(1) demonstrate meaningful environmental commitment and leadership,
(2) cost-effectively reduce energy-use and emissions, and
(3) implement a customized pricing system to match organizational structure and goals.

The proposed pricing system is designed to capitalize on each of these categories while fitting smoothly into the existing organizational structures and maintaining the university's core mission.

The Commission recommends that revenue generated by the carbon price be divided as follows: 30 percent to directly return to the contributing unit earmarked for energy efficiency upgrades; and the remaining 70 percent to feed into the REF, or the OCS energy management team if an REF is not created. In general, the revenue should be invested in the lowest cost (i.e., $/MTCO$_2$ reduction) opportunity to mitigate emissions.

As explained by the ECP analysis team, the REF and carbon pricing system play synergistic roles in providing the incentives and means for reducing emissions through energy conservation projects. The two policies work well together because they promote increased use of each mechanism more than if only one were implemented alone. Without the carbon price, the use of

[14] Regional Greenhouse Gas Reduction Initiative: https://www.rggi.org/

the REF for energy efficiency projects is less urgent to units; without the REF, the carbon price places a larger financial burden on units before centralized revenues grow large enough to begin funding energy efficiency projects for all units to reduce their emissions. The two policies, when paired together, give leaders and staff of university units the agency and responsibility to reduce their unit's carbon emissions through energy conservation measures, both technological and behavioral.

The Commission acknowledges that unit-level resistance to this recommendation is to be expected, and that U-M needs to engage units directly in developing the program to make it work. To ensure the effectiveness and integrity of the system, U-M should be clear about how the carbon pricing revenue will be spent and should develop mechanisms to ensure that all units benefit directly from associated energy conservation investments in the long run.

The Commission recommends that U-M begin by implementing a proxy carbon price across all three campuses for Scope 1 and Scope 2 emissions. A proxy price will assist the university in assessing the feasibility of applying a carbon price across all three U-M campuses. Based on the findings, the Commission recommends phasing implementation of a carbon price in line with the recommendations put forth by the ECP analysis team. The Commission recommends the university begin with a carbon price of \$50/MT$CO_2$, which is a commonly accepted social cost of carbon, and escalate the price at 2.5 percent per year, as recommended by the ECP analysis team. To further incentivize action by units, the top two units by percent emissions reductions each year would receive an additional 10 percent of their carbon charge revenue. The desire for a competitive component was a clear lesson from Yale's Carbon Charge program with different pricing systems.[15]

Once carbon emissions accounting and tracking is standardized across units, this price should be expanded to Scope 3 emissions that are included in carbon neutrality goals, which are quantifiable and within U-M's ability to reduce.

To catalyze progress on this recommendation, one initial step is to form a committee comprising unit leaders and university budget officials to develop the details in a way that will make it workable with U-M budget structures and their likely evolution in the coming years. As the proposed carbon pricing system is phased in, organizational structure and budget model considerations will be evaluated, and changes made in accordance with lessons learned. The university will need to work closely with the UM-Dearborn and UM-Flint campuses to design customized carbon pricing infrastructure, and to identify emissions reduction strategies to address historic inequalities in resource access. Before a price is implemented on the Flint campus, sub-metering infrastructure and more robust accounting programs will need to be put in place.

After these steps are taken during the first year and depending on the findings from the proxy pricing study, U-M will begin to implement the pricing system incorporating lessons learned during the preliminary phase. This will entail collecting the first revenue, continuing to

[15] Yale University. (2020, January 1). *Yale Carbon Charge*. Yale Carbon. Retrieved December 3, 2020, from https://carbon.yale.edu/

collaboratively build energy management capacity, and reviewing the first cohort of projects for the efficiency investment fund. Then the carbon price should be incrementally increased until it reaches a $50/ton carbon price by Year 5 in line with the social cost of carbon, and the price should be adjusted over time to reflect the latest thinking on an appropriate social cost of carbon.

To measure progress on this recommendation, the Commission recommends that U-M track emissions reductions from the energy conservation measures, the annual cost savings, and the number of energy conservation measures completed with the REF. Current U-M metric and verification practices are inadequate to support the efforts of carbon neutrality and must be substantially revised for the carbon price to function effectively and sustainably. The Commission suggests that one unit be identified to oversee and manage both the REF and the carbon pricing program.

**Refer to Appendix H for more specific evaluation criteria related to this recommendation.**

## Building Standards

As noted by the building standards analysis team, most approaches to the design and evaluation of high-performance buildings to date are based on energy demand calculations, such as Energy Use Intensity (EUI). Increasing energy efficiency of U-M buildings will be extremely important going forward, because reducing energy demand across campuses (particularly peak demand) will decrease the size and cost of projects to transform U-M's heat and power infrastructure. A singular focus on units of energy demand can be misleading because energy demand and consumption have a variable relationship to GHG emissions depending on factors including the building's energy mix.

As of 2019, buildings on the U-M Ann Arbor campus consumed 98.5 percent of the total measured energy and contributed 97.3 percent to measured Scope 1 and Scope 2 $CO_2$ emissions. In the past 10 years, the Ann Arbor campus has seen approximately 6.5 million gross square feet of growth in building area.[16] In contrast, the Flint and Dearborn campuses have seen much smaller rates of growth and are also significantly smaller in total building gross area. If growth trends continue, the rate at which new construction contributes to future $CO_2$ emissions will be strongly influenced by the types of buildings constructed. With this in mind, the Commission recommends the following new construction and major renovation building standards:

**Preliminary Draft Recommendation:** *Establish best-in-class $CO_2$ emissions targets across 9 building types for all new construction and major renovations*

In line with the building standards analysis team report, the Commission recommends that U-M adopt strict emissions targets for all new construction projects, including major renovations, on the Ann Arbor, Dearborn and Flint campuses. The emissions target should be specific to nine

[16] University of Michigan Office of Campus Sustainability. "University of Michigan, Environmental Metrics FY19." https://ocs.umich.edu/wp-content/uploads/2020/04/FY2019-Env-metrics.pdf

building types found on U-M's campuses (Table 3). This shift would prioritize evaluating buildings based on their $CO_2$ emissions, while recognizing that energy performance considerations are also important. Prioritizing $CO_2$ emissions into the new construction building standards inherently requires the consideration of both the building's individual performance, as well as the impact of its energy intensity on total campus emissions, which aligns with the Commission's heat and power infrastructure recommendation. This recommendation is a shift from U-M's current energy/cost building code (ASHRAE), and because there are no existing codes for a carbon per square foot approach, it is something U-M would need to develop.[17]

Table 3. Proposed building types compared with major building codes and standards

***Proposed Building Types compared with MI Building Code, LEED and Living Building Challenge definitions***

| | | | | Table 403.3.1.1 2015 MI Mechanical Code |
|---|---|---|---|---|
| **Building Standards IAT Proposed Building Types** | **2015 MI Building Code, Section 302 Use and Occupancy Classification** | **LEED v4.1** | **Living Building Challenge** | **Area outdoor airflow rate in breathing zone, CFM/sf** |
| Athletic<br>Library | Assembly | | | *Range: 0.06 - 0.48* |
| Administrative<br>Educational (no lab)<br>Educational (low load lab) *<br>Educational (high load lab) * | Business | Data Centers | Commercial | *Range: 0.06* |
| | Educational | Schools | | *Range: 0.06 - 0.18* |
| | Factory<br>Industrial | | | |
| | High Hazard | | | |
| Clinical | Institutional | Healthcare | Institutional<br>Medical + Laboratory | |
| | Mercantile | Retail | | |
| Residential (low rise, duplex, single family)<br>Residential (dormitory) | Residential | Single Family Homes<br>Multifamily Homes | Single Family Homes<br>Multifamily Homes | *Range: 0.06* |
| | Storage | Warehouses<br>Distribution Centers | | *Range: 0.06* |
| | Utility<br>Miscellaneous | New Construction<br>Major Renovation | | |

** Educational occupancy is defined by the Michigan building code to include grades K-12 only. Higher education is classified under business occupancy.*

In alignment with the heat and power infrastructure (i.e., geoexchange) recommendation, all new and renovated buildings at U-M should be designed and constructed such that they can be easily converted to a medium temperature hot water system. In addition, the Commission recommends that advanced metering be installed to measure hourly consumption of electricity, natural gas, steam, and water input and outflow.

With its large and varied portfolio of buildings ranging in purpose from residential, to classroom, utility, heavy research, to medical, the university has the ability to implement aggressive building standards that would have significant impacts across multiple building types and provide U-M with an opportunity to demonstrate leadership in the state and nation. Such diverse building standards would be especially scalable and transferable to peer institutions, industry, hospitals, and like-minded institutions with carbon neutrality aspirations.

U-M's Architecture, Engineering, and Construction (AEC) currently oversees all building renovation and new construction projects over $3 million on the Ann Arbor, Dearborn and Flint campuses. AEC has also developed and implemented extensive design standards that meet or

[17] University of Michigan Architecture, Engineering and Construction. (2020, January 1). *Design Guidelines*. U-M Architecture, Engineering and Construction. Retrieved December 2, 2020, from https://umaec.umich.edu/for-vendors/design-guidelines/

exceed building standards implemented at the state level. This unit therefore is expected to play a pivotal role in the successful implementation of the proposed new building standards. Strict standards are likely to add significant up-front cost to new construction projects. Success will require the engagement of deans and other unit leaders to understand their perspectives, address potential concerns, and achieve buy-in.

The Commission recommends U-M utilize dynamic modeling technology to track the proposed building standards throughout the design phase of buildings. Models should include dynamic efficiency values of heating, ventilation, and air conditioning (HVAC) systems, and include locally specific values for the impact of the building's energy mix over time. U-M should also verify design targets with actual building performance over time. Verification will require ubiquitous metering per building across all input and output types.

When designing new construction projects, the Commission recommends that U-M pursue cost comparisons and feasibility studies for energy efficiency and renewable energy options that could be building-integrated and complement district-level systems. These studies must account for the interlocking impacts of other Scope 1 and 2 recommendations when calculating the full cost/benefit impact when assigning standards to a particular building type. The Commission also recommends that AEC work closely with the Dearborn and Flint campuses to determine the best way to scale the recommended construction building standards to meet their particular needs. The Revolving Energy Fund could serve as one mechanism to support ECM measures in major renovation projects.

The Commission recommends U-M immediately begin to pursue the following next steps to catalyze progress:

- Expand the analysis of new construction building standards on all three campuses, and finalize a set of criteria and costs needed to ensure building construction standards align with U-M carbon neutrality goals.
- Prior to permitting construction, mandate that all new buildings follow the guidelines established to achieve net-zero emissions in alignment with U-M carbon neutrality goals.
- Review all ongoing construction projects and assess the costs and practicality of having these projects fully, or partially conform to the agreed-upon standards.
- Expand research on net-zero emissions buildings standards and systems. Specifically, the work needs to enable this research to impact the direction of U-M locally and enable the scalability and transferability to other universities and beyond.

**Refer to Appendix I for more specific evaluation criteria related to this recommendation.**

## Deep Building Retrofits

In addition to the work completed by the building standards analysis team, the Commission hired an external consultant (SmithGroup) to identify and provide cost estimates on strategies to significantly minimize energy use and carbon impacts in existing campus buildings. A goal of this work was to identify energy reduction conservation measures that can be repeated across

similar building types and used to reduce energy use and carbon emissions. The initial desire was to conduct these analyses for five specific building types (i.e., administrative/classroom, research, clinical, athletic, residential) across campus, but due to time and budget constraints, only two studies were initiated – the Art & Architecture Building (administrative/classroom) and Couzens Hall (residential). At the time of writing, the Art & Architecture (A&A) study is complete and the Couzens Hall study is ongoing.

Constructed in 1971 and with a significant addition built in 2017, the A&A Building has a variety of space types, including studios, workshops, labs, classrooms, and administrative offices. The ECM strategies evaluated by SmithGroup included mechanical and electrical building systems, the building enclosure, walls, and roof, as well as various combinations of these same systems. The analysis concluded that A&A is a prime candidate for significant renovations. However, the costs of deep retrofits to drive significant carbon reductions would be very high in terms of dollars spent per ton of carbon reduced. Specifically, the retrofit scenario resulting in the largest GHG reduction (77 percent) is projected to cost $114 million with a simple payback of 492 years.

Based on this initial study, the Commission determined that Integral's district-level approach to decarbonizing U-M's energy infrastructure, while also expensive, is preferable to a distributed decarbonization approach at the building level. The Commission recommends that U-M continue to conduct these studies of different building types to get clarity on which ECM strategies are most cost-effective in reducing energy consumption, particularly peak demand for electricity.

**Refer to Appendix J for more information on SmithGroup's study of the Art & Architecture Building.**

# Scope 3 Emissions

This section addresses Scope 3 emissions, which are all off-campus GHG emissions (other than purchased electricity) that are associated with U-M's activities (upstream and downstream). Unlike Scope 1 and 2 emissions, it is both difficult to measure Scope 3 emissions with a high degree of accuracy and challenging to influence their trajectory, as seen in Figure 6. This is because U-M's Scope 3 emissions are someone else's Scope 1 and 2 emissions, so eliminating these emissions requires concurrent action by many individuals and organizations.

Figure 6. U-M's ability to influence and estimate emissions levels for Scopes 1, 2 and 3.

*U-M's Ability to Directly Influence Emission Levels*

*U-M's Ability to Confidently Estimate Emission Levels*

| | High | Medium | Low |
|---|---|---|---|
| High | • Central Power Plant<br>• Boilers & Other Stationary<br>• UM Vehicle Fleet<br>• Maintenance Equipment | • Purchased Electricity<br>• Waste Disposal | |
| Medium | | • Commuting<br>• UM-sponsored Travel | • Upstream<br>(Electricity and Fuels) |
| Low | | | • Food Purchasing<br>• General Purchasing |

*Color Key:* *Scope 1* *Scope 2* *Scope 3*

# Carbon Neutrality Goal Summary

The following are preliminary draft recommendations for setting carbon neutrality goals for Scope 3 emissions. They do not represent the Commission's final recommendations, nor do they represent that commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

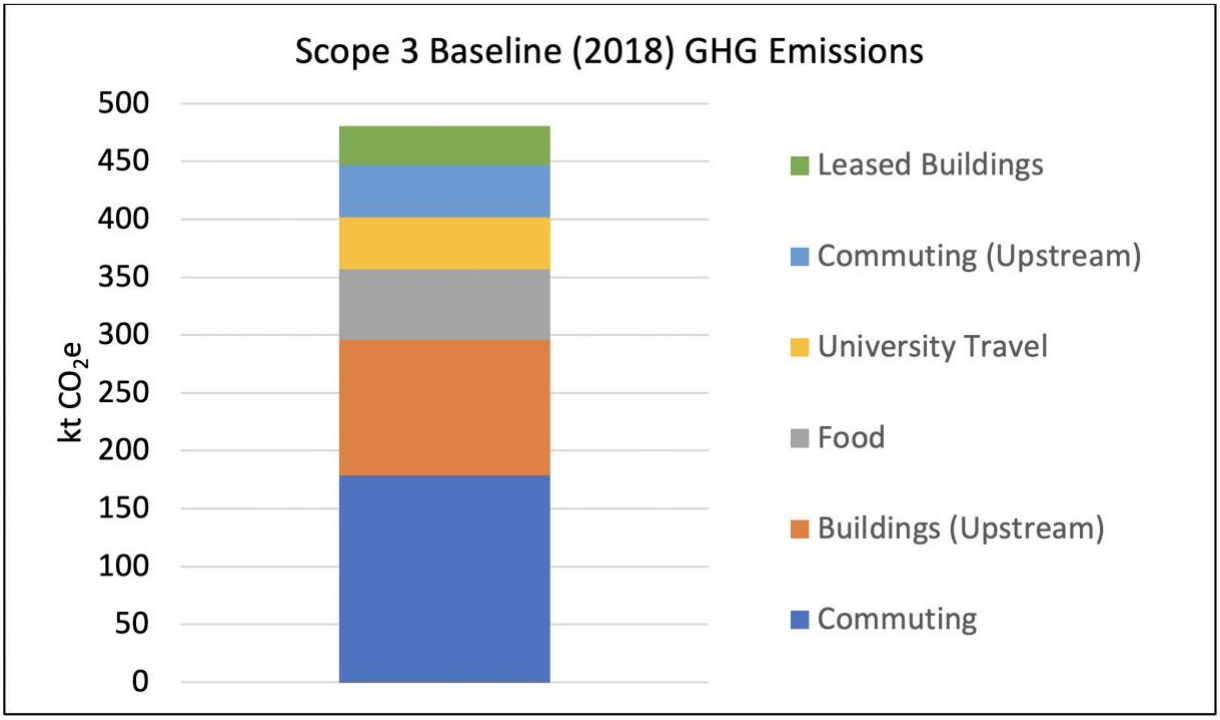
| | |
|---|---|
| Scope 3 Emissions | By no later than 2025, set carbon neutrality goal dates for each of the Scope 3 categories recommended for inclusion by the Commission, recognizing that goal dates may vary by category based on U-M's ability to measure and influence the associated emissions categories. The Commission also recommends that, in 2025 and at regular subsequent intervals, U-M actively consider including additional Scope 3 categories in its goals, if the University can accurately measure and reasonably influence emissions in that category. |
| Scope 3 Emissions | In setting carbon neutrality goal dates for Scope 3 emission categories, establish targets (inclusive of offsets as needed) that are more aggressive than science-based targets[18] and reach neutrality no later than 2040. |

[18] See Key Terms section for definition.

## Boundaries and Baselines

Scope 3 emissions result from upstream (pre-combustion) fuel extraction and processing, commuting, University travel, food (upstream and downstream), water treatment (upstream and downstream), land use, and upstream (production) embodied in purchased goods and services. Figure 7 below estimates the most impactful Scope 3 baseline emissions for U-M.[19] Due to significant accounting uncertainty at this time, purchased goods are not included in these estimates, but are likely larger than any of the other categories. The Commission's carbon accounting team estimates that emissions associated with purchased goods could range from 300 to 1,400 kt $CO_2e$.

Figure 7. Scope 3 baseline GHG emissions FY18




[19] Refer to the Carbon Accounting team report for further delineation of these categories, as well as data and information on additional Scope 3 categories that have less significant GHG impacts.

## Goals, Timelines, and Interim Targets

**Preliminary Draft Recommendation:** *By no later than 2025, set carbon neutrality goal dates for each of the Scope 3 categories recommended for inclusion by the Commission, recognizing that goal dates may vary by category based on U-M's ability to measure and influence the associated emissions categories. The Commission also recommends that, in 2025 and at regular subsequent intervals, U-M actively consider including additional Scope 3 categories in its goals, if the University can accurately measure and reasonably influence emissions in that category.*

Whereas U-M's current GHG reduction goal includes only Scope 1 and 2 emissions, the Commission recommends that U-M establish carbon neutrality goals inclusive of Scope 3 emissions. This recommendation is intended to put U-M on that path while acknowledging that it is difficult to measure Scope 3 emissions with a high degree of accuracy and challenging to influence their trajectory. The Commission recognizes the importance of providing U-M with time to implement accounting systems to better track and establish baselines for these emission categories, and to better assess the degree to which U-M can influence these emission categories.

As illustrated in Figure 8 below, there is wide variance among this sample of peer institutions with regard to tracking Scope 3 emissions and setting goals for them. Many of these institutions are actively working to better measure Scope 3 emissions for purposes of eventually including them in carbon neutrality goals.

Figure 8. Scope 3 emissions peer tracking and goal-setting benchmarking

**Scope 3 Emissions Peer Benchmarking**

Tracked and included in CN Goal
Tracked / Not yet included in CN goal
NOT tracked / Not included in CN goal

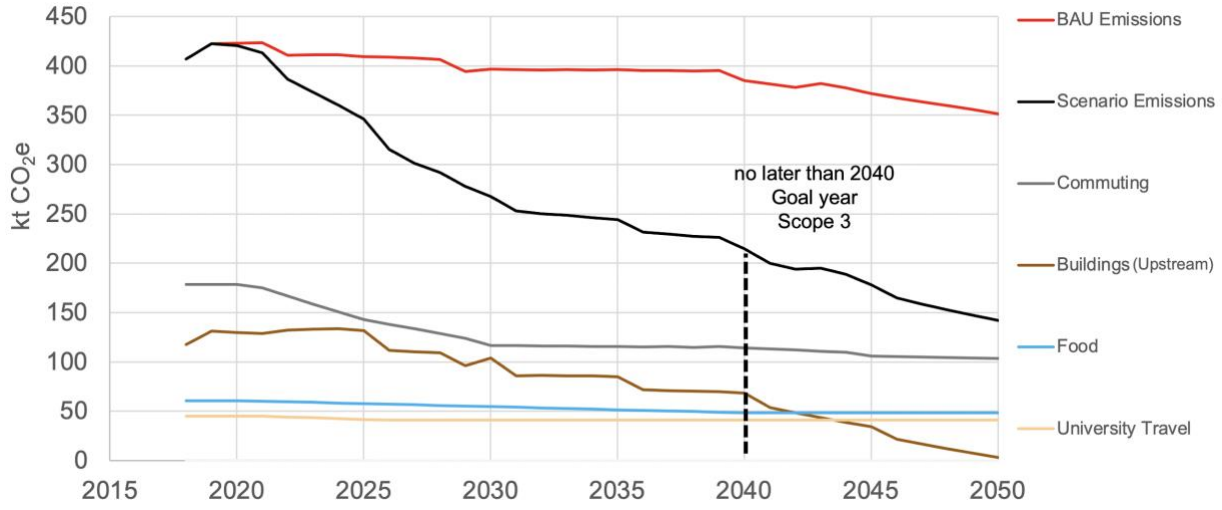
| Emissions Category | Cornell | Ohio State | Stanford | Cal (Berkeley) | UCLA | Illinois | UNC (Chapel Hill) | Texas (Austin) | Virginia | Michigan State | Duke | Harvard | Yale | Wisconsin (Madison) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commuting | 2035 | 2050 | | | 2050 | 2050 | | | | | | | | |
| University Travel | 2035 | 2050 | | | 2050 | 2050 | | | | | | | | |
| Food | | | | | | | | | | | | | | |
| Purchased Goods | | | | | | | | | | | | | | |
| Solid Waste | | 2050 | | | | | | | | | | | | |
| Wastewater | | 2050 | | | | | | | | | | | | |
| Upstream Methane Losses (NG) | | | | | | | | | | | | | | |
| Upstream T&D Losses (electricity) | | 2050 | | | | | | | | | | | | |

**Preliminary Draft Recommendation:** *In setting carbon neutrality goal dates for Scope 3 emission categories, U-M should establish targets (inclusive of offsets as needed) that are more aggressive than science-based targets[20] and reach neutrality no later than 2040.*

With this recommendation, the Commission both acknowledges the urgency of moving toward carbon neutrality across all emission categories and the fact that eliminating these emissions is complex and requires concurrent action by many individuals and organizations that are largely beyond U-M's control. In response to IPCC guidance and in the interest of global climate justice, it is important that U-M move quickly and work with others to do the same.

Figure 9 illustrates trajectories for U-M Scope 3 emissions beginning with a 2018 baseline and continuing until 2050. The red line reflects a business-as-usual scenario, which takes into account changes to the electricity fuel-mix that are projected to take place between now and 2050. The black line projects total Scope 3 emissions reductions (excluding purchased goods) that reflect Commission recommendations for mitigation strategies. In addition to the sub-categories shown, a number of other smaller categories are also included in the scenario emissions total.

Figure 9: Scope 3 emissions trajectories[21]




One Scope 3 category that is not included in the BAU or scenario emissions total is purchased goods. As noted above, this category is significant and U-M needs to take steps to improve its ability to account for these emissions. Specific recommendations are provided in the Purchased Goods section below.

[20] See Key Terms section for definition.

[21] Refer to the Carbon Accounting Modeling Project report for additional information on the accounting model and emissions reduction scenarios.

## Strategy Recommendations Summary

The following are preliminary draft recommendations for mitigating Scope 3 emissions. They do not represent the Commission's final recommendations, nor do they represent that commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

The table below seeks to provide generalized comparisons of the draft recommendations in terms of Financial Investment, GHG Levels, and Culture Shift. These are subjective judgments based on best available information and are for illustrative purposes only.

| **Preliminary Draft Strategy Recommendations** | **Financial Investment** | **GHG Levels** | **Culture Shift** |
|---|---|---|---|
| *Commuting:* Reform the university's parking policy on each of U-M's three campuses and reduce or eliminate incentives for personal vehicle commuting. | $$ | ↓ ↓ | High |
| *Commuting:* Expand the availability of electric vehicle charging stations across all three U-M campuses. | $$ | ↓ | Med |
| *Commuting:* Invest in affordable and accessible alternatives to the personal vehicle commute, including rideshare, cycling, and free bus access on the Flint and Dearborn campuses. | $$ | ↓ ↓ | High |
| *Commuting:* Proceed with the design and development of the Ann Arbor campus connector and integrate it with local/regional transit systems. | $$$$ | ↓ ↓ | Med |
| *Commuting:* Embrace and incentivize flexible telecommuting options for employees | $ | ↓ ↓ | High |
| *Commuting:* Prioritize central locations for construction projects and consider expanding on-campus housing for faculty, staff and students at the campus periphery. | $ | ↓ ↓ | Med |
| *University Travel:* Provide and incentivize low-carbon ground transport options (e.g., trains, hybrid/electric buses and passenger vehicles) for university-sponsored travel. | $$ | ↓ ↓ | Med |
| *University Travel:* Promote video conferencing as an alternative to in-person meetings and travel. | $ | ↓ ↓ | High |

| | | | |
|---|---|---|---|
| *University Travel:* Implement a carbon price for faculty, staff and students who travel on university business, with the revenue being used to support the reduction or offsetting of U-M emissions. | $ | ↓ | High |
| *Food:* Pursue plant-forward food procurement and consumer diets across all three U-M campuses. | $ | ↓↓ | High |
| *Purchased Goods:* Request production emissions data from vendors to strengthen guidance for low-carbon procurement at U-M. These data can be used in purchasing decisions in addition to cost and performance criteria, as well as in emissions reduction tracking. | $ | ↓↓ | High |
| *Solid Waste:* Reduce and divert food waste from landfills by scaling up food waste diversions and reductions, increasing capacity for composting on U-M's campuses, and launching a campus-wide composting program at UM-Dearborn and UM-Flint | $$ | ↓ | High |
| *Water:* Explore improved water efficiency and site design standards for all new construction to reduce both upstream and downstream emissions from water treatment. | $ | ↓ | Low |
| *Leased Buildings:* Strive to meet additional space needs through better utilization of permanent space and leased spaces that are intentionally designed as flexible co-working facilities for staff across multiple units who, for example, telecommute three or more days per week. | $ | ↓↓ | High |
| *Leased Buildings:* Prioritize leasing arrangements that allow the university to pay electric and gas utility bills directly. This model simplifies accounting for GHG emissions and creates an incentive for U-M units to reduce their energy usage and to include these emissions in a carbon price. In cases where this model is not possible, U-M should include a provision in lease agreements to supply monthly utility use data for UM-occupied space. | $ | ↓ | Low |
| *Leased Buildings:* Develop and implement language in all leasing policy documents that requires high energy efficiency and a low GHG footprint, ideally in alignment with U-M building standards. Require property owners/managers to provide detailed information pertaining to their efforts to implement energy efficiency and emissions reductions. | $ | ↓ | Med |

## Accounting Recommendations Summary

The following are preliminary draft recommendations for Scope 3 emissions accounting. They do not represent the Commission's final recommendations, nor do they represent that commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

| **Preliminary Draft Accounting Recommendations** |
| --- |
| *University Travel:* Standardize travel data collection to facilitate carbon footprint calculations and provide feedback to community members on the impacts of their university-sponsored travel. |
| *Food:* Establish and standardize food purchasing data collection to facilitate carbon footprint calculations and provide feedback to community members on the impacts of their food procurement and consumption. |
| *Purchased Goods:* Implement an accounting system for GHG emissions associated with purchased goods, which disaggregates expenditures into sector categories and uses an Economic Input-Output (EIO) approach to estimate an emissions baseline and inform targets by category. |
| *Water:* Generate data on emissions intensity of local water and wastewater treatment for all U-M campuses and implement an accounting system for tracking and reporting GHG emissions from water and wastewater treatment. |
| *Leased Buildings:* Develop and implement an accounting system for Scope 1 and 2 emissions associated with all leased space and integrate it with U-M's GHG accounting system. |

## Emissions Reduction and Accounting Strategies

The following recommendations reflect strategies that the Commission believes will be most impactful in improving measurement and influencing the trajectory of Scope 3 emissions. After embarking upon these efforts, U-M should re-evaluate these strategies on a regular basis, consistent with guidance provided in the Leadership Structure section of this report.

**Commuting**

Although the university does not directly control the impact of faculty, staff or student commutes, its policies and practices in parking, public transit, housing, land-use planning, and telecommuting all shape the decisions of the U-M community regarding how far to commute, how frequently to commute, and which transportation modes to use when commuting to the campus. With that in mind, the Commission recommends the following strategies to reduce the carbon intensity of the university commute.

**Preliminary Draft Recommendation:** *Reform the university's parking policy on each of U-M's three campuses and reduce or eliminate incentives for personal vehicle commuting.*

The central tool the university has to reduce emissions from the commute in the immediate term is its parking policy. Across all three campuses (Ann Arbor, Dearborn and Flint) the Commission recommends that U-M:

- Eliminate annual and monthly parking permits and replace them with a daily parking payment structure. Commuters who purchase an annual or monthly pass lack incentive to walk, cycle, carpool, or use public transportation. By contrast, daily payment ensures that while the commuter remains able to park, there are incentives to consider alternatives to driving, even if on an occasional basis. Eliminating annual and monthly parking permits empowers the individual commuter to choose whether to drive each day or commute in a less carbon-intensive way.
- Link parking rates to an employee's salary to promote just implications for commuters based on their ability to pay. This policy is in place at Rutgers University, Rochester Institute of Technology, and the University of Indiana.

*Ann Arbor Campus*

The Commission recommends that the Ann Arbor campus eliminate the $172 per-year university contribution to the parking passes of faculty and staff, but should take this current benefit into account when setting the income-adjusted pricing structure recommended above. This university contribution represents a direct subsidy to carbon emissions in the commute, and one from which commuters who make the lowest-carbon choices are unable to benefit.

The Commission also recommends that the U-M Ann Arbor campus set parking charges with the goal of utilizing available parking throughout the campus. During peak periods, central parking locations are at or beyond capacity, while approximately 1,300 spots in peripheral locations are vacant (refer to Commuting Report, Appendix D). This inefficient utilization of existing parking leads to pressure for expanding close-in parking capacity, with its inevitable

carbon impacts. Adopting this recommendation might require adjusting public transit resources to accommodate higher ridership from the peripheral locations. The U-M Ann Arbor Logistics, Transportation and Parking (LTP) Office will be responsible for implementing parking policy reform on the Ann Arbor campus.

*Dearborn and Flint Campuses*

On the Dearborn and Flint campuses, the Commission recommends parking charges currently incorporated into mandatory per-term registration fees be disaggregated and made optional to offer cost savings to students who opt to reach campus by different modes. Unlike on the Ann Arbor campus, where lower carbon modes of transport are more available to community members, the Dearborn and Flint campuses are primarily commuter campuses. The campus communities commute by personal vehicle and park on campus out of necessity. This means that other transportation options must be developed and available to get the community to and from campus before parking disincentives are applied to the system on the Dearborn and Flint campuses. The reformed parking policies must also align with a compelling communications plan so the campus community can access and understand the policy reforms. The UM-Flint Parking Office and UM-Dearborn Facilities and Operations Office will be responsible for implementing parking policy recommendations.

To maintain progress on this recommendation, the Commission recommends that U-M create a system to track the following metrics: the number of parking system participants; and the automated counting of daily parkers.

The Commission recommends that U-M pursue the proposed parking policy reform in steps:

1) the elimination of the parking subsidy;
2) gearing parking fees to an individual's salary; and
3) phased elimination of the annual parking pass.

Each step should include robust community engagement across all three campuses to gain buy-in and inform the final design of the new parking policies. Parking policy and pricing is an issue that affects the daily life of faculty, staff and students on all three campuses, and therefore requires extensive community engagement and buy-in to be successful.

**Refer to Appendix K for more specific evaluation criteria related to this recommendation.**

**Preliminary Draft Recommendation:** *Expand the availability of electric vehicle charging stations across all three U-M campuses.*

Commuter vehicle choices directly impact the carbon intensity of the commute. Each commuter that shifts to an electric vehicle (EV) will incrementally reduce the carbon intensity of the university commute. To provide adequate EV charging infrastructure and to incentivize EV adoption among faculty, staff and students, the Commission recommends U-M expand EV charging infrastructure across all three U-M campuses. According to the Mobility Electrification report, there are currently 14 Level 2 charging stations available on the Ann Arbor campus, 8 charging stations on the UM-Dearborn campus, and 1 charging station on the UM-Flint campus.

Providing ample charging stations across U-M's campuses will enable widespread EV use for travel to and from campus. The mobility electrification analysis proposed an illustrative target of 20 percent EV use by 2030 for long-distance commuters for the Ann Arbor campus. This illustrative target is based on goals articulated by the City of Ann Arbor and other entities (Mobility Electrification report).

In addition to expanding EV charging capacity on campus, the Commission recommends that U-M explore partnerships with the utilities that assist U-M community members to invest in home charging systems for their EVs. Home charging systems will allow U-M community members to charge their vehicles at off-peak hours, thus reducing the need for incremental electricity infrastructure to meet electric vehicle demand during peak times.

By both increasing EV charger availability on campus, and partnering with utilities to provide home charging system incentives and assistance, U-M will encourage its community members to make decisions that help reduce commuting emissions in pursuit of carbon neutrality goals.

To maintain progress on this recommendation, the Commission recommends U-M create a system to track the following metrics:

- The number of EV chargers installed on each campus;
- EV charger utilization data including electricity consumption and charging session durations; and
- Implied carbon emissions reductions and fuel cost savings; and the actual costs of the charging equipment and electricity use.

Additional study is needed on the Dearborn and Flint campuses to determine the best placement and quantity of EV chargers. The Commission stresses the importance of significant community engagement through the formation and implementation of these policies, since they impact the daily lives of the U-M community.

To implement the EV charging infrastructure, the Commission recommends U-M AEC, the U-M Ann Arbor LTP Office, the UM-Flint Parking Office, UM-Dearborn Facilities and Operations, and the OCS partner to develop a detailed implementation timeline. Such a timeline should be informed by EV adoption rates by the commuters on each campus and regionally and by robust engagement with the campus communities. The timeline should be updated periodically, as EV adoption rates increase over time. In addition, the implementation planning team should develop policy around rates to be paid by users of the charging stations. Pricing should seek to strike a balance between encouraging the use of EVs and not causing unintended consequences, such as incentivizing charging during peak hours when people are on campus and disincentivizing at-home charging during off-peak hours.

**Refer to Appendix K for more specific evaluation criteria related to this recommendation.**

**Preliminary Draft Recommendation:** *Invest in affordable and accessible alternatives to the personal vehicle commute, including rideshare, cycling, and free bus access on the Flint and Dearborn campuses.*

*Rideshare*

Currently, rideshare programs are supported on the Ann Arbor campus, but not on the UM-Dearborn and UM-Flint campuses. According to the commuting analysis team's estimates, fewer than one percent of university affiliates currently commute by rideshare to the Ann Arbor campus. Rideshare is particularly relevant for longer-distance commutes, which account for an outsized fraction of the carbon impact of the commute as a whole. The Commission recommends that U-M enhance the current program on the Ann Arbor campus to increase use through enhanced matchmaking systems and incentives for commuters who choose to participate in the rideshare program. On the Dearborn and Flint campuses, the Commission recommends the university pursue additional engagement to determine if this is a desirable program for the faculty, staff and students on the campuses. If so, the Commission strongly recommends U-M build out these programs. The U-M Ann Arbor LTP office, UM-Dearborn Facilities and UM-Flint Parking Office will be responsible for implementing this recommendation. Rideshare usage is already tracked on the U-M Ann Arbor campus. Tracking should be implemented on the UM-Dearborn and UM-Flint campuses.

*Cycling*

The Commission views cycling as an increasingly relevant and integral part of campus transit, and encourages the university to pursue a multi-modal transportation system by incorporating accessible and safe cycling paths. Additionally, the Commission proposes U-M create a workable Central-to-North Campus bike route, and establish an on-campus bike-service facility.

*Dearborn and Flint Campuses*

As previously stated, the UM-Dearborn and UM-Flint campuses populations commute by automobile largely out of necessity. To reduce the personal vehicle commute, the university will need to provide accessible and affordable alternative modes of transportation.

The university currently provides free access to Ann Arbor Area Transportation Authority (AAATA) buses for all students, faculty and staff. The Commission recommends the extension of universal-access transit agreements to all students, faculty, and staff on the Dearborn and Flint campuses. The transit agreements should be cooperative agreements with the Suburban Mobility Authority for Regional Transportation (SMART) on the Dearborn campus, and the Mass Transportation Authority for the Flint campus. Increased bus service to campus, including a higher number of accessible bus stops and campus-based routes should be included in the agreements for both the Dearborn and Flint campuses.

The Commission also recommends that U-M work with the City of Dearborn to fund and complete the bikeways to the Dearborn campus currently proposed in the City of Dearborn Multimodal Plan.[22] There are also a variety of cycling improvements that should be explored on

[22] City of Dearborn. (2019, June 6). *City of Dearborn Multimodal Plan*. City of Dearborn Multimodal Plan. Retrieved November 30, 2020, from https://walkbike.info/Dearborn/plan/

the Flint and Dearborn campuses, including: secure and maintained bike racks, road markings, signage, traffic signal timing, and shower facilities.

Before implementation begins, issues related to alternative transportation need to be better understood from the UM-Dearborn and UM-Flint context to ensure that the proposed policies and alternatives create the desired change. This process could be started by implementing a transportation survey on both campuses to collect the necessary data.

Progress on these recommendations should be tracked by measuring the number of cyclists and bike path usage; and the number of farebox swipes on the Flint and Dearborn campuses.

**Refer to Appendix K for more specific evaluation criteria related to this recommendation.**

**Preliminary Draft Recommendation:** *Proceed with the design and development of the Ann Arbor campus connector and integrate it with local/regional transit systems.*

The Commission recommends that U-M proceed with developing the proposed high-capacity Ann Arbor campus connector. Development of the campus connector would result in the removal of 25 U-M busses from the fleet, which would reduce GHG emissions by approximately 1,400 MT annually and lower U-M's overall demand for electrified replacement buses. There would also be additional emission reductions associated with less inter-campus personal vehicle travel which are not quantified at this time.

In developing the connector, U-M should take additional steps to integrate it with the municipal and regional transit systems to ensure that it aids in transit movements to campus in addition to serving as an intercampus shuttle. Toward this end, U-M should develop this project in close collaboration with the City of Ann Arbor, Ann Arbor Township, and the Michigan Department of Transportation. In line with the commuting analysis team's recommendation, the Commission recommends that the system be extended to US 23 in the east and to Blake Transit Center in the west. The system should also link with the site of the potential rail station at Fuller Road adjacent to the Michigan Hospital. The system's capacity should be designed under the assumption that the U-M Ann Arbor campus connector will ultimately be a major node in a larger municipal system.

The commuting analysis team recommended that U-M consider designing the system as bus rapid transit, as opposed to high speed rail, to accommodate the buses of the Ann Arbor Area Transportation Authority as well as those of the university. Such integration could accelerate transit service between town and a range of campus destinations. Regardless of system technology and configuration, the Commission strongly supports the development of an electrified rapid transit system to interconnect the Ann Arbor campuses, and recommends that the carbon footprint of the infrastructure required for various options be a major consideration in designing the system. As a shared community benefit, this proposal could form the basis of a funding application to the Federal Transit Administration. Federal and state funding opportunities are likely to become more available under a Biden administration and as a consequence of Gov. Whitmer's recent executive order on carbon neutrality, respectively.

**Preliminary Draft Recommendation:** *Embrace and incentivize flexible telecommuting options for employees*

While current data on the net emissions impacts of telecommuting are inconclusive, the Commission intuits that the net benefits should be favorable due to fewer vehicle trips from homes to campuses, and longer-term opportunities for U-M to more effectively utilize campus space and decrease the need for new construction. As evidenced by the COVID-19 pandemic, telecommuting provides a viable option for many workers to conduct their work effectively without the need for daily trips to and from campus. As U-M continues with current task force efforts focused on the future of telecommuting policies at U-M, the Commission recommends that when in-person work is deemed safe to resume, that the university implement flexible telecommuting policies and incentives across all three campuses that facilitate the opportunity to work remotely on a regular basis. The Commission also recognizes that face-to-face interactions with colleagues and students are important for individual well-being and community thriving, and thus strongly supports telecommuting policies with a high degree of flexibility that best meet the needs of individuals and the broader community.

**Preliminary Draft Recommendation:** *Prioritize central locations for construction projects and consider expanding on-campus housing for faculty, staff and students at the campus periphery.*

Prior to the approval of any new construction, the university should prioritize enhanced space utilization in existing facilities to minimize new building footprints and their associated emissions (e.g., ongoing energy use and embedded carbon in materials). When new construction projects are unavoidable, the Commission recommends that U-M focus future campus construction in central locations, and prioritize renovating and rebuilding over converting green space. Central locations offer the best alternatives for non-automotive commuting and hence the best potential for university growth while minimizing the increase in carbon emissions. For example, once centrally located parking structures reach the end of their useful lives, the land on which they sit should be considered for expansion of academic functions. The Commuting analysis provides examples of existing structures that could be converted in the commuting analysis final report. The Commission also recommends that U-M explore faculty, staff, and student needs for affordable housing on its campuses to facilitate lower carbon intensity commuting and address equity considerations around local housing costs. The Commission recommends that student housing should be the highest priority because students live in smaller spaces, which would increase density to a greater extent than providing faculty or staff housing. This in turn would reduce the pressure on off-campus student housing and that should have positive impacts on reducing demand.[23] Engagement with the campus communities is necessary to understand the need and desire for additional student housing on both campuses.

It should be noted that any decisions to build additional university housing would increase U-M's Scope 1 and Scope 2 emissions until a carbon neutral energy infrastructure is in place. If the university pursues additional on-campus housing for faculty, staff and/or students, the Commission recommends U-M utilize the building standards analysis on net-zero housing to inform best practices for on-campus housing expansion.

[23] Urban and Regional Planning Graduate Student Projects, URP 508- Larsen, Fall 2019

**Refer to Appendix K for more specific evaluation criteria related to this recommendation.**

## University-Sponsored Travel

The Commission defines university-sponsored travel as travel by faculty, students, staff, and visitors that is paid for with university administered funds across all three campuses. This does not include business trips paid for by other institutions, personal trips, or daily commuting by faculty, staff or students.

Reducing U-M's travel carbon footprint will be a challenge. It will require cultural and behavioral shifts to separate university travel from academic life. U-M will need to empower the university community to reduce their own travel by developing a culture where individuals are encouraged to:

1. Evaluate whether their travel is worthwhile;
2. Substitute ground for air travel or hold a virtual meeting; or
3. Mitigate air travel by means of a travel carbon offset.

At an institutional level, the Commission recommends that U-M incentivize low-carbon ground transport, provide viable alternatives to travel, such as videoconferencing, and require departments to purchase travel offsets once appropriate carbon accounting measures are in place.

**Preliminary Draft Recommendation:** *Standardize travel data collection to facilitate carbon footprint calculations and provide feedback to community members on the impacts of their university-sponsored travel.*

The Commission recommends a centralized system be developed to collect all necessary information on all university-sponsored travel to establish a baseline of miles traveled, number of travel segments, and the travel carbon footprint to monitor the reduction progress. Since Concur already hosts most of U-M's travel data including the UM-Dearborn and UM-Flint campuses, the Commission recommends all other sources of travel data be integrated with Concur. The system should also be able to provide automatic carbon footprint information to the traveler to facilitate behavioral changes to reduce the university-sponsored travel carbon footprint. The system should require information such as travel data, departure location, arrival location, and mode of travel (air, train, car, or bus).

The metrics used to keep track of travel should be the amount of greenhouse gas emissions per trip measured in $MTCO_2e$. The emissions will be calculated by an internal calculator embedded in the Concur system.

To catalyze progress on this recommendation, the Commission recommends that U-M establish a group assigned to oversee the development of a standardized travel data collection system across all three U-M campuses. Such a group should include individuals from each U-M

campus. Establishing a standardized accounting system for university-sponsored travel carbon footprint is integral to reducing emissions and measuring the success of the employed travel emissions reduction strategies.

**Preliminary Draft Recommendation:** *Provide and incentivize low-carbon ground transport options (e.g., trains, hybrid/electric buses and passenger vehicles) for university-sponsored travel.*

The Commission recommends that U-M promote and incentivize transportation options that have the lowest carbon emissions per passenger mile. This includes the use of low-carbon ground transportation options (e.g., trains, electric/hybrid buses, electric/hybrid vans) as an alternative to air travel for trips under 300 miles. According to a survey administered by the university-sponsored travel analysis team, 81 percent of the 2,300 survey respondents are willing to use ground transportation for distances under 300 miles to reduce greenhouse gas emissions. These distances would cover locations such as Chicago, Indianapolis, Pittsburgh, and Toronto. Disincentives for air travel under 300 miles should also be established. When air travel is necessary, U-M should create incentives for students, faculty, and staff to use low-carbon ground transportation options to and from the airport. For more on the survey and analysis, see the university-sponsored travel team's final report, Appendices I and J.

**Preliminary Draft Recommendation:** *Promote video conferencing as an alternative to in-person meetings and travel.*

The Commission agrees with the university-sponsored travel team's assumption that a significant portion of university travel could be replaced with video conferencing. Video conferencing platforms have steadily improved over the past decade, and due to the COVID-19 pandemic, their use has surged due to technology improvements and increased familiarity. The Commission recommends that U-M promote the use of video conferencing via several methods. The university should establish and staff state-of-the-art video conferencing facilities in easily accessible locations across all three campuses to facilitate best-in-class hybrid meetings. U-M should establish a standard of live-streaming and archiving all public lectures and seminars so that community members have multiple options for interaction.

The Commission recognizes that the primary downside to virtual meetings is that connections are easier to make in person. However, much of the university's historical travel is well-suited to virtual meetings. In the university-sponsored travel team's survey, participants were open to video conferencing for several forms of travel, including grant review panels, society committee meetings, and networking events.

The Commission also recommends that video conferencing should be strongly promoted and encouraged for cross-campus meetings to minimize unnecessary travel and inefficient use of time traveling from one campus to another.

**Preliminary Draft Recommendation:** *Implement a carbon price for faculty, staff and students who travel on university business, with the revenue being used to support the reduction or offsetting of U-M emissions.*

Once appropriate and accurate carbon accounting systems are in place, the Commission recommends U-M pursue additional engagement and analysis to determine the best way to implement a carbon price on university-sponsored travel. Such a price could be incorporated into the Commission's broader carbon pricing recommendation for Scope 1 and Scope 2 emissions.

In designing such a system, special attention will need to be given to the various funding sources used to support university travel and what types of expenses are allowable. For example, some grant funds may not permit such an expense directly but it could perhaps be covered with indirect cost rebates or unrestricted funds.

Attention will also need to be given to designing the system with clear guidelines as to how the revenue will be collected and used. Potential options for using the revenue include direct investments in U-M's carbon reduction infrastructure projects, increasing funding levels for the Revolving Energy Fund, or purchasing carbon credits that align with the PCCN's Carbon Offsets Guidance to help offset emission levels. Additional thought should be given to equity considerations and whether there may be ways for the revenue to directly benefit carbon reduction efforts within the unit.

To measure progress on the carbon emissions from university-sponsored travel, U-M should track the number of air travel trips and air trips averted by use of ground transportation or video conferencing each year.

The proposed changes to the university's current university-sponsored travel programs will require significant culture and behavior changes, which can be challenging to predict. Educational programming will be integral to the success of these programs. See the Organization and Culture section of the report for the educational program recommendations.

**Refer to Appendix L for more specific evaluation criteria related to the university-sponsored travel recommendations.**

**University-Procured Food**

As the food analysis team uncovered for the Commission, the U-M food system is a complex and decentralized network of both self-operated units and units with contracts to external operators. The Ann Arbor campus has separate food services through Michigan Athletics, Michigan Dining, Michigan Medicine patient and retail operations, the Ross School of Business, the University Unions, the North Campus Research Center, and the U-M Law School in addition to strategic catering and vending services. Based on FY19 food spend data obtained from the various units by the food analysis team, MDining constitutes nearly half (42.1 percent) of the annual food expenditures across U-M's three campuses. There are also separate food operations at UM-Dearborn and UM-Flint. For a comprehensive overview of food operations across the university, see the food analysis report, appendix H.

**Preliminary Draft Recommendation:** *Establish and standardize food purchasing data collection to facilitate carbon footprint calculations and provide feedback to community members on the impacts of their food procurement and consumption.*

To develop a carbon emissions reduction goal for emissions from on-campus food, accurate greenhouse gas emissions baselines for units other than MDining will need to be determined. The university food service and retail outlets on U-M's three campuses are diverse and present challenges to monitoring and accessing supply chain data necessary to understand the greenhouse gas emissions footprint. Consistent data that lists the weight and cost of food being procured by each university unit are essential to assess the cost and carbon footprint implications of menu changes, to track U-M's annual food-related greenhouse gas emissions annual footprint, and to assess progress on the goals.

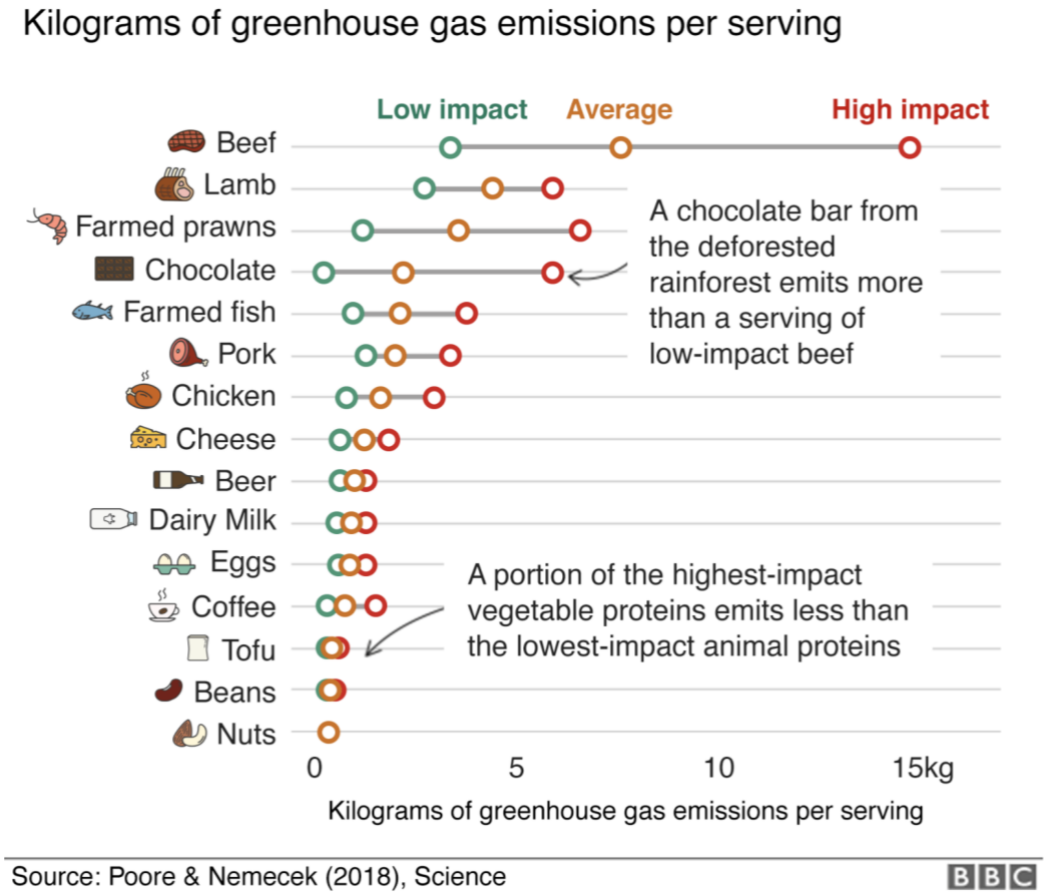
In line with the food analysis team's recommendation to improve tracking of university-procured food, the Commission recommends that Procurement Services negotiate with current vendors to submit detailed food item purchase lists for each year. As new contracts are established, new vendors should be required to submit detailed food item purchase lists. The detailed lists could then be linked to a food lifecycle database to calculate food-related emissions. MDining has nearly completed the process of linking all food items they procure to an emissions database. Adjustments to this database may be needed for smaller food operations versus those with large-scale food contracts.

The proposed actions will require coordination through procurement services with vendors, engagement across all food service operations on the three U-M campuses, and the use of the General Fund to support the implementation of these actions.

**Preliminary Draft Recommendation:** *Pursue plant-forward food procurement and consumer diets across all three U-M campuses*

U-M has a current goal in place to procure 20 percent of its food from sustainable sources by 2025, as defined by Sustainable Food Guidelines that U-M developed in 2011.[24] While progressive at the time, these guidelines do not account for the fact that different diets have vastly different carbon footprints, and that locally-sourced or third party certified foods are not consistently associated with lower carbon emissions.[25] The carbon footprint differences between diets are in large part driven by the relative proportion of animal-source foods in diets; specifically ruminant meat is responsible for the largest amount of greenhouse gas emissions. Therefore, replacing ruminant meat in diets with plant-based foods, and to a lesser extent fish and poultry, can lead to considerable emissions reductions. Figure 10 provides examples of the kilograms of greenhouse gas emissions per serving of various food items.[26] Plant-forward diets are one culinary strategy to implement such substitutions.

Figure 10.




[24] University of Michigan Office of Campus Sustainability. (2020, January 1). *Sustainable Food*. University of Michigan Office of Campus Sustainability. Retrieved November 30, 2020, from https://ocs.umich.edu/sustainability-goals/sustainable-food/ ; University of Michigan Office of Campus Sustainability. (2014, November 1). *University of Michigan – Ann Arbor, Sustainable Food Guidelines*. Google Document. Retrieved November 30, 2020, from https://docs.google.com/document/d/1kmofOkOQ8glzCUVFjglBUXseoS2VInEgFWyC18Hu05M/edit

[25] Weber, Christopher L. and H. Scott Matthews. "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." Environmental Science and Technology 42, no. 10 (2008): 3508–13. https://doi.org/10.1021/es702969f.

[26] Stylianou, N., Guibourg, C., & Briggs, H. (2019, August 9). Climate change food calculator: What's your diet's carbon footprint? *BBC News*. https://www.bbc.com/news/science-environment-46459714

Plant-forward eating is “a style of cooking and eating that emphasizes and celebrates, but is not limited to, plant-based foods” (e.g., fruits, vegetables, whole grains, legumes).[27] Importantly, plant-forward diets can include animal-source foods, such as meat, dairy, and eggs, though these foods are de-emphasized relative to plant-based foods. Among animal-based proteins, fish and poultry are prioritized, dairy and eggs play a supporting role, and red meats are limited.

It is important to expend considerable effort in making plant-forward menus attractive to avoid the unintended consequence of having U-M community members reject the choices and opt for more carbon intensive food options off campus. MDining has demonstrated leadership in offering and promoting healthy and flavorful “plant-forward” options in its dining halls that should serve as a model to be emulated in other dining establishments throughout the university. The Commission recommends the following actions to reduce emissions from food procurement across all three U-M campuses and all food operations:

- Increase the overall number of plant-based dishes and food options available;
- Restructure choice architecture within dining halls and retail outlets, for example:
  - Reduce the amount of counter space devoted to serving animal protein;
  - Ensure that the protein option is an “opt in” choice or is added last to plates;
  - Control protein portions at all-you-care-to-eat facilities
- Employ taste-focused labeling to re-brand dishes through use of fresh ingredients, complementary seasonings, and the combination of two or more fruits and vegetables to build flavor;
- Emphasize plating and the visual appeal of plant-based foods with a focus on rebalancing plates such that vegetables serve as entrees and protein is an accent on the plate;
- Use products that incorporate blended plant and animal protein;
- Use less carbon-intensive animal proteins;
- Ensure that sufficient meal options respecting religious and cultural traditions, as well as dietary restrictions are maintained;
- Engage in campus-wide educational programs to provide rationale for moving to a more intensive plant-based diet, and partner with MHealthy to amplify the message, and;
- Separate the goal of decarbonizing food purchasing from the existing Sustainable Purchasing Guidelines and current goal.

Consistent with the food analysis team’s recommendation, the Commission recommends that U-M establish a university-wide Sustainable Purchasing Policy with a section focused on low-carbon food procurement best practices and policies (e.g., plant-based proteins, low-carbon meats sourced from regenerative farms). As a part of this policy, the Commission recommends that all requests for proposals for new food contracts require suppliers to demonstrate how they will conform to U-M’s carbon neutrality goals. The decision-making criteria for awarding contracts must explicitly include a vendor’s commitment to reducing carbon emissions, and all food providers should be held accountable to U-M’s goals. See the food analysis report, appendix J for more details on this recommendation.

[27] The Culinary Institute of America and the Harvard T.H. Chain School of Public Health Department of Nutrition. “Menus of Change 2019 Annual Report.” (New York, NY, 2019). https://www.menusofchange.org/images/uploads/pdf/2019MOC_AnnualReport.pdf

To track progress on advancing plant-forward diets throughout the university's food system, the Commission recommends the following metrics be tracked and analyzed: expenditures on animal versus plant-based proteins; food-related greenhouse gas emissions by unit and academic year; number of staff and units trained in plant-forward menus across the university; and the number of research collaborators with the new plant-forward diet programs.

To catalyze progress on this recommendation, the Commission recommends the following priority actions:

- Expand the work of the food analysis team to develop robust carbon accounting for all food operations across the three U-M campuses;
- Expand educational programming for students, faculty and staff around attractive plant-forward food options in line with the Organization and Culture recommendations; and
- Hire culinary trainers to assist food operations across the Ann Arbor, Dearborn and Flint campuses.

**Refer to Appendix M for more specific evaluation criteria related to this recommendation.**

## Purchased Goods

Production emissions data for purchased goods are only available on a very limited basis. The Commission makes two recommendations related to the accounting of purchased goods: one focused on using existing U-M expenditure data to estimate an emissions baseline for this category, and two seeking to improve the production emissions data available for decision-making and tracking emissions reduction into the future.

**Preliminary Draft Recommendation:** *Implement an accounting system for GHG emissions associated with purchased goods, which disaggregates expenditures into sector categories and uses an Economic Input-Output (EIO) approach to estimate an emissions baseline and inform targets by category.*

The Commission recommends that U-M implement a carbon accounting system to more precisely quantify carbon emissions from U-M purchased goods and services across all three campuses. U-M should disaggregate purchased goods expenditures into sector categories (e.g., office furniture, medical supplies, computers, chemicals, vehicles, food, natural gas) to refine estimates and reduce double counting of emissions included elsewhere in the Commission's GHG accounting model.

Once purchasing data is disaggregated, U-M should use an Economic Input-Output (EIO) approach to estimate an emissions baseline for U-M purchased goods and to set targets by purchasing category. An EIO approach traces economic transactions through the supply chain of a product system and evaluates resource requirements and environmental emissions using a commodity input-output model coupled with key environmental impact datasets. Limitations to the EIO approach include a high level of aggregation in industry or commodity classifications and a basis in monetary value that can distort physical relations between industries due to price

inhomogeneity. For this reason, EIO estimates of emissions are generally not useful for product selection decisions. As part of its work for the Commission, the carbon accounting modeling team used an EIO data to estimate the potential range of values for emissions based on U-M spending on purchased goods.[28]

**Preliminary Draft Recommendation:** *Request production emissions data from vendors to strengthen guidance for low-carbon procurement at U-M. These data can be used in purchasing decisions in addition to cost and performance criteria, as well as in emissions reduction tracking.*

U-M has an opportunity to use its buying power to reduce emissions through procurement of university goods and services. This positive change could be amplified through engagement with peer institutions, including through existing consortiums of peer institutions.

**Refer to Appendix N for more specific evaluation criteria related to this recommendation.**

## Solid Waste and Wastewater

OCS currently tracks the volume of solid waste disposal to landfill, recycling and composting, as well as the volume of water used and wastewater dispersal on the Ann Arbor campus. However, it does not include emissions from solid waste and wastewater disposal in its GHG emissions accounting. Reducing solid waste and wastewater are important strategies to decrease energy used upstream in wastewater treatment facilities, downstream for solid waste management, and on campus for heating water.

**Preliminary Draft Recommendation:** *Reduce and divert food waste from landfills by scaling up food waste diversions and reductions, increasing capacity for composting on U-M's campuses, and launching a campus-wide composting program at UM-Dearborn and UM-Flint*

Directly relevant to U-M's current goal to reduce landfill waste by 40 percent below 2006 levels by 2025,[29] the Commission recommends that U-M adopt or expand the following key strategies across all dining, retail, catering and contract food services on U-M's three campuses, many of which are already standard practice at MDining:

1. Cut post-consumer waste through trayless dining, smaller portions and plates, customized portion sizes and "try a taste" stations, room service and menu choices for patients, and messaging on the environmental harm of food waste;
2. Further reduce pre-consumer waste and reinforce such strategies with new kitchen staff (e.g., efficient food storage, preparation, menu planning, food repurposing);

[28] The FY19 complete financial statements line item for purchased supplies and services was $2.5 billion. Using a low-impact category (travel services) with an emission factor of 146t CO2e /$1 million results in a GHG emission estimate of 290 kt CO2e. Using a high-impact category (paints and coatings) with an emission factor of 680t CO2e /$1 million) results in a GHG emission estimate of 1,360 kt CO2e. For reference, total U-M Scope 1 and 2 emissions in 2018 were 750 kt CO2e.

[29] University of Michigan Office of Campus Sustainability. (2020, January 1). *Waste Reduction*. University of Michigan Office of Campus Sustainability. Retrieved November 30, 2020, from https://ocs.umich.edu/sustainability-goals/waste-reduction-goal/

3. Adopt creative options for increasing food donations to area food banks, student food pantries on all three campuses, and pilot innovative methods to address food insecurity while also cutting food waste;
4. Offer incentives, cost-sharing and infrastructure required to prioritize reusable products and reduce single-use plastics, and standardize the use of compostable materials across all three campuses in U-M owned/operated food operations and on-campus vendors and caterers;
5. Develop compostable material standards and require that all third party food service providers (e.g., Sodexo, Aramark, caterers) comply with U-M composting and zero Waste standards;
6. Expand the capacity to recycle and compost on U-M Ann Arbor's campus. Already near capacity, U-M's Waste Management Services will not be able to meet the demand if U-M expands composting and recycling. Based on staff estimates, another truck would be needed ($340,000) along with two drivers ($100,000);
7. Launch a composting program at Dearborn and Flint. With no municipal composting, the financial and emissions cost of hauling would need to be explored in comparison with on campus systems;
8. In all buildings on all three campuses, increase composting and recycling bins through pilots to identify the best placement and provide visible and clearly understandable signage and education to ensure proper and increased use;
9. Explore opportunities to expand composting efforts into other areas of the medical/hospital system (currently composting prep-waste from patient and cafeteria kitchens). Staff kitchens and smaller food service/vendor areas may be a feasible next step, though the challenges of dock-space limitations will need to be addressed, and;
10. Require on-campus food vendors/companies compost pre-consumer food waste from their own production and operations

To track progress on reducing emissions from university waste, the Commission recommends U-M continue to track tons of waste to landfill and tons of waste diverted. Additionally, U-M should strive to track food waste to landfill, compost and the amount of food donated, and the amount of reduced contamination in food waste audits. Improved data collection is necessary to establish a realistic baseline and to track university-wide progress more accurately. Food waste tracking also provides chefs and consumers feedback on progress, which helps to further reduce waste.[30] Specific recommendations on food waste audits and tracking are available in the food analysis report.

An accurate diversion and reduction baseline based on the actual makeup of current landfill waste is necessary across all three U-M campuses. Additional work is required to create a composting program and accounting system on the UM-Dearborn and UM-Flint campuses.

**Refer to Appendix O for more specific evaluation criteria related to this recommendation.**

[30] Ragab, Yasmeen. "Dining Services Reduce Food Waste through Donation and Tracking System." The Daily Illini, 2018.https://dailyillini.com/news/2018/04/23/dining-services-reduce-food-waste-through-donation-and-tracking-system/; ReFed. "Foodservice Food Waste Action Guide," 2018. https://www.refed.com/downloads/Foodservice_Guide_Web.pdf.

**Preliminary Draft Recommendation:** *Generate data on emissions intensity of local water and wastewater treatment for all U-M campuses and implement an accounting system for tracking and reporting GHG emissions from water and wastewater treatment.*

Once emissions from solid waste and wastewater are incorporated into the accounting, the Commission recommends that these emissions be incorporated into a Scope 3 emissions reduction goal.

*Ann Arbor Campus*

Water and wastewater treatment services are energy and carbon intensive.[31] Cities, on average, use 3,300-3,600 kWh/million gallons of water delivered and treated. In 2013, energy-related emissions resulting from wastewater treatment operations, excluding organic sludge degradation, were 15.5 Tg $CO_2e$. These services are likely included in U-M's purchased supplies and services expenditure as U-M relies on municipal water utilities for these services.

*Dearborn and Flint Campuses*

The UM-Dearborn and UM-Flint campuses do not currently track quantities of waste and wastewater on their campuses. The Commission recommends that U-M implement a tracking system for quantity of and carbon emissions from waste and wastewater disposal on both campuses. Once such a system is implemented, the emissions from waste and wastewater disposal should be incorporated into a Scope 3 emissions reduction goal with an accompanying plan to reduce the emissions.

**Preliminary Draft Recommendation:** *Explore improved water efficiency and site design standards for all new construction to reduce both upstream and downstream emissions from water treatment.*

Water management within urban contexts is undergoing a significant transformation toward approaches favoring integration and resource recovery. This shift has come to be recognized as the "One Water" approach that promotes geographically contextual water management as a single resource to be managed holistically, viably, and sustainably. The One Water approach works from a watershed perspective to consider the inter-relationships between all waters running through it including drinking water, wastewater, stormwater, recycled water, aquifers, and rivers. This approach makes a more explicit connection between energy and water, and hence carbon reduction potential. High performance buildings typically focus on reducing a building's operational energy demand through improvements to a building's envelope and HVAC systems. Water delivery and treatment systems also consume energy and therefore contribute to a building's overall emissions footprint.

The Commission recommends that U-M convene a group of experts to analyze the emissions reduction impacts of improved water efficiency in new construction and major renovation projects. If the findings are significant, the Commission recommends U-M pursue additional

[31] Center for Sustainable Systems, University of Michigan. 2020. "U.S. Wastewater Treatment Factsheet." Pub. No. CSS04-14. Center for Sustainable Systems, University of Michigan. 2020. "U.S. Water Supply and Distribution Factsheet." Pub. No. CSS05-17.

construction standards and site design standards to attain emissions reductions in this area. See Appendix E in the building standards report for additional information.

**Refer to Appendix O for more specific evaluation criteria related to this recommendation.**

## Electricity and Fuels Upstream

Upstream impacts are those that occur prior to fuel combustion, and include emissions from resource extraction, flaring, leakage, refining, and transportation of fuels. Upstream emissions associated with electricity depend on the mix of fuels used for electricity generation. Transmission and distribution losses in electricity systems are also included in Scope 3. Emissions resulting from construction of infrastructure (pipelines, refineries, transmission lines) are not included. Upstream emissions are reduced by reducing use of petroleum-based liquid fuels, natural gas, and electricity generated from these fossil sources, either by reducing demand or switching to renewable sources.

Increased attention is now being paid to methane leakage in the natural gas production process. According to the analysis completed by the Committee's carbon accounting subgroup, for every metric ton of $CO_2$ emitted from the combustion of natural gas at U-M, methane emissions and other upstream emissions in the natural gas production process result in an additional 0.39 tons $CO_2e$ emitted (using $GWP_{100}$=30 and Alvarez estimates),[32,33] with methane leakage alone contributing 0.15 tons of that amount. For additional information on estimating methane leakage and its applications to U-M, see Appendix P.

Based on this analysis, the OCS estimated the impacts associated with expanding U-M's Central Power Plant (CPP), concluding that the CPP expansion will reduce U-M's GHG emissions, with a cumulative reduction of more than 400,000 metric tons of $CO_2e$ within the first ten years of operation. The use of Renewable Natural Gas at the CPP could reduce upstream impacts, though fugitive emissions are still likely to exist and have the same atmospheric impact as conventional natural gas.

**Preliminary Draft Recommendation:** *Estimate upstream electricity and fuels emissions using Argonne National Lab's Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model.*

[32] Alvarez, R. A., D. Zavala-Araiza, D. R. Lyon, D. T. Allen, Z. R. Barkley, A. R. Brandt, K. J. Davis, S. C. Herndon, D. J. Jacob, A. Karion, E. A. Kort, B. K. Lamb, T. Lauvaux, J. D. Maasakkers, A. J. Marchese, M. Omara, S. W. Pacala, J. Peischl, A. L. Robinson, P. B. Shepson, C. Sweeney, A. Townsend-Small, S. C. Wofsy, S. P. Hamburg, Assessment of methane emissions from the U.S. oil and gas supply chain. *Science* (2018), doi:10.1126/science.aar7204.

[33] Using EPA estimates or GWP20=85 result in different estimates of the upstream emissions.

The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model is a tool that examines the life-cycle impacts of vehicle technologies, fuels, products, and energy systems. GREET allows the use of different estimates for natural gas emissions.

## Leased Buildings

U-M leases space in buildings it does not own to meet both short term space needs and to accommodate growth. Most emissions associated with leased buildings are related to energy and water usage. U-M has good utility data on most of its leased properties, which in general are less efficient than U-M buildings. In cases where property management companies do not provide U-M with good utility cost data, it complicates emissions estimation and tracking.

**Preliminary Draft Recommendation:** *Strive to meet additional space needs through better utilization of permanent space and leased space that is intentionally designed as flexible co-working facilities for staff across multiple units who, for example, telecommute three or more days per week.*

**Preliminary Draft Recommendation:** *Prioritize leasing arrangements that allow the university to pay electric and gas utility bills directly. This model simplifies accounting for GHG emissions and creates an incentive for U-M units to reduce their energy usage and to include these emissions in a carbon price, per PCCN recommendation. In cases where this model is not possible, U-M should include a provision in lease agreements to supply monthly utility use data for UM-occupied space (including electricity, heating fuel(s), and water).*

**Preliminary Draft Recommendation:** *Develop and implement language in all leasing policy documents that requires high energy efficiency and a low GHG footprint, ideally in alignment with U-M building standards. Require property owners/managers to provide detailed information pertaining to their efforts to implement energy efficiency and emissions reductions, and how this ethic is woven into their overarching operating principles.*

**Preliminary Draft Recommendation:** *Develop and implement an accounting system for Scope 1 and 2 emissions associated with all leased space and integrate it with U-M's GHG accounting system.*

**Refer to Appendix Q for more specific evaluation criteria related to this recommendation.**

# Carbon Offsets and Sinks

Carbon offsets are defined in many ways. For example, the nonprofit organization that manages the Presidents' Climate Leadership Commitments defines a carbon offset as a reduction or removal of carbon dioxide equivalent greenhouse gas emissions ($CO_2e$) that is used to counterbalance or compensate for emissions from other activities.[34] Alternatively, the World Wildlife Fund (WWF) defines a carbon credit as an electronic and serialized unit that represents one ton of $CO_2e$ that is reduced, avoided, or sequestered from projects applying an approved carbon credit methodology.[35]

## Recommendations Summary

The following table summarizes the Commission's preliminary draft recommendations with regard to carbon offsets and sinks. They do not represent the Commission's final recommendations, nor do they represent that commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

| **Preliminary Draft Carbon Offsetting Recommendations** |
|---|
| As a minimum threshold of consideration, all carbon offset investments made by U-M should be real, measurable, additional, permanent, leakage avoidant, verified, enforceable, and compliant with social and environmental safeguards. |
| Clearly define and prioritize desired co-benefits criteria associated with carbon offsetting, and prioritize offset investment opportunities accordingly. |
| Identify opportunities for biosequestration projects on U-M lands that have significant carbon sequestration potential, and meaningful achievements across prioritized co-benefit categories. |
| Establish a standing expert committee to review the offset guidance recommended by the Commission; routinely solicit input and validation from reputable external experts and stakeholders to establish minimum requirements for offsetting Scope 1 and Scope 3 emissions; develop clear guidance on desired co-benefits criteria; and periodically issue broad calls for proposals that meet all threshold requirements and address desired co-benefits criteria. This committee will advise U-M leadership annually on our ability to use offsets to meet or surpass existing carbon neutrality goals. It will also monitor developments in this rapidly-evolving field and advise of emerging opportunities for U-M to lead regionally and nationally in this area. |

[34] Second Nature report on Carbon Markets and Offsets Guidance
[35] WWF Position and guidance on voluntary purchases of carbon credits

## Context and Recommendations

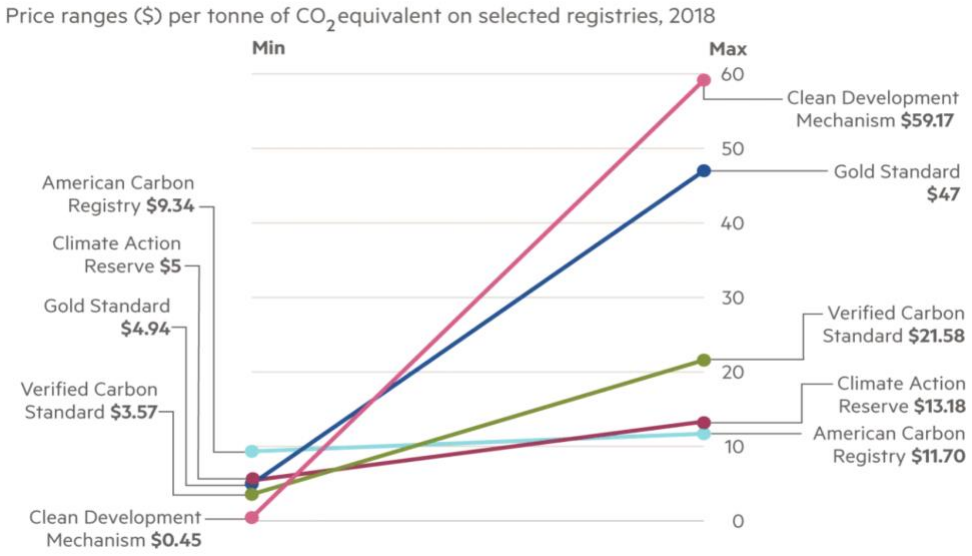
Until an organization eliminates all $CO_2e$ emissions associated with its activities, it cannot achieve carbon neutrality without using carbon offsets and sinks to counterbalance its remaining emissions. In addition, the Science Based Targets Initiative (SBTi) holds that offsets should not be counted as progress towards science-based targets, instead only in addition to meeting these targets through direct mitigation efforts.

Carbon offsetting activities can be implemented at locations throughout the world, and the credits associated with these offsetting activities can be acquired by individuals and institutions worldwide. Some strategies that organizations employ to counterbalance their direct GHG emissions include investments in renewable energy, technological sequestration projects, reforestation, other forms of biosequestration, and credits from cap-and-trade schemes.

One important distinction to understand is the difference between carbon offsets and Renewable Energy Certificates (RECs). Specifically, carbon offsets can be used to counterbalance Scope 1 and 3 emissions if they meet "additionality" and other requirements. On the other hand, according to The Center for Resource Solutions (CRS), there are no additionality requirements associated with RECs (see Scope 2 recommendations section). In addition, CRS and several other reputable experts on offsetting, including EPA Green Power Partnership, The International REC Standard, Second Nature, and Edison Energy, advise that RECs can only be used to counterbalance Scope 2 emissions and that RECs cannot be applied to Scope 1 and 3 emissions.

For myriad reasons, carbon offsets are complex and controversial, with quality levels and costs being highly variable. Figure 11 below illustrates the wide variability in offset prices.

Figure 11: Price ranges ($) per tonne of CO2e on selected carbon registries in 2018, including: the Clean Development Mechanism, the Verified Carbon Standard, the Gold Standard, the Climate Action Reserve, and the American Carbon Registry.[36]




[36] Gross, A. (2020, September 28). Carbon offset market progresses during coronavirus. *Financial Times*. https://www.ft.com/content/e946e3bd-99ac-49a8-82c9-e372a510e87c

Due to the complexity and controversial nature of offsets, there are divergent views on their merits and how they should be used as part of U-M's carbon neutrality strategy. Carbon offsets and other offsite mechanisms are widely used by business and industry; local, state and national governments; academic institutions; and NGOs. While offset markets and investments are imperfect mechanisms, they are nevertheless playing a significant role in helping institutions meet their carbon neutrality goals. The Commission recommends that U-M prioritize direct reductions whenever possible, and acknowledges that carbon offsets will be required to achieve the carbon neutrality recommendations in this report, with decreased reliance on them over time.

Given the variable quality of carbon offsets available on the market, credibility is of the utmost importance when using them as part of a carbon neutrality strategy, and certain threshold criteria must be met. In addition, different offsetting opportunities present a range of potential co-benefits that warrant consideration in selecting among the various options. This informs the Commission's first recommendation on the topic.

**Preliminary Draft Recommendation:** *As a minimum threshold of consideration, all carbon offset investments made by U-M should be real, measurable, additional, permanent, leakage avoidant, verified, enforceable, and compliant with social and environmental safeguards.*

- ***Real -–*** The reduction must have actually occurred and not as a result of flawed accounting (e.g., overstated impacts, double-counting).

- ***Measurable –*** Carbon credits must be calculated based on robust scientific data using accurate quantification methods and must be expressed in quantitative terms using standardized GHG metrics.

- ***Additional –*** The reduction would not have occurred in the absence of a market for offset credits or without U-M initiating and supporting the project directly for the purpose of offsetting its emissions.

- ***Permanent –*** The reduction must last in perpetuity or for as long as the credit is being claimed. Permanence is particularly relevant to biosequestration projects (i.e., nature's ability to permanently store carbon without releasing it at some point in the future).

- ***Leakage avoidant –*** The generation of carbon credits should not lead to an increase in emissions elsewhere, or safeguards must be in place to monitor and mitigate any increase that does occur.

- ***Verified –*** The reduction must have been monitored and confirmed to have occurred by a reputable, unbiased, third party verification organization to ensure that the credibility of the claim is beyond reproach.

- ***Enforceable –*** The reduction must be counted only once and then retired.

- ***Compliant with social and environmental safeguards –*** The generation of carbon credits should not violate laws, regulations, or treaties, or result in social or environmental grievances, and should meet international best practice standards for social and environmental safeguards.

Refer to Appendix R for a list of notable examples of other institutions' approaches to using carbon offsets to counterbalance their GHG emissions.

Beyond meeting the basic requirements described in the first recommendation, the Commission recommends that U-M consider various socioeconomic and environmental co-benefits when evaluating which carbon offset strategies to pursue.

**Preliminary Draft Recommendation:** *Clearly define and prioritize desired co-benefits criteria associated with carbon offsetting, and prioritize offset investment opportunities accordingly.*

Co-benefits are desirable elements associated with various offset strategies that are above and beyond threshold requirements. There are many possible co-benefit categories and they may be prioritized differently depending on the organization's unique circumstances. The Commission recommends that key co-benefits include:

- Providing education and research opportunities for U-M students and faculty;
- Being located within the State of Michigan with positive multiplier effects for Michigan communities
- Having clearly attributable social equity and justice benefits
- Promoting environmental health, conservation, and restoration
- Offering opportunities to develop and advance partnerships in the local/regional community, and;
- Having significant potential for scalability, transferability, and replicability.

In addition to considering carbon offset opportunities beyond the campus, the Commission also established an internal analysis team focused on the biosequestration potential of U-M lands, which would serve as carbon sinks to counterbalance university GHG emissions.

**Preliminary Draft Recommendation:** *Identify opportunities for biosequestration projects on U-M lands that have significant carbon sequestration potential, and seek meaningful achievements across prioritized co-benefit categories.*

According to the internal analysis team, *Biosequestration is the ability of plants to collect carbon from the air via photosynthesis, and store carbon structurally via growth (e.g., in wood, photosynthetic tissues, roots, etc.) and.it currently plays a large role in mitigating carbon emissions on local and global scales.* The team recommended that to maintain existing levels of sequestration and ecosystem services, U-M owned natural lands should be protected, expanded, and enhanced by the university. Potential benefits of this approach include direct control and ownership of projects and the ability to weave in other co-benefits. However, the

Commission recognizes that many considerations go into land-use planning and that multiple factors will guide such decisions.

In line with internal analysis team guidance, the Commission recommends that if land use modifications reduce the amount of carbon stored in its natural lands, then this should be reflected as an increase in U-M's carbon footprint. Alternatively, if the university increases the amount of carbon stored in its natural lands, then this should be reflected as a decrease in the U-M's carbon footprint. The Commission also recommends that U-M pursue smaller-scale biosequestration projects, as recommended by the internal analysis team, as described in the Research and Education section below.

**Refer to Appendix S for specific evaluation criteria related to this recommendation.**

While the Commission spent a significant amount of time reviewing and discussing various approaches to offsetting carbon, the complexity and rapidly changing offsets landscape requires sustained attention for as long as offsetting strategies are used. This informs the Commission's final recommendation with regard to carbon offsetting.

**Preliminary Draft Recommendation:** *Establish a standing expert committee to review the offset guidance recommended by the Commission; routinely solicit input and validation from reputable external experts and stakeholders to establish minimum requirements for offsetting Scope 1 and Scope 3 emissions; develop clear guidance on desired co-benefits criteria; and periodically issue broad calls for proposals that meet all threshold requirements and address desired co-benefits criteria. This committee will advise U-M leadership annually on our ability to use offsets to meet or surpass existing carbon neutrality goals. It will also monitor developments in this rapidly-evolving field and advise of emerging opportunities for U-M to lead regionally and nationally in this area.*

# Organization and Culture

For carbon neutrality efforts to be successful and sustainable, U-M's commitment must be woven into all levels of its organizational fabric, and not limited to particular individuals or units. Achieving carbon neutrality will require coordinated action and accountability from all units throughout the university, and success requires that the structural and cultural architecture of the university align with the goals and critical work. This is currently being accomplished with Diversity, Equity and Inclusion (DEI) efforts at U-M, and similar approaches are required for carbon neutrality.

## Recommendations Summary

The following table summarizes the Commission's preliminary draft recommendations with regard to organization and cultures. They do not represent the Commission's final recommendations, nor do they represent that the commissioners unanimously support each recommendation. The Commission will continue to evaluate potential goals and strategies until it finalizes its recommendations in February 2021, at which time minority views may be included with regard to some of the final recommendations.

***NOTE:*** *The table below seeks to provide generalized comparisons of the draft recommendations in terms of Financial Investment, GHG Levels, and Culture Shift. These are subjective judgments based on best available information and are for illustrative purposes only.*

| **Preliminary Draft Recommendation** | **Financial Investment** | **GHG Levels** | **Culture Shift** |
|---|---|---|---|
| The university must institutionalize its commitment to carbon neutrality by providing the necessary leadership and organizational support to achieve its goals. This includes implementing mechanisms to integrate responsibility and accountability at the unit level throughout the university, and creating a position that assists, advises and reports to the President to facilitate carbon neutrality progress across the entire university. | $$ | n/a | High |
| Make significant investments in research on routes to achieving carbon neutrality. | $$ | n/a | Med |
| Invest in institutional structures to expand and support carbon neutrality focused "living-learning labs"across all three U-M campuses | $$ | n/a | High |

| | | | |
|---|---|---|---|
| Expand and prioritize carbon neutrality curriculum, training and literacy programs to all members of the UM community across all three campuses. | $ | n/a | High |
| Conduct targeted network mapping related to all carbon neutrality strategies and and pursue intentional engagement with key stakeholders to inform implementation | $ | n/a | Med |
| Tailor carbon neutrality communication and education, and expand opportunities for stakeholder input | $ | n/a | Med |

## Leadership Structures

**Preliminary Draft Recommendation:** *The university must institutionalize its commitment to carbon neutrality by providing the necessary leadership and organizational support to achieve its goals. This includes implementing mechanisms to integrate responsibility and accountability at the unit level throughout the university, and creating a position that assists, advises and reports directly to the President to facilitate carbon neutrality progress across the entire university.*

U-M's path toward carbon neutrality requires full presidential and regential commitment to make it a long-term priority at all levels of the organization, where the commitment is built to endure regardless of who sits in leadership positions. Successful efforts around carbon neutrality require centralized leadership and coordination, as well as decentralized commitments and strategies at the unit level. Similar to U-M's Diversity, Equity, and Inclusion (DEI) efforts, the current and future Presidents and their senior leadership need to be consistently out front and visible on carbon neutrality to help embed it in U-M's culture.

U-M must design its carbon neutrality effort in ways that leverage, invest in, and elevate existing organizational structures and resources throughout the university, which are essential to carrying out the work. U-M must avoid redundant efforts, organizational bloat, and emerging political tensions at all costs. A key question to answer from an organizational design perspective is whether U-M has the right people with the right knowledge and skills in the right positions in order to execute its critical work. If not, then U-M has to either build the requisite capabilities of our current people, or hire additional qualified personnel.

To accelerate progress and accountability at the unit and individual levels, U-M must invest in creating a robust network that empowers and supports faculty, staff and students engaging in this work. In addition, every unit leader must develop, pursue, and be evaluated on critical carbon neutrality-related tasks that they have the authority to prioritize, control, and execute. Similar to DEI, goals, accountability and annual reporting mechanisms need to become the norm in units throughout the university.

A successful carbon neutrality effort also requires a new leadership position reporting directly to the President with responsibility for planning and organizing the overall effort across all three campuses in consultation with wide-ranging stakeholders, tracking and reporting on progress in a scheduled, periodic manner to the entire campus community, and working with units as a consulting partner to build capabilities. The individual in this role will help the President and other U-M leaders understand how all major university decisions are or are not compatible with carbon neutrality goals. Supportive structures, like internal executive committees or external advisory boards, with broad representation and diverse perspectives, are also needed to inform and support the effort, and to help ensure accountability throughout the university.

Some of the key responsibilities for the new position include:

- Establishing, for internal and external stakeholders, a clear point of contact that formally represents the U-M administration on university-wide carbon neutrality issues through an integrated lens of education, research, operations, and outreach.
- Providing the President with a primary advisor on carbon neutrality matters.
- Ensuring that carbon neutrality considerations are represented in Executive Officer discussions and appointments, which span all areas of the university.
- Regularly convening high-level internal and external carbon neutrality advisory bodies to ensure that widespread perspectives inform university strategy, decision-making, and accountability.
- Working across all U-M units in a consultative role to ensure mechanisms are implemented that cultivate and embed carbon neutrality culture at the unit and individual levels.
- Leading efforts to periodically and transparently report on U-M's progress and shortcomings across all plan dimensions throughout the university
- Regularly collaborating and engaging with the DEI Office and other cross-university efforts to identify synergies and accelerate one another's priorities.
- Demonstrating deep understanding of and ability to work towards environmental justice
- Building and accelerating partnership networks (internally and externally) to collaboratively design scalable strategies that are sustainable and just.
- Establishing and maintaining equitable relationships with all three campuses
- Closely partnering with the cities of Ann Arbor, Dearborn, and Flint to work together toward shared carbon neutrality goals.

The individual in this role will have limited authority or direct oversight over executing much of the critical work that is needed. Complete responsibility for the goals and associated critical work cannot be assigned to one individual because that would set this person up for failure and not recognize or appreciate the organizational requirements to achieve such goals. Clear guidance will need to be developed and communicated regarding how this role interfaces with, collaborates with, and influences units (on the Ann Arbor, Flint and Dearborn campuses) to ensure expectations are aligned throughout the university.

**Refer to Appendix T for specific evaluation criteria related to this recommendation.**

## Research and Education

**Preliminary Draft Recommendation:** *Make significant investments in research on routes to achieving carbon neutrality.*

The University of Michigan's strength in research is second to none in the United States, and possibly the world. In particular, there are many world-leading groups in many areas directly related to achieving carbon neutrality, including those studying renewable energy generation, carbon sequestration, energy efficiency, electricity grid design and management, mobility, life cycle analysis, carbon pricing policies, and the social impacts of climate change. It is thus apparent, and indeed U-M's responsibility, to engage the broad spectrum of research, scholarship and educational opportunities in providing solutions to the institutional and global challenges leading carbon neutrality.

The Commission recommends that U-M accelerate efforts to make the institution an undeniable thought leader in the broad areas related to carbon neutrality. This requires a significant emphasis on integrating existing research efforts spanning the physical, natural, engineering and social sciences, as well as arts and humanities. Integrating across disciplines must be prioritized and will lead to opportunities for the university to attract significant external funding to take this work even further.

To accomplish this task, the university should invest significantly in carbon neutrality research and education as broadly defined above. The Commission recommends that U-M scale up the current $5 million fund to $10 million to support proposals from the university research community. Proposals should be selected via conventional peer review mechanisms with preference given to proposals that cross interdisciplinary boundaries, given the fundamentally interdisciplinary nature of effective climate change solutions. Furthermore, research should promote unique educational opportunities for graduate and undergraduate students alike, so that U-M students will come to be recognized as the most knowledgeable and effective contributors to this emergent field of study. An excellent model for managing this initiative is the recent Carbon Neutrality Acceleration Program for faculty research administered by the Graham Sustainability Institute.[37]

Funds should be disbursed in a manner that best accomplishes the following goals:

- Provide realistic, scalable, transferrable and socially equitable solutions consistent with the charge of PCCN.
- Establish U-M as a global leader in carbon neutrality research solutions.
- Provide unique educational experiences in both the classroom and research lab, to provide a breadth of training in all of the multi- and interdisciplinary aspects of carbon neutrality.
- Provide a platform from which large-scale external team funding can be attracted to UM, such as National Science Foundation (NSF) Engineering Research Centers, Materials

[37] Graham Sustainability Institute Carbon Neutrality Acceleration Program: http://graham.umich.edu/carbonneutrality

Research Science and Engineering Centers, and Department of Energy Energy Frontier Research Centers.

- To provide both internal and external visibility that appropriately emphasizes U-M's commitment to carbon neutrality, with research awards administered and tracked by an institute focused on carbon neutrality and energy.
- Provide a core activity that can attract external donor funding to sustain the initiative funding until the goal of carbon neutrality is achieved.

The initiative funds should be managed by an independent U-M entity that is best suited to this purpose, and has strong backing and support from the central administration. For U-M to be successful in carrying out its carbon neutrality aspirations, it must invest significantly, and for the long haul, in the organizational assets necessary to organize and integrate the work, similar to what it has done around the biosciences.

**Preliminary Draft Recommendation:** *Expand and prioritize sustainability curriculum, training and literacy programs to all members of the U-M community across all three campuses*

A priority building block toward achieving carbon neutrality is ensuring that the U-M community is engaged and educated to make daily choices that reduce carbon emissions where they live, learn, work and visit, and are prepared to take their learned experiences with them off campus throughout their lives. To educate and prepare the U-M community, the Commission recommends that the university prioritize and encourage baseline carbon neutrality educational modules for use by all three U-M campuses. The university community is a diverse collection of individuals with varying priorities and levels of interaction with the institution. As U-M moves towards carbon neutrality, it will be essential that it develop educational opportunities for faculty, staff, students, community members, and visitors to contribute toward our carbon neutrality goals. The education, involvement and accountability of U-M community members throughout their time at U-M is critically important for the university to achieve its carbon neutrality aspirations.

**Orientation programs** are a critical touch point for all U-M students, faculty and staff. All new students, faculty and staff should complete an introductory training on U-M's sustainability programs and carbon neutrality goals. The Planet Blue Ambassadors (PBA) program is currently working with U-M Student Life to develop an online orientation module, which should be fit to the specific student, faculty and staff experience. As U-M sets carbon neutrality goals, the Commission recommends that a training module be updated to address new goals, information on the projects driving U-M towards carbon neutrality, and ways that members of the university community can participate. The Commission recommends adapting the orientation programming with details specific to the Ann Arbor, Dearborn, Flint campuses, and for remote employees and students. Key topics for inclusion include: environmentally friendly food choices, carbon-friendly travel alternatives, opportunities to reduce the carbon intensity of the commute, and U-M workplace and classroom sustainability features. Orientation programming should also publicize educational materials on the climate-friendly retirement investment options offered by Fidelity and TIAA-CREF, U-M's retirement account providers, and in a readily available and accessible format to all faculty and staff. According to the campus culture and communication internal analysis team, U-M's Human Resources (HR) office, which

oversees retirement benefits, is able to identify specific funds in both TIAA and Fidelity that invest in low and no carbon options. The team's report also indicated that the HR office would be willing to offer workshops for employees to make them aware of these investment options.

**Curriculum** is another major touchpoint for U-M students. The university is responsible for educating and preparing almost 65,000 undergraduate and graduate students across all three of its campuses each year, many of whom go on to pursue careers that create meaningful and lasting change in global society. As a result, U-M has a responsibility to ensure that each student, no matter their field of study, is prepared to engage with the global challenge of climate change and be part of the solution in their industry or chosen field of endeavor.

Because different students and departments have varying needs and degree requirements, the Commission asserts that developing a single mandatory course for all undergraduate and graduate students is unrealistic. Rather, the Commission recommends that every academic unit be required to develop their own plan for building carbon neutrality concepts into their core curricula for both undergraduate and graduate students, and that incentives (e.g., planning grants) be established to support these efforts (see Leadership Structures section). This would allow each U-M student to learn both how climate change affects their chosen field of study, and how their chosen field of study can be a part of the global solution during their time at the University of Michigan. It also provides academic units with opportunities to develop cutting-edge pedagogical approaches that can be replicated at other universities. This curriculum requirement should be integrated into the annual reporting and review process for each academic unit.

The Commission also recommends that U-M establish an ad hoc committee to inventory all existing courses that are relevant to climate and carbon neutrality, and draw particular attention to those that approach the issue holistically where issues of ethics and environmental justice are integral. These courses should be highlighted in multiple formats (e.g., fact sheets, web pages) and in multiple fora at key touch points throughout the student experience, and in locations that are visible to current and prospective U-M community members.

**Widespread and frequent educational cues** will be necessary to remind the U-M community of how their choices impact the environment and the university's carbon neutrality goals. Carbon neutrality is a community-wide endeavor that should be clearly communicated as faculty, staff, students and visitors interact with the institution in their daily lives. Educational materials (e.g., information packages, signage, art installations) will provide community members the tools, inspiration, and encouragement necessary to make daily decisions to make carbon-neutral choices. Key subject areas to highlight include, but are not limited to: environmentally responsible food choices, carbon-friendly travel alternatives, and methods to reduce the carbon intensity of the commute. Avenues to reach the U-M community on a regular basis include: grant award materials, scholarship materials, office administrator handbooks, study abroad materials, housing contracts and materials, dining halls, lab manuals, and parking pass materials.

For all recommendations put forth in this report, education and awareness of the U-M community is a primary element to its success. The university needs to educate the community

on why it is taking these actions, and what the positive impact of such changes are to achieving carbon neutrality, and capture the hearts and minds of the community to make these changes a permanent, shared cultural ethic.

**Preliminary Draft Recommendation:** *Invest in institutional structures to expand and support carbon neutrality focused "living-learning labs" across all three U-M campuses.*

Over the past ten years, the University of Michigan currently has created many examples of living-learning laboratory programs and activities across campus that advance education and research, and accelerate its sustainability goals. Some of the existing initiatives include: The Campus Farm, Sustainable Living Experience at Oxford Residence Hall, MDining Sustainability programs, the Planet Blue Ambassadors Program.

In pursuing the carbon neutrality strategies recommended throughout this report, the Commission recommends that U-M invest in hands-on educational and research opportunities for students and faculty that highlight U-M's carbon neutrality efforts and support the university's core mission. A successful living-learning lab program requires investments in the organizational assets needed to incentivize and coordinate bottom-up and top-down collaborations between individual units and the centralized organizational structures. Expanding these efforts should also be done in collaboration with external partners, including surrounding municipalities, local organizations, and corporations.

Living-learning laboratory programs create a visible way for the U-M community to engage in the places they live, work, learn and visit. They establish a direct connection between transforming the campus operationally and integrating those efforts with research and education, making them excellent opportunities for donor-supported funding.

Some examples of such opportunities include:

- Cultivating the campus landscape to increase bio sequestration, while providing visible examples of U-M's commitment to carbon neutrality. Potential projects include: increasing canopy cover through tree planting, replacing turfgrass with environmentally-friendly alternatives, and establishing green infrastructure on campus (rain gardens, native gardens, bioswales, and green roofs). Find more information in the bio sequestration analysis final report.
- Constructing a sustainable and affordable net-zero residential building in U-M's cold climate region to demonstrate the feasibility.
- Ensuring on-campus renewable energy deployment, such as photovoltaics or geo-exchange, is accessible for educational purposes (see Scope 1 Recommendations section).
- Expanding plant-forward diets across dining halls and food service locations on all three campuses (see University-Procured Food section).
- Expanding waste reduction strategies, composting and recycling programs across all three U-M campuses (see Waste and Wastewater reduction strategies section).

- Exploring the use of Positive Impact Points (PIPs) to encourage daily sustainable behaviors by U-M students.[38]
- Investing in carbon offset projects that support and expand education and research opportunities for the U-M community (see Carbon Offsets Guidance)
- Supporting student and faculty research projects focused on campus sustainability challenges at an increased level from current investments (see Research and Education section)

**Refer to Appendix U for evaluation criteria related to the research & education recommendations.**

## External Collaboration

The climate crisis is a global issue that requires coordinated action to solve, and thus effective collaboration is critically important to the success of carbon neutrality efforts. For the University to have maximum impact, it must intentionally, deeply, and wisely engage with external stakeholders, partners, peers and constituents. Effective carbon reduction, both locally and at scale, requires partnerships to be successful. If done well, U-M will benefit from support, information, and participation from a wide array of external stakeholders, while advancing its own goals of creating scalable and transferable solutions to advance action on climate change beyond its three campuses.

External collaboration involves multi-directional and strategic partnerships that involve both engagement and communication with stakeholders. U-M must seize the opportunity to establish a model of effective external collaboration that other institutions will emulate as they pursue their own paths to carbon neutrality. With that aspiration in mind, the key priorities of external collaboration for carbon neutrality are four-fold to:

1. Assure that the proper skills, knowledge, and support are brought to the University to assure success of the carbon neutrality goals.
2. Create an inclusive process that allows affected vulnerable communities to be aware of this effort, and have a voice in its implementation.
3. Identify collaboration opportunities and potential obstacles to be overcome.
4. Coordinate activities with external partners in pursuit of shared carbon neutrality objectives.
5. Create an environment in which all relevant stakeholders' concerns and objections are heard, addressed and accounted for to ensure the delivery of viable solutions for the overall long-term success.

To accomplish such priorities, the Commission recommends the following:

[38] For more on Positive Impact Points, refer to their website: https://www.pipsrewards.com/ourstory

**Preliminary Draft Recommendation:** *Conduct targeted network mapping related to all carbon neutrality strategies and pursue intentional engagement with key stakeholders to inform implementation.*

As U-M begins its implementation of recommendations set forth in this report, it should make a concerted effort to identify and characterize the interests of the U-M stakeholder community, while also identifying missing groups, such as under-represented communities and constituents linked to the Dearborn and Flint campuses. The Commission recommends that the unit tasked with leading U-M's carbon neutrality efforts work with U-M's existing external relationship managers, such as the Office of Government Relations, Business Engagement Center, and the Ginsberg Center, to help identify external stakeholders who should be engaged. This will help U-M identify the different types of engagement strategies and approaches that will be required for success.

Once U-M establishes a high-level network map, collaborators and stakeholders specific to individual recommendations and initiatives should be identified, prioritized, and connections made. The process of engagement and stakeholder mapping will be an ongoing and evolving process as U-M charges towards its carbon neutrality goals. The university needs to establish a strong organizational infrastructure, diverse networks, and a robust plan for making our external constituents real partners in the decisions U-M makes along its path to carbon neutrality.

The University should consult all relevant stakeholders via outreach, but should particularly focus on engaging stakeholders who will be the most impactful to meeting U-M's carbon neutrality goals. In particular, while some constituents who provide technical services to the University may be relatively easy to identify, those from under-represented communities in and around U-M may require proactive and concerted efforts to achieve meaningful engagement. Inclusivity considerations should be prioritized alongside technical and commercial considerations.

**Preliminary Draft Recommendation:** *Tailor carbon neutrality communication and education for specific audiences, and expand opportunities for stakeholder input.*

For external collaboration and partnerships to be successful, the U-M needs to tailor its outreach and expand opportunities for stakeholder engagement. To do so, the University should develop targeted communication and outreach programs for reaching the various stakeholder groups that are identified through its stakeholder mapping exercise, while acknowledging the varying levels of sustainability and carbon neutrality literacy of each external community. U-M should meet each stakeholder group where they are, and facilitate education when relevant while employing cultural humility and shared decision-making. Doing so will both accelerate the work of the University in transitioning to carbon neutrality, but will also amplify the scalability and transferability of U-M's solutions.

The Commission also recommends that special consideration be devoted to engaging communities that may lack the resources, knowledge, or familiarity with communicating with the U-M campuses. To do this, U-M should create and adapt feedback channels that invite input from the external community in an inclusive manner. Existing feedback structures (e.g., vendor

solicitations, surveys, Regents' meetings) should be adapted to intentionally solicit input on carbon neutrality efforts and new channels should be established that are squarely focused on these issues. All feedback channels should be widely promoted and attentive to managing expectations with regard to how the stakeholder input will be handled by the university.

**Refer to Appendix V for evaluation criteria related to the external collaboration recommendations.**

## Carbon Accounting Model

The Commission's carbon accounting subgroup developed and implemented a comprehensive carbon accounting model for the University of Michigan (Ann Arbor, Dearborn, and Flint campuses). The model integrates existing work completed by internal analysis teams, external analyses, the mobility electrification subgroup, and Office of Campus Sustainability, supplemented with additional analysis by the carbon accounting subgroup. The model provides guidance and informs the Commission on emissions reduction strategies (including both technical and policy strategies) and their reduction potential over time, the development of carbon neutrality pathways, and selection of neutrality goal years. The Carbon Accounting Subgroup also developed an iterative analysis and goal setting process for the PCCN incorporating the carbon accounting model.

The subgroup also developed recommendations for improving carbon accounting systems for tracking progress and implementation of strategies for emissions reduction. The lack of data in several areas, mostly related to Scope 3 activities, highlight the need for improved accounting systems. This pertains especially to purchased goods and services, as is more fully detailed in the carbon accounting subgroup report. The carbon accounting model will require annual updating and refinement and additional work will be required to transition the PCCN carbon accounting tool to an operational OCS tool for planning, tracking, reporting, and verification. In addition, it is recommended that emissions accounting be conducted at the building-level to more fully engage academic units in achieving carbon neutrality.

**Refer to Appendix W for more information on the carbon accounting model**

## Financial Analysis

Pursuant to the financial responsibility criteria set forth in the President's charge, the Commission and its analysis teams sought to conduct financial analyses to the extent possible to inform cost projections for the various recommendations.

Several recommendations in this report, particularly those that are the most capital-intensive, were informed by significant financial analysis to determine preliminary, high-level cost estimates. For example, the Integral Group worked closely with U-M staff to develop a life-cycle cost analysis (LCCA) comparing the financial outcomes of distinct future scenarios over the study's 30-year period (refer to Appendix D). The LCCA was driven by upfront capital costs; maintenance costs; energy costs; and financing costs, and compared a Business as Usual (BAU) case with a Proposed Project case. For the deep energy retrofits study, SmithGroup also

conducted a LCCA to estimate the full costs of acquiring, owning, and disposing of building components and systems for the energy conservation management (ECM) scenarios they evaluated (refer to Appendix J)

Many of the internal analysis teams also conducted financial analyses to inform their reports, with the most notable examples being the Energy Consumption Policies, Building Standards, and Mobility Electrification teams. Other internal analysis teams provided cost estimates to the degree possible given the time and resources available to them.

The Commission was not tasked to make recommendations as to how U-M should finance recommended actions and no such recommendations are provided. More in-depth financial analysis and costing would be needed for all recommendations moving forward.

# APPENDICES

## Appendix A: Abbreviations Glossary

| | |
|---|---|
| **ASHRAE** | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| **AAATA** | Ann Arbor Area Transportation Authority |
| **AEC** | Architecture, Engineering, and Construction |
| **BAU** | Business-as-Usual |
| **CCTC** | Central Campus Transit Center |
| **CPP** | Central Power Plant |
| **CCA** | Community Choice Aggregation |
| **DOE** | Department of Energy |
| **DEI** | Diversity, Equity and Inclusion |
| **EIO** | Economic Input-Output |
| **EV** | Electric Vehicle |
| **ECM** | Energy Conservation Measure |
| **EUI** | Energy Use Intensity |
| **GHX** | Geo-exchange |
| **GWP** | Global Warming Potential |
| **GHG** | Greenhouse Gas Emissions |
| **GREET** | Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation |
| **HVAC** | Heating, ventilation, and air conditioning |
| **IRENA** | International Renewable Energy Agency |
| **$KTCO_2$** | Kilotons of Carbon Dioxide |
| **LCCA** | Life Cycle Cost Assessment |
| **LDAR** | Leak Detection and Repair |
| **LED** | Light emitting diode |
| **MTHW** | Medium temperature hot water |
| **$MTCO_2$** | Metric Tons of Carbon Dioxide |
| **NSF** | National Science Foundation |
| **PV** | Photovoltaics |
| **PBA** | Planet Blue Ambassadors |
| **PPA** | Power Purchase Agreement |
| **PCCN** | President’s Commission on Carbon Neutrality |
| **REC** | Renewable Energy Credit |
| **RFP** | Request for Proposal |
| **ROI** | Return on investment |
| **REF** | Revolving Energy Fund |
| **SBTi** | Science-Based Targets Initiative |
| **SMART** | Suburban Mobility Authority for Regional Transportation |
| **CRS** | The Center for Resource Solutions |
| **OCS** | The Office of Campus Sustainability |
| **LTP** | Logistics, Transportation and Parking Office |
| **VPPA** | Virtual Power Purchase Agreement |
| **WWF** | World Wildlife Fund |

## Appendix B: Public Engagement Event Summary

- October 29, 2020 – Webinar: Distinct Analyses, One Sustainable Direction: Students and Faculty Share Insights from U-M's Carbon Neutrality Push
- March 18, 2020 – CANCELLED – The Role of Climate Justice in Carbon Neutrality at the University of Michigan
- March 16, 2020 – CANCELLED – U-M Flint Town Hall: The Role of Food and Campus Culture in Carbon Neutrality at the University of Michigan
- February 27, 2020 – U-M Dearborn Town Hall: The Role of Food and Campus Culture in Carbon Neutrality at the University of Michigan
- February 27, 2020 – North Campus Sustainability Initiative: Commuting Analysis Team Lunchtime Talk
- February 25, 2020 – U-M Flint: Charting U-M's Path to Carbon Neutrality
- February 5, 2020 – Ann Arbor Student Town Hall: The Role of Food in Carbon Neutrality at U-M
- January 23, 2020 – U-M Ann Arbor Commuting Internal Analysis Team Town Hall
- January 22, 2020 – U-M Dearborn Commuting Internal Analysis Team Town Hall
- December 10, 2019 – Business and Carbon Neutrality: A Panel Discussion on Becoming a Carbon-free Campus
- October 21 & 22, 2019 – Ross School (Zell-Lurie Institute) Business Pitch Competition
- October 18, 2019 – Charting our University's Path to Carbon Neutrality, University of Michigan-Dearborn's Strategic Planning Thought Leader Series
- September 25, 2019 – PCCN Community Forum; Watch Recording.
- April 9, 2019 – A Special Public Session with President Schlissel; Watch Recording.
- April 16, 2019 – Open Forum: President's Community on Carbon Neutrality
- April 3, 2019 – Town Hall Meeting #2; Watch Recording.
- March 11, 2019 – Town Hall Meeting #1; Watching Recording.

## Appendix C: Heat and Power Infrastructure Decarbonization Solution Matrix

| Option | Benefits | Limitations / Risks | Long-Term Outlook |
|---|---|---|---|
| **Electrification** | • Mature technologies (e.g. solar, wind) can produce zero-carbon and increasingly cost-effective electricity<br>• Most climate scientists, including those involved with the Intergovernmental Panel on Climate Change (IPCC), believe electrification of the building sector is a vital component of a pathway to <2° global warming | • Intermittency of renewable power poses a big challenge: wind doesn't always blow and sun doesn't always shine when buildings need power<br>• While energy storage holds promise, batteries remain expensive<br>• Reliance on the centralized electric grid, with its bulk power generation and long transmission lines, can be less reliant than onsite Combined Heat & Power (CHP) | • While still the source of significant debate, an increasing number of energy modelers find credible pathways to 80%+ renewable energy<br>• Battery storage costs are falling; costs may drop below $100/kWh by 2024 (from $1,100 in 2010)<br>• A breakthrough in electricity generation, such as hydrogen or nuclear, would help catapult the penetration of zero-carbon resources |
| **Biofuels / Biomass / "Renewable Natural Gas" (RNG)** | • Transition from natural gas to biofuels — such as RNG generated from landfills and farms — can leverage existing infrastructure; a "fuel switch" can achieve quick carbon reductions<br>• Biofuels often provide improved reliability relative to solar or wind generation | • Biofuel feedstock, including landfill gas and wood, is relatively limited; experts predict biofuels could only scale so far, satisfying just 10-15% of US thermal demand<br>• Biofuels face criticism about whether they are "zero carbon" in practice (e.g. wood "waste" has at times included forest clear-cutting) | • Because of inherently limited supply, increased demand in the biofuels market could work against itself: increased demand for biofuels would, almost definitionally, increase prices<br>• Biofuels suppliers, particularly those involving wood "waste," may continue to seek loopholes in market requirements, minimizing carbon impact |
| **Carbon Offsets** | • Carbon offsets — ranging from Renewable Energy Credits (RECs) to tree planting — provide a quick and often cheap path to decarbonization | • Real-world experience with carbon offsets is poor, often falling well short of decarbonization goals<br>• Many widely-accepted carbon accounting practices devalue or reject the use of offsets | • While directly reducing emissions — i.e. reducing onsite building emissions — will be a superior option, offsets could play a meaningful role in carbon mitigation if accounting standards tighten |
| **Geo-Exchange (GHX)** | • Leveraging the earth's constant temperature vastly improves efficiency of electric HVAC equipment (e.g. heat pumps) | • Land constraints can limit viability<br>• Increased first-cost relative to other all-electric solutions (e.g. air-source heat pumps) | • Reduction in total life-cycle costs will continue to make geo-exchange attractive when land constraints not an issue |
| **Onsite Solar PV** | • Mature technology<br>• Costs have fallen dramatically over the last decade ($10/W to below $2/W for commercial sector) | • Onsite solar is limited in its ability to generate high % of demand; even if *every* U-M roof and parking lot were covered with solar, unlikely to generate more than 20% of electric needs | • Increased panel efficiency may be as important as cost reductions — as efficiency improves, onsite solar can provide greater portion of energy demand |
| **Solar Thermal** | • Tech, which heats water, has better efficiency than solar PV<br>• Improves GHX efficiency by reheating ground in winter | • Solar thermal is unable to meet significant portion of thermal demands on its own | • While more of a complementary (rather than primary) solution, solar thermal can play a meaningful role in key applications |
| **Carbon Capture** | • Onsite carbon capture (e.g. using flue gas from onsite CHP) can provide carbon mitigation with minimal disruption to business-as-usual | • The carbon capture industry has seen little more than pilot projects thus far; critics argue carbon capture has long over-promised and under-delivered | • While an infusion of government R&D could change the dynamics, the carbon capture industry is far from proving commercial viability |
| **Nuclear (Modular)** | • In theory, modular nuclear could provide extremely reliable onsite power generation | • Even at utility scale, nuclear remains very expensive; at modular scale, it's even more expensive at present<br>• Concerns remain about nuclear waste and safety | • While industry has a budget-busting history, it continues to see very significant R&D — with some investors confident costs will come down |
| **Hydrogen** | • Hydrogen can be stored and transported, a big advantage over traditional renewables<br>• Converting hydrogen to heat and electricity produces no GHGs | • At present, most hydrogen production is natural-gas driven<br>• Costs remain very expensive relative to alternatives | • Some observers see a future in which hydrogen is generated at scale by solar (vs. natural gas)<br>• While industry needs breakthroughs, may hold most promise of "long shot" tech incl carbon capture, nuclear |

## Appendix D: Integral Group Life Cycle Cost Assessment

The Life-Cycle Cost Analysis (LCCA) for this project is a tool to compare the financial outcomes of distinct future scenarios over the study's 30-year period for:

- Business as Usual (BAU): baseline costs to maintain (and replace when necessary) existing energy infrastructure and purchase fuel (e.g. electricity, natural gas), vs.
- Proposed Project (PP): costs to build / maintain new energy infrastructure and purchase fuel

The LCCA is driven by four key components: upfront capital costs; maintenance costs; energy costs; financing costs.

Construction Costs (for BAU and PP)

These costs are largely derived from market intelligence, gained from Integral's past projects and discussions with vendors, and in some instances from U-M's cost estimates for recent or present projects. The LCCA assumes a 30 percent contingency, per U-M's feedback. This is roughly equivalent to the contingency level that Integral typically uses.

Maintenance Costs (for BAU)

Maintenance costs, which include system replacement when necessary, are central to the BAU case. Integral and U-M worked diligently to develop an accounting of major existing systems, date installed, expected lifetime, planned replacement (in select instances when replacement is already planned), and associated costs.

Financing Costs / Discount Rate (for BAU and PP)

The LCCA's discount rate accounts for opportunity costs, borrowing costs, and the time value of money. It is anticipated that this figure will be refined with further feedback from the University.

Energy Costs (for BAU and PP)

The LCCA's current forecasted rate escalations for electricity and natural gas are derived from the "2020 Annual Energy Outlook" from the US Department of Energy's (DOE) Energy Information Administration (EIA). The analysis includes base case; high rate escalation scenario (attributed to high future oil and gas prices); low rate escalation scenario (attributed to low economic growth). At present, the analysis uses a very rough approximation for the price and escalation of Renewable Natural Gas (RNG): a simple multiple of natural gas prices.

## LCCA Model Intro

| | | |
|---|---|---|
| OVERVIEW | | This LCCA is a tool to compare the financial outcomes of distinct future scenarios over the study's 30-year period: Business as Usual (BAU) vs. proposed Carbon Neutral (CN) energy systems. The BAU case includes baseline costs to maintain (and replace when necessary) existing energy infrastructure and purchase utilities (e.g. electricity, natural gas); the CN case includes costs to construct new energy infrastructure and purchase utilities (e.g. electricity, natural gas). |
| Key Cost Components | Construction Costs | Construction costs (for the proposed CN solutions) largely come from market intelligence gained from Integral's past projects and discussions with vendors; in some instances estimates come from U-M's cost estimates for recent or present projects. >> Risk: As with any large-scale construction project, costs overruns are possible. This risk is addressed by a contingency included in the estimated costs. |
| | Maintenance Costs | Maintenance costs come from a detailed accounting of major existing systems, date installed, expected lifetime, planned replacement, and associated costs. In total, ~425 pieces of equipment (chillers, boilers, and turbines) were analyzed. >> Risk: Forecasting energy system replacement timelines and costs is very difficult. |
| | Utility Costs | Electricity and natural gas costs come from U-M's "enterprise rates" (6/20); these rates account for the fuel costs + associated O&M. Forecasted rate escalations come from the "2020 Annual Energy Outlook" from the US Energy Information Administration (EIA). >> Risk Forecasting future commodity prices is very difficult — particularly in an environment of potentially changing regulations related to fossil fuels. |

| | | |
|---|---|---|
| Key LCCA line items. Each of these terms is used in the "SUMMARY" tab. | Discount rate | The discount rate accounts for the time value of money; ex. 4% is roughly U-M's cost of capital |
| | Capital Cost - Carbon Neutral Infra | Total capital costs for the proposed carbon neutral (CN) energy systems |
| | Business As Usual BAU): Existing System Replacement (30-yr) | Known costs to replace and maintain existing energy systems |
| | BAU: Utility Costs (30-yr) | Utility costs with existing energy systems; e.g. est. utility costs if no changes are made |
| | Carbon Neutral Infra (CN): Utility Costs (30-yr) | Utility costs with proposed CN energy systems; e.g. est. future utility costs (after CN transition) |
| | BAU: Life-Cycle Cost (30-yr) | Total cost to maintain existing energy systems + utility costs |
| | CN: Life-Cycle Cost (30-yr) | Total cost to install proposed CN energy systems + utility costs |
| | NPV: Δ CN - BAU | Net Present Value (NPV) is the sum of [CN case] minus [BAU case] |
| | Hypothetical carbon fee | This 'shadow' price of carbon intended to reflect the social cost of carbon. |

** Note: all 30-year costs are discounted using discount rate indicated in Summary tab*

## LCCA Output Summary

| | | |
|---|---|---|
| CENTRAL CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 1,638,641,052** |
| | Business As Usual BAU): Existing System Replacement (30-yr) | $ 252,603,011 |
| | BAU: Utility Costs (30-yr) | $ 1,607,696,641 |
| | Carbon Neutral Infra (CN): Utility Costs (30-yr) | $ 1,110,372,869 |
| | BAU: Life-Cycle Cost (30-yr) | $ 1,860,299,651 |
| | CN: Life-Cycle Cost (30-yr) | $ 2,685,989,265 |
| | NPV: Δ CN - BAU | $ (825,689,614) |
| NORTH CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 904,455,068** |
| | BAU: Existing System Replacement | $ 163,178,529 |
| | BAU: Utility Costs | $ 653,890,585 |
| | CN: Utility Costs | $ 445,837,703 |
| | BAU: Life-Cycle Cost | $ 817,069,114 |
| | CN: Life-Cycle Cost | $ 1,315,506,038 |
| | NPV: Δ CN - BAU | $ (498,436,923) |
| ATHLETIC CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 432,595,878** |
| | BAU: Existing System Replacement | $ 6,271,869 |
| | BAU: Utility Costs | $ 102,238,091 |
| | CN: Utility Costs | $ 58,165,675 |
| | BAU: Life-Cycle Cost | $ 108,509,960 |
| | CN: Life-Cycle Cost | $ 474,123,250 |
| | NPV: Δ CN - BAU | $ (365,613,289) |
| FLINT CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 233,113,540** |
| | BAU: Existing System Replacement | $ 6,716,891 |
| | BAU: Utility Costs | $ 63,144,149 |
| | CN: Utility Costs | $ 37,137,198 |
| | BAU: Life-Cycle Cost | $ 69,861,040 |
| | CN: Life-Cycle Cost | $ 261,284,833 |
| | NPV: Δ CN - BAU | $ (191,423,793) |
| DEARBORN CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 184,323,984** |
| | BAU: Existing System Replacement | $ 870,984 |
| | BAU: Utility Costs | $ 41,570,741 |
| | CN: Utility Costs | $ 2,336,047 |
| | BAU: Life-Cycle Cost | $ 42,441,725 |
| | CN: Life-Cycle Cost | $ 179,570,647 |
| | NPV: Δ CN - BAU | $ (137,128,922) |
| EAST MED CAMPUS | **CAPITAL COST - CARBON NEUTRAL INFRA** | **$ 73,804,744** |
| | BAU: Existing System Replacement | $ 870,984 |
| | BAU: Utility Costs | $ 53,532,867 |
| | CN: Utility Costs | $ 35,690,634 |
| | BAU: Life-Cycle Cost | $ 54,403,851 |
| | CN: Life-Cycle Cost | $ 106,656,734 |
| | NPV: Δ CN - BAU | $ (52,252,883) |

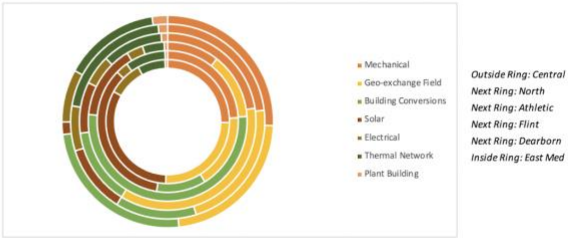
| | | |
|---|---|---|
| **TOTAL CAPITAL COST** | **$ 3,466,934,267** | |
| **TOTAL NPV** | $ (2,070,545,425) | |
| Discount rate | 4.0% | *<-- user can adjust this figure* |

| | | Simple payback (yrs) |
|---|---|---|
| Total Utility Savings (nom) | $ 1,696,892,582 | 61 |
| Total Utility Savings (dis) | $ 832,532,948 | |
| Utility Savings - w carbon tax (nom | $ 3,394,954,681 | 31 |
| Carbon tax (hypothetical) | $ 200 | *<-- user can adjust this figure* |

**Cost Category Breakdown**

| *$ shown in millions* | Central | North | Athletic | Flint | Dearborn | East Med | TOTAL |
|---|---|---|---|---|---|---|---|
| **Low Carbon Plants** | $ 478 | $ 303 | $ 129 | $ 53 | $ 89 | $ 38 | $ 1,090 |
| *Mechanical* | *$ 323* | *$ 161* | *$ 75* | *$ 19* | *$ 34* | *$ 14* | $ 626 |
| *Electrical* | *$ 101* | *$ 52* | *$ 18* | *$ 6* | *$ 4* | *$ 5* | $ 186 |
| *Solar* | *$ 24* | *$ 79* | *$ 31* | *$ 27* | *$ 49* | *$ 18* | $ 228 |
| *Plant Building* | *$ 30* | *$ 11* | *$ 4* | *$ 1.3* | *$ 0.9* | *$ 0.4* | $ 48 |
| **Geo-exchange Field** | $ 286 | $ 154 | $ 120 | $ 24 | $ 24 | $ 14 | $ 622 |
| **Thermal Infrastructure Network** | $ 185 | $ 145 | $ 37 | $ 8 | $ 13 | $ 4 | $ 392 |
| **Building Conversions** | $ 312 | $ 94 | $ 47 | $ 94 | $ 16 | $ - | $ 563 |
| Subtotal Before Contingencies | $ 1,261 | $ 696 | $ 332 | $ 179 | $ 141 | $ 55 | $ 2,665 |
| **TOTAL PROJECT COST** | **$ 1,639** | **$ 904** | **$ 433** | **$ 233** | **$ 184** | **$ 74** | **$ 3,467** |

**Capital Cost Breakdown by Major Line Item**



## Appendix E: Heat and Power Infrastructure Strategies Evaluation Criteria

**Heat and Power Infrastructure**

**Preliminary Draft Recommendation:** *Embark upon a phased, district-level approach to converting U-M's heating and cooling infrastructure to be fossil fuel-free, beginning with electrified systems centered on geo-exchange with heat recovery chiller technology, and with the flexibility to pivot to other proven technological solutions as they emerge.*

*Carbon Neutrality Impacts*

GHG emissions projections are highly dependent on the grid electricity emissions factor, which in turn depends on the size, type, and operating schedules of different generating facilities. U-M's current grid emissions factor is currently relatively high compared to the national average, and very high compared to areas of the country with abundant renewable energy. However, U-M's grid emissions factor will decline over the coming decades as DTE and Consumers Energy decarbonize their electricity supply. The PCCN's emission trajectory model factors in how the grid emissions factor is projected to evolve going forward. The choices made for phasing should consider the relative carbon intensity of current electricity sources (e.g., Central Power Plant (CPP) vs. DTE grid) over time.

The Proposed New Systems scenario includes reductions from onsite photovoltaic generation, though it should be noted that the same level of emissions reduction could be achieved if the university decided not to install onsite photovoltaic generation and instead purchased an equivalent amount of renewable electricity from the grid that meets all standards for carbon offsets, in particular additionality, articulated by the Commission in the Carbon Offsets and Sinks section. If the University decided against installing onsite photovoltaic generation or purchasing an equivalent amount of renewable electricity from the grid, the total GHG emissions with the proposed new geo-exchange systems would still be lower than the University's Business-as-Usual GHG emissions.

*Equity and Justice Considerations*

The Commission has identified three primary equity and justice considerations for this Preliminary Draft Recommendation:

1. Locally generated electricity and thermal energy (including renewables) could benefit the local economy by creating construction jobs in the short term.
2. This proposal will reduce the amount of natural gas and fuel oil burned in Ann Arbor, Dearborn and Flint and will replace that energy with clean electricity. This will result in local health benefits from cleaner air.
3. Funding sources and mechanisms are not equivalent for the three campuses. To maintain an equitable share of burden, centralized planning and resource allocation should be instituted with representation from all campuses.

*Regional Community Involvement*

This is an extraordinary endeavor that will require cooperation with the surrounding communities. U-M will need to work with its utility providers, regulators, and surrounding

communities to ensure that the campus transformation does not have adverse effects on the surrounding areas.

*Scalable and Transferable*

Geo-exchange technology is a feasible solution to decarbonize U-M's heat and power infrastructure. Although geo-exchange has been demonstrated at scales similar to that of one of the smaller U-M's campuses, a project the scale of all six U-M campuses does not exist. If U-M were to undertake this project, it would be a leader and model to other institutions and communities. The campus-level approach of this recommendation is scalable and transferable as it allows institutions of various sizes and building types to find a comparable model to their situation in one of the six U-M campuses, though land constraints can limit viability.

*U-M Community Participation and Accountability*

The required construction would result in a significant amount of disruption of roads, buildings, fields, lawns and parking lots across all six U-M campuses. Much of the proposed infrastructure improvements, including geo-exchange technology, is not visible to the eye once installed. However, signage and other communications tools throughout the campus could draw attention to the geo-exchange system and educate the community about its benefits. Including other renewable technologies in the implementation plan, such as photovoltaics, would communicate U-M's commitment to carbon neutrality.

*Financial Considerations*

The chart below shows the Commission's consultant's high-level estimated projected cost for the proposed project. Actual costs would need to be determined over time through detailed engineering studies and contractor bids. Uncertainties exist which could affect the cost of the project, including availability of governmental subsidies for clean energy projects, variable construction costs, and electric infrastructure. Using traditional analysis, the nominal payback period based on these high-level estimates would be 61 years; the 30-year NPV is $2.01B.

## Appendix F: University-owned Vehicles and Maintenance Equipment Emissions Reduction Strategies Evaluation Criteria

### University-owned Vehicles and Maintenance Equipment

**Preliminary Draft Recommendation:** *The university should convert its entire vehicle fleet – automobiles, trucks and buses – and all maintenance equipment to be electric-powered.*

*Carbon Neutrality Impacts*

Replacing a single BlueBus with an eBlueBus on the Ann Arbor campus would reduce combined Scope 1 and Scope 2 emissions by 60% relative to the current average emissions from a diesel bus. Emission reductions from bus electrification will start small but accelerate as the electric grid is decarbonized, offering a cumulative abatement of about 44,000 tCO2e by 2040. Further reductions could be realized through grid decarbonization at a rate faster than currently planned in DTE and Consumers Energy's articulated goals for reducing its CO2 emissions.

On the Dearborn campus, the emissions reduction potential for replacing the UM-Dearborn shuttles with an electric shuttle would reduce emissions by 0.65 tCO2e/day.

*Equity and Justice Considerations*

Campus buses serve individuals from all U-M demographic groups and are relied upon by individuals who lack access to automobiles. Replacing diesel buses with electric buses will maintain the equity and social justice features of U-M's mass transit services. Further, because electric buses avoid the local air pollution and direct individual exposure to toxic exhaust caused by the existing diesel buses, the electric buses will enhance the welfare for the demographic groups that rely on U-M bus services.

*Regional Community Involvement*

The timing and scale of these transitions may also be affected by the political landscape and associated incentives. Efforts to transform U-M's transit system should be done in partnership with other key stakeholders in the region (e.g., cities, utilities) to optimize transit solutions at the local and regional level. Early movement by U-M could accelerate broader uptake of these technologies in the region. Further, as the University considers the conversation to electric buses, opportunities to partner in the deployment of charging infrastructure should be explored with DTE, Consumers Energy, and third-party charging station companies.

*Scalable and Transferable*

Electrifying the U-M bus fleet and shuttle buses will help to increase the already growing scale of electric transit bus use in the United States. It would also position U-M as a leader in U-M's region, providing operational experience that can be transferred to the AAATA and other regional transit agencies.

*U-M Community Participation and Accountability*

The Commission foresees no particular issues related to campus culture beyond those customary for the operation and use of the Blue Bus and shuttle bus services. The bus systems are widely used and highly visible to the community and would be a strong signal of U-M's commitment to carbon neutrality. Should en-route fast-charging be considered in the future, there may be impacts to scheduling due to needs to recharge en-route; a matter that would require some communication with the campus community.

*Financial Considerations*

An earlier analysis concluded that an eBlueBus currently exceeded the cost of a conventional diesel bus by $375,000. However, the estimated operations and maintenance savings were $30,00 per year for an average bus route. Additional analysis is also necessary to determine the financial savings associated with replacing the UM-Dearborn campus shuttle buses and the U-M Connector buses. The Commission is certain that electric bus and vehicle prices will fall over time, although are uncertain of the rate at which they will fall.

## Appendix G: Purchased Electricity Emissions Reduction Strategies Evaluation Criteria

### Purchased Electricity

**Preliminary Draft Recommendation:** *Issue a Request for Proposals (RFP) to procure all purchased electricity for U-M's three campuses in a manner that generates Renewable Energy Certificates that are retired by U-M or on its behalf, and aligns with the principles outlined by the Commission.*

**Preliminary Draft Recommendation:** *Engage with the cities of Ann Arbor, Dearborn, Detroit, and Flint, and other entities that are, or could be partners in, advocating for renewable electricity policy changes in the State of Michigan to better understand their perspectives, conduct necessary due diligence, and potentially partner in advocacy efforts that reflect mutually-shared objectives, as well as actively explore ways to partner directly in pursuit of carbon neutrality goals.*

*Carbon Neutrality Impacts*

If U-M sources all purchased electricity from renewable sources, this would result in a 405,000 $MTCO_2e$ reduction below FY19 levels.

*Equity and Justice considerations:*

Early moves by U-M and other large institutions across the State will demonstrate that significant demand exists for renewable electricity solutions, which should help to accelerate the retirement of coal plants in Michigan. Such an effect should decrease associated health risks, primarily for lower income and disadvantaged populations who live close to coal-fired power plants.

*Regional Community Involvement*

Efforts to source 100 percent of U-M purchased electricity from renewable sources could be done in a variety of ways. Depending on the selected option(s), U-M should partner with other key stakeholders in the region (e.g., cities, utilities) to optimize renewable energy solutions at the local and regional level. Swift movement by U-M could accelerate broader renewables uptake in the region. U-M should also engage with the cities of Ann Arbor, Dearborn, Detroit, and Flint, and other entities that are, or could be partners in, advocating for renewable electricity policy changes in the State of Michigan.

*Scalable and Transferable*

Renewable energy generation (particularly solar photovoltaics) is the fastest growing segment of the energy mix in the US. U-M's purchasing power and size could help to accelerate both DTE and Consumer Energy's plans to transition their generation to renewable electricity sources. If replicated at significant scale, these large investments in utility-scale solar should also further reduce costs, making other applications like rooftop solar more affordable for commercial facilities and residences across the state and nation. Additionally, policy changes

related to renewable electricity in the State of Michigan will likely expand the ability for municipalities to reduce their GHG footprint through renewable electricity procurement.

*U-M Community Participation and Accountability*

In general, purchased electricity has low visibility and thus has minimal implications for campus culture. Therefore, to the extent possible, investments in renewable electricity should be paired with research and education opportunities for U-M faculty, students, and the broader communities surrounding U-M's campuses. Additional campus culture benefits could be realized through visible projects on U-M structures and lands. The community can be made aware of the impact of renewable energy generation on campus by mounting displays in buildings that give quantitative data of the amount of electricity being locally generated (see for example the display in Pierpont Commons relating to the DTE solar field on North Campus).

*Financial Considerations*

Despite the rapidly declining costs of renewable electricity in recent years, current programs such as MIGreenPower and SolarGardens still have a significant price premium over U-M's standard electricity tariff, which includes a diverse mix of fuels (e.g., nuclear, coal, natural gas). The timing and structure of investments in renewable electricity will need to take into consideration projected future cost trends. It should also be noted that transformation of U-M's heat and power infrastructure (Scope 1 Recommendation) will nearly eliminate our reliance on combusting natural gas. This, however, will also have the effect of significantly increasing the need for electricity required to power U-M's campus. Purchased electricity demand can be reduced by generating renewable electricity on campus, or on nearby properties acquired for that purpose. However, economies of scale make larger solar installations more cost-effective than smaller projects. Further investigation is required to determine the cost/benefit of the installation of renewables on our three campuses.

## Appendix H: Demand-side Management Strategies Evaluation Criteria

### Revolving Energy Fund

**Preliminary Draft Recommendation:** *Create a Revolving Energy Fund (REF) on each of U-M's three campuses.*

*Carbon Neutrality Impacts*

Based on the energy consumption policies (ECP) analysis estimates, an REF with $25 million of seed funding on the Ann Arbor campus is expected to reduce U-M Ann Arbor Scope 1 and Scope 2 emissions by 25% through energy conservation projects over 10 years. After 10 years of operation, annual emissions are projected to be 104,727 $MTCO_2e$ less than they were at the start of the 10-year period.

It is estimated that REF programs will result in 25% emissions reduction over 10 years at Dearborn and Flint. Due to incomplete data from the Dearborn and Flint campuses, the Commission recommends U-M begin by expanding the data collection capabilities at these campuses.

*Equity and Justice considerations*

All units will receive equal support from their regional energy manager to identify energy efficiency projects. This means that all units will have an equal opportunity for receiving funds from the REF based on the need of their building(s) and the merits of their proposals. Units with buildings that have not been recently renovated will have a greater need for project funds than units with newly renovated buildings. There may also be opportunities to extend this approach to support external projects in low-income communities, perhaps supported with donor funding, where there are explicit research and learning components that contribute to the mission of the university.

*Regional Community Involvement*

As stated above, there may be opportunities to extend REF funds to support external projects in low-income communities where there are explicit research and learning components. The university should seek to partner with the surrounding community on such projects.

*Scalable and Transferable*

Through the ECP analysis team's benchmarking, the team noted that 20 institutions have instituted REFs, although the specific details of each REF was difficult to acquire. U-M could scale and transfer their REF program by making their operational details available online. For this purpose, a single point of contact should be listed to answer relevant questions. Beyond that, the REF is a concept that can be applied to institutions and communities at any scale, and hence is readily transferable. The REF also offers potential partnership opportunities with U-M's electricity providers. For example, DTE has expressed that they may be willing to: a) sponsor a second level study to go deeper into programmatic designs and financial implications for all parties; b) establish a special energy efficiency incentive design offering as a motivation for early adopters in the REF initiative; c) provide additional technical support and/or leverage of

the Michigan Saves energy efficiency loan financing program (already in place and active with DTE's C&I energy efficiency program), and/or d)
supporting funding to the REF via a new vehicle working in conjunction with DTE's energy efficiency programs (and subject to regulatory approval).

*U-M Community Participation and Accountability*

The REF will empower university units to take ownership of their building's energy efficiency through identifying and creating their own energy conservation measure project proposals. This provides local control and benefits for the most active units. The REF and the ECM projects that result also present research and learning opportunities for faculty and students.

*Financial Considerations*

Consistent with the ECP analysis team, the Commission recommends $2.2 M in seed funding for the Dearborn REF, and $2.4 M in seed funding for the Flint campus. The Commission suggests an REF on the Ann Arbor campus with at least $25 million in seed funding.

## Carbon Pricing

**Preliminary Draft Recommendation:** *Establish a carbon pricing system across U-M where the revenue funds new energy conservation measures.*

*Carbon Neutrality Impacts*

Once the full carbon price is established, the energy conservation policies (ECP) analysis team estimates a 51 percent baseline reduction in Scope 1 and Scope 2 carbon emissions over 10 years, with a cumulative abatement of approximately 943,000 $MTCO_2e$ over 10 years of implementation on the Ann Arbor campus.

*Equity and Justice Considerations*

This system seeks to address equity issues head on by having entities bear the social costs of carbon that are attributable to their activities. However, consideration needs to be given to interdepartmental differences among the various campuses and their units. Initially, more efficient buildings will have the advantage of paying less, however, less efficient buildings will receive a larger amount of direct return funds and will have more competitive projects for consideration if the REF is implemented. In addition, there are equity considerations to address with respect to different types of units (e.g., high vs. low energy intensity operations). Special attention must also be paid to its implementation at Dearborn and Flint given their different budget allocation models. For example, all utility and building budgets at U-M Flint are centralized, and hence a direct replication of what works at Ann Arbor must be modified to provide correct incentives to these two campuses.

*Regional Community Involvement*

As this would be an internal budgetary mechanism, there would be limited need for broader engagement around implementation of a carbon price. However, there would be opportunities to discuss the approach with other organizations in the region with an eye toward education and potential replicability.

*Scalable and Transferable*

Through analysis of various carbon pricing tools, the ECP analysis team found that Direct Return funds earmarked for energy efficiency projects provide a novel and equitable incentive structure. U-M could pilot this feature so that peer institutions could learn about the transferability of a carbon price to a large-scale public institution. Implementing this recommendation would be a major contribution to the existing body of knowledge on carbon pricing and a step towards leadership in higher education climate action. When implemented across all three campuses, U-M has a unique opportunity to provide models transferrable to other organizations and campuses of widely differing sizes and budget constructs.

*U-M Community Participation and Accountability*

A carbon price offers a special opportunity to engage all U-M units in the carbon neutrality trajectory. A carbon pricing program will empower individual units and unit leaders to see and understand the implications of their unit's energy consumption, and take necessary action to reduce the unit's consumption. Strong leadership from the President and other campus administrators is required for the success of a sustainable program for carbon pricing. Resistance from U-M units with higher levels of energy intensity is to be expected, but the

proposed proxy price will hopefully help to solve this problem by providing a multi-year pilot that normalizes the concept prior to full implementation with budget implications. To be most effective, a carbon pricing system needs to be highly visible at the unit level to incentivize actions focused on carbon neutrality.

*Financial Considerations*

A fully implemented carbon price of $50/ton would equate to 0.66 percent of the overall U-M budget, though that percentage would vary across units. In general, budget impacts are well below 1 percent for each unit, with only three units above 1 percent. Those units are: the Medical School, the Provost & Executive Vice President for Academic Affairs, and the Vice President for Student Life. For specific information on the estimated budget impact per Ann Arbor Budgeting Unit, see the ECP report, Appendix E.2.

## Appendix I: Building Standards Strategies Evaluation Criteria

### Building Standards

**Preliminary Draft Recommendation:** *Establish Best-in-Class $CO_2$ Emissions Targets Across 9 Building Types for All New Construction and Major Renovations*

*Carbon Neutrality Impact*

Adopting the recommended emissions targets for new construction projects would result in a range of emissions reductions between 20 and 78 percent per building depending on the building type (Table I-1). More details on the emissions targets for new construction can be found in the building standards analysis report, Appendix C. Ultimately, the carbon footprint of a building is directly tied to the carbon footprint of U-M's energy sources and district-level systems that supply the building. The University needs to prioritize decarbonizing its purchased electricity and existing heat and power infrastructure, as called for in the Scope 1 and 2 Recommendations Summary.

***Based on University of Michigan Ann Arbor Campus***
***Recommended Maximum Emissions Targets by Building Type***

| U-M Buildings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Classification | Educational Building (no lab) | Educational Building (low load lab) | Educational Building (high load lab) | Library | Clinical | Residential (dormitory) | Residential (low rise, duplex, single family) | Administrative | Athletic (excluding natatoria) |
| ASHRAE 90.1 2013 | | | | | | | | | |
| kg CO2/sqft | 14.0 | 21.0 | 28.0 | 7.5 | 19.0 | 7.9 | 4.5 | 15.0 | 7.0 |
| Recommended Goal | | | | | | | | | |
| kg CO2/sqft | **10.0** | **16.0** | **21.0** | **6.0** | **15.0** | **5.2** | **1.0** | **10.0** | **5.0** |
| % reduction from ASHRAE 90.1 2013 | 28.6% | 23.8% | 25.0% | 20.0% | 21.1% | 34.2% | 77.8% | 33.3% | 28.6% |

Table I-1. Proposed maxim emissions targets by building type based on the U-M Ann Arbor campus courtesy of the building standards analysis report.

*Equity and Justice Considerations*

The current budget model of the university places most of the economic responsibility for major renovations at the level of its 19 schools and colleges, and on the three individual campuses. The finances of the various schools, colleges, units and campuses differ significantly, and would limit or prevent many from embarking on construction projects that implement carbon minimization strategies. To ensure equity across schools, colleges, units and campuses, and by extension, the academic communities, measures will need to be taken to overcome these inherent economic discrepancies through a centralized implementation process and equitable funding.

*Regional Community Involvement*

As these would be internal building standards, there would be limited need for broader engagement to implement and apply the standards to university buildings. However, if the standards are implemented, there will be an opportunity to share best practices with other like-minded institutions. Additionally, the State of Michigan building standards are currently set at the American Society of Heating, Refrigerating and Air-Conditioning Engineers' (ASHRAE) 90.1

2013. The ASHRAE 90.1 standards have steadily issued revisions to improve energy efficiency standards yet are still a decade away from issuing net-zero energy building standards according to the building standards analysis. U-M has the opportunity to engage with the local and regional communities to advocate for improved building standards at the state level to drive significant carbon reductions beyond the scope of the university.

*Scalable and Transferable*

The nine established building types are representative of most of the built environment. The proposed dynamic modeling methods have strong promise for transferability. The modeling methods will enable peer institutions to implement and apply similar emissions-focused building standards to their new construction and major renovations projects. External engagement related to issues of thermal comfort, the emerging aesthetics of low emissions buildings, and the visibility of these efforts on all three U-M campuses will be an important part of implementation.

*U-M Community Participation and Accountability*

Individual preferences and broader cultural expectations of thermal comfort can significantly influence building performance and energy consumption. Appendix H of the building standards analysis report offers information on the potential impacts of occupant behavior on building performance.

*Financial Considerations*

There is no cost to implement the new standard. However, there is a cost to apply the standard to new construction and renovations. Costs are dependent on the size and type of project, with administrative buildings being the least costly to apply the standard to, and lab and clinical buildings being the most costly. These costs should be met by embedding them in the fund raising for the new constructions, in the same manner as all energy saving and operating costs are now included before a building is permitted to be constructed. More details are available in Appendix C of the building standards analysis report.

## Appendix J: Art & Architecture Building Energy Efficiency Study

### Introduction & Scope

This Building Efficiency Study focused on the original Art & Architecture Building (A&A Bldg), circa 1971. The focus of the study was to develop strategies to significantly reduce energy use and maximize the reduction of carbon emissions. The building was evaluated for Energy Conservation Measures (ECM) that were applicable to this type of structure and building use. Please note the recent 2017 addition was not included within this study. The design team started by visiting the building, collecting existing utility data, and reviewing the existing drawings. Their initial task was to determine how the current building was performing, to set a benchmark for comparison.

Then the team developed eleven (11) individual ECMs, and three (3) combined ECMs that were evaluated and cost-estimated. The ECM strategies included mechanical and electrical building systems, the building enclosure itself, as well as various combinations of the individual ECMs. A summary of the ECMs is contained on pages 4-13 of the report. More in-depth descriptions of each of the ECMs can be found on pages 25-30, including explanatory graphics. The combined ECMs were as follows:

- ECM Scenario A: This ECM reflects a combination of ECMs that the team estimated would typically be done under current UM Design Guidelines during a building renovation.
- ECM Scenario B: This ECM reflects a combination of ECMs selected to produce the maximum reduction in carbon.
- ECM Scenario C: This ECM combination is the same as ECM B but with no photovoltaics (PV)

To be judicious with the budget and schedule allocated for the study, shoebox (simplified) energy modeling was employed to compare the original building energy performance with the proposed ECM energy performance.

### Project Costs

To determine the estimated Project Costs of the various scenarios, the team worked with a Construction Manager to develop high-level construction cost estimates (see Exhibit 6 – Costs Analysis, the Opinion of Probable Cost (OPC). Although the OPCs could be perceived as high when comparing specific ECMs to various benchmarks, it's important to consider that these estimates take into account the specific existing conditions at the A&A Building and include the full scope of associated work in the A&A Building to implement the ECMs. The full scope of this associated work is detailed in the Report and Appendix, and provides a comprehensive understanding of the full scope of associated construction work that is required to implement each ECM. The total estimated Project Costs for the scenarios include the estimated construction costs, related construction costs (such as hazardous materials abatement and City utilities costs), contingencies, and professional fees and therefore represents the total costs anticipated to implement the various ECMs and bundled ECM scenarios.

### Analysis of the ECMs

As noted, the study looked at the simple payback for each of the ECMs. The study calculated simple payback in years as the difference between the Project Cost divided by the Annual Energy Cost savings. The simple paybacks assumed the existing system(s) did not need to be replaced. This assumption produces long simple paybacks. A comparative example would be replacing your home's windows solely for the purpose of gaining the benefit of improved energy efficiency. The EUI (energy use per square foot per year) was calculated for each of the ECMs. The most promising and compatible discipline ECMs were combined and then analyzed via a very high-level Life Cycle Cost (LCC) analysis for comparative purposes, see pages 41 & 42 of the report. LCC is a method for assessing the total cost of ownership in present value terms, which takes into account all costs of acquiring, owning, and disposing of a building or building system. The tables below summarize the results of the Simple Payback and Life Cycle Costs analysis for each of the ECM scenarios.

**ART & ARCHITECTURE INDIVIDUAL ECM STRATEGIES**

| | Energy Conservation Measure | EUI (kBtu/sf) | % Energy Savings | CO2 (tons/year) | % CO2 Savings | Annual Energy Cost | Annual Energy Cost/SF | % Cost Savings | Project Cost* | Simple Payback (Years) |
|---|---|---|---|---|---|---|---|---|---|---|
| Existing Condition | NA | 175 | - | 3,251 | - | $ 338,377 | $ 1.46 | - | - | - |
| HVAC Systems | HVAC-1 DOAS, Chilled Beams | 136 | 22% | 2,566 | 21% | $ 270,858 | $ 1.17 | 20% | $ 55,566,000 | 823 |
| | HVAC-2 DOAS, Chilled Boxes & Chilled Beams | 129 | 26% | 2,478 | 24% | $ 264,866 | $ 1.14 | 22% | $ 54,831,600 | 746 |
| | HVAC-3 DOAS, Chilled Sails, Destrat Fans | 98 | 44% | 2,019 | 38% | $ 225,756 | $ 0.98 | 33% | $ 58,378,050 | 518 |
| | HVAC-4 DOAS, Water-Source VRF (high-lift transfer) | 49 | 72% | 1,910 | 41% | $ 275,688 | $ 1.19 | 19% | $ 61,956,900 | 988 |
| ELECT Systems | ELECT-1 PV | 153 | 13% | 2,381 | 27% | $ 212,726 | $ 0.92 | 37% | $ 16,152,750 | 129 |
| | ELECT-2 LED | 173 | 1% | 3,128 | 4% | $ 319,115 | $ 1.38 | 6% | $ 17,346,150 | 901 |
| ARCH Systems | ARCH-1 New Curtain Wall | 168 | 4% | 3,070 | 6% | $ 316,423 | $ 1.37 | 6% | $ 18,835,200 | 858 |
| | ARCH-2 High Performance Curtain Wall | 164 | 6% | 3,012 | 7% | $ 310,565 | $ 1.34 | 8% | $ 22,512,600 | 809 |
| | ARCH-3 High Performance Skylights | 173 | 1% | 3,191 | 2% | $ 331,494 | $ 1.43 | 2% | $ 4,126,950 | 600 |
| | ARCH-4 10% Existing Glazing Reduction | 170 | 3% | 3,137 | 4% | $ 325,487 | $ 1.41 | 4% | $ 1,482,300 | 115 |
| | ARCH-5 - Alt 1 Brick Reskin, High Perf Curtain Wall & Skylights, 10% Glazing Reduction | 141 | 19% | 2,595 | 20% | $ 269,151 | $ 1.16 | 20% | $ 40,729,500 | 588 |
| | ARCH-5 - Alt 2 Rainscreen Reskin, High Perf Curtain Wall & Skylights, 10% Glazing Reduction | 141 | 19% | 2,595 | 20% | $ 269,151 | $ 1.16 | 20% | $ 39,756,150 | 574 |
| | ARCH-5 - Alt 3 Metal Panel Over Existing Brick, High Perf Curtain Wall & Skylights, 10% Glazing Reduction | 141 | 19% | 2,595 | 20% | $ 269,151 | $ 1.16 | 20% | $ 38,568,150 | 557 |

Natural Gas Rate: $3.40/Mcf
Electricity Rate: $0.086/kWh
*Project Cost based on Walbridge Cost Estimate V2 dated 6/2/2020

*Table A: Individual ECM Strategies*

| ART & ARCHITECTURE COMBINED ECM STRATEGIES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Energy Conservation Measure** | **Description** | **EUI** (kBtu/sf) | **% Energy Savings** | **CO2** (tons/year) | **% CO2 Savings** | **Annual Energy Cost** | **Annual Energy Cost/SF** | **% Cost Savings** | **Project Cost** | **Simple Payback** (Years) |
| **Existing Condition** | Dual Duct AHU, Cooling Towers, Chillers, Steam Boilers, Lighting at 0.8 W/sf, Original Envelope at 0.75 CFM/sf leakage factor | **175** | **-** | **3,251** | **-** | **$ 338,377** | **$ 1.46** | **-** | **-** | **-** |
| **Combined ECM-A** HVAC-2, ARCH-2, ELEC-2 | DOAS, Chilled Boxes, High-Perf. Curtain Wall, LED | **115** | **34%** | **2,266** | **30%** | **$ 246,305** | **$ 1.06** | **27%** | **$ 87,879,600** | **954** |
| **Combined ECM-B** HVAC-4, ARCH-5, ELEC-1, ELEC-2 | VRF (high-lift), HP Wall/Sky, 10% Glazing, Brick, LED, PV | **19** | **89%** | **735** | **77%** | **$ 105,981** | **$ 0.46** | **69%** | **$ 114,238,350** | **492** |
| **Combined ECM-C** HVAC-4, ARCH-5 | VRF (high-lift), HP Wall/Sky, 10% Glazing, Brick, LED, No PV | **41** | **77%** | **1,605** | **51%** | **$ 231,632** | **$ 1.00** | **32%** | **$ 107,558,550** | **1,008** |
| Natural Gas Rate: $3.40/Mcf<br>Electricity Rate: $0.086/kWh<br>*Project Cost based on Walbridge Cost Estimate V2 dated 6/2/2020 | | | | | | | | | | |

*Table B: Combined ECM Strategies*

| Life Cycle Cost Summary (1) | | | |
|---|---|---|---|
| **Energy Conservation Measure** | **Project Cost** | **Life Cycle Cost** | **Total CO2 (3)** |
| Existing Bldg. Condition | - | (2) | 97,530 |
| ECM-A | $87,879,600 | $95,848,168 | 67,980 |
| ECM-B | $114,238,350 | $120,530,681 | 22,050 |
| ECM-C | $107,558,550 | $115,744,291 | 48,150 |

(1) 30-year life cycle

(2) Not provided as not comparable to ECM A, B, C.

(3) 30-year total CO2 emissions in tons (lower values are better). An approximation provided for comparative purposes only; does not adjust for reductions in CO2 emissions associated with DTE electricity production anticipated to occur over the 30-year period.

## Conclusion

There are opportunities to reduce the carbon emissions of the A&A Building significantly.

## Appendix K: Commuting Emissions Reduction Strategies Evaluation Criteria

**Commuting**

**Preliminary Draft Recommendation:** *Reform the University's parking policy on each of U-M's three campuses and reduce or eliminate incentives for personal vehicle commuting.*

*Carbon Neutrality Impact*

A conservative estimate of the Ann Arbor component of the parking policy reform could result in a carbon reduction of 6,300 $MtCO_2e$/year, or 6 percent of the carbon impact of the faculty and staff commute to the Ann Arbor campus.

*Equity and Justice Considerations*

Linking parking charges to the commuter's income is necessary to ensure that the impacts of the proposed changes do not fall to those least able to afford them. Low-income staff are challenged by Ann Arbor's high cost of living. Many live in outlying communities and have a relatively long-distance commute.

*Regional Community Involvement*

As this recommendation is for internal parking policy reform, there would be limited need for broader engagement around implementation. However, there would be opportunities to discuss the U-M's parking policy reform with other organizations with an eye toward education and potential replicability.

*Scalable and Transferable*

No single institution has combined all of the recommended parking reform policies, so this is an opportunity for U-M to lead by employing all of the proposed parking policies for optimal carbon emissions reductions. The Commission also recommends that U-M partner with the City of Ann Arbor to coordinate complementary and mutually reinforcing EV charging infrastructure plans. Additionally, U-M should make sure to share knowledge gained with other communities in the region. Transforming the parking system could also provide research opportunities to generate findings that could inform improvements and promote potential replicability at other institutions.

*U-M Community Participation and Accountability*

Faculty and staff frequently expect available parking within an easy walk of their workplace, an expectation that pushes parking system expansion. This recommendation represents a shift toward alternatives to parking and toward efficient parking-system management.

*Financial Considerations*

To install gates on un-gated lots will require an infrastructure investment. This cost can be avoided if un-gated lots opt to use hang tags instead. The suggested changes to the parking program will have revenue impacts to the University Parking system. The Parking System is self funded and parking revenue is essential for paying the debt service on parking structures and lots, capital maintenance, and daily operating costs. Parking revenues are also used to fund current Alternative Transportation programs like MRide for free access to U-M staff on AAATA's

bus system, Vanpools and studies for alternative transportation programs. The University has also directed parking funds to support other university initiatives like Recreations Sports. $30 million dollars annually is generated from the parking program that supports the above programs/functions. This suggested change to the parking program will have revenue impacts to the University Parking system. The Parking System is self-funded and parking revenue is essential for paying the debt service on parking structures and lots, capital maintenance, and daily operating costs. Parking revenues are also used to fund current Alternative Transportation programs like MRide for free access to UM staff on AAATA's bus system, Vanpools and studies for alternative transportation programs. The University has also directed parking funds to support other university initiatives like Recreations Sports. $30 million dollars annually is generated from the parking program that supports the above programs/functions.

**Preliminary Draft Recommendation:** *Expand the availability of electric vehicle charging stations across all three U-M campuses.*

*Carbon Neutrality Impact*

EV adoption by 20% of long-distance faculty and staff commuters would result in a reduction of 9,200 mtCO2/year in 2030. This is equivalent to approximately 10% of current commuting emissions.

*Equity and Justice Considerations*

To ensure charging access for all employees, the Commission recommends charging stations be evenly distributed across permit types, and that 4% of charging spaces be ADA accessible. The Commission also recommends the creation of a permit to reserve charging stations for those who own an EV and commute from outside Ann Arbor.

*Regional Community Involvement*

U-M should explore partnerships with the local utilities that assist the U-M community members to invest in home charging systems for the EVs. These charging stations will allow the U-M community to charge their vehicles at off-peak hours, thus reducing the need for incremental electricity infrastructure to meet electric vehicle demand during peak times.

*Scalable and Transferable*

EV readiness is a key area in which U-M can constructively engage with the broader community and business partners in the automotive, electric utility and related industries. The Commission recommends U-M continue to pursue these partnerships to assist in scaling EV readiness across the state and region.

*U-M Community Participation and Accountability*

EV chargers will be visible to the broader community, and create a signal for U-M’s commitment to carbon neutrality.

*Financial Considerations*

To install the proposed number of EV chargers on campus would require an initial investment of approximately $4 million. This investment would support a 20 percent EV adoption rate of long-

distance commuters by 2030. On-campus EV chargers would require approximately $73,000 per year in maintenance costs. The Commission advises against offering free EV charging for U-M community members because it provides an incentive for people to take personal transportation over mass transit and human-powered options. For charging stations that are powered by the grid, charging fees should vary based on the time of day and overall electricity demand. In other words, the charging fees should be highest during peak load periods and lowest when grid demand is at its lowest level.

**Preliminary Draft Recommendation:** *Invest in affordable and accessible alternatives to the personal vehicle commute.*

*Carbon Neutrality Impact*

The commuting analysis team estimated emissions reduction of 8,200 mtCO2e/year for expanding rideshare programming across all three U-M campuses, and reduction of 50 mtCO2e/year for universal transit access at UM-Dearborn and UM-Flint. The commuting team also estimated 1,500 mtCO2e/year reduction from cycling improvements on the Ann Arbor and Dearborn campus. For the full carbon accounting methodology, see here.

*Equity and Justice Considerations*

Increased opportunities for alternatives to driving alone will help save commuters commuting costs, particularly for lower-salaried commuters from farther away. The universal-access program will give the U-M community visible and viable commute alternatives. Additionally, cycling infrastructure will improve campus access and safety. A bike service center will offer students and employees easy access to maintenance and cycling information.

*Regional Community Involvement*

There are significant opportunities to engage the local and regional community around alternatives to the personal vehicle commute. On the Ann Arbor campus, the university will need to engage significantly with the City of Ann Arbor, Ann Arbor Township, and the Michigan Department of Transportation to ensure that the U-M connector system aids in transit movements to campus in addition to serving as an intercampus shuttle. U-M should also seek to engage with the City of Ann Arbor as it expands its cycling infrastructure.

On the Dearborn campus, the university should work closely with the City of Dearborn to explore opportunities for partnership around the City of Dearborn's Multimodal Plan.[39]

On the Flint campus, the university should work closely with the City of Flint to understand the community's needs and priorities and identify areas for partnership relating to public transportation.

*Scalable and Transferable*

The value of universal-access agreement can grow over time if U-M pursues the development of park and ride services that specifically serve hubs where students, faculty and staff live.

[39] City of Dearborn. (2019, June 6). *City of Dearborn Multimodal Plan*. City of Dearborn Multimodal Plan. Retrieved November 30, 2020, from https://walkbike.info/Dearborn/plan/

Integration of the UM-Connector with the broader public-transit environment can occur in phases, with the U-M connector potentially beginning on U-M land as an exclusively university project. The proposed cycling policies will help to build a strong working relationship between the cities of Ann Arbor, Dearborn and U-M around transportation. This relationship could be mobilized for further improvements such as a bikeway between Ann Arbor and Ypsilanti. Further development/refinement of the above recommendations would benefit from increased engagement with the communities surrounding U-M's three campuses.

*U-M Community Participation and Accountability*

A focus group and survey in Dearborn found that 1) there is a prevalent campus culture of driving to work, and 2) there is also an interest in using the bus; and 3) there are significant barriers to riding the bus. Ongoing engagement and marketing campaigns are needed to help overcome these barriers.

*Financial Considerations*

Costs range significantly, with the lowest cost proposal being the rideshare programming and highest cost proposal being the UM-Connector.

**Preliminary Draft Recommendation:** *Prioritize central locations for construction projects and consider expanding on-campus housing for faculty, staff and students at the campus periphery.*

*Carbon Neutrality Impact*

The emissions-growth-mitigating impact of focusing future Ann Arbor campus expansion in central locations is estimated at 900 $mtCO_2e$ per year for each 1,000 employees located in central, rather than peripheral, locations. Full analysis and estimates of direct effects of housing development on the carbon impact of the commute are presented in the commuting analysis report.

*Equity and Justice Considerations*

Housing programs promote equity differently in the three campuses. Housing expansion in Ann Arbor can help expand affordable options locally even as it sharply reduces commuting costs for residents. In Flint, policies to encourage local residence can be a force for urban revitalization. In Dearborn, policies to encourage nearby residence can significantly lower the cost of living for employees and students through reduced commute costs. Some housing units can be set aside for leasing or renting at affordable rates. For example, University of California Santa Cruz groups employees based on income and ensures each group receives a certain percentage of on campus housing.

*Regional Community Involvement*

As this recommendation is focused on U-M campus expansion, there would be limited need for broader engagement around implementation. However, the findings of the housing exploration process may be relevant to the surrounding communities and their housing market. There may be opportunities to partner with the surrounding community on housing developments.

*Scalable and Transferable*

Enhanced and creative construction and housing policies have the potential to scale and transfer to U-M's peer institutions. Affordable housing close to university campuses can be a challenge at many major universities.

*U-M Community Participation and Accountability*

Prioritizing central locations for construction projects offers the best alternatives for non-automotive commuting and hence the best potential for University growth while minimizing the increase in carbon emissions from the commute.

*Financial Considerations*

Consistent with past practice, the cost of student housing should be net-zero to keep education as affordable as possible. Housing development on University-owned land in Ann Arbor could be a revenue-generating program.

## Appendix L: University-Sponsored Travel Emissions Reduction Strategies Evaluation Criteria

**University-Sponsored Travel**

**Preliminary Draft Recommendation:** *Standardize travel data collection to facilitate carbon footprint calculation and provide feedback to travelers*

**Preliminary Draft Recommendation:** *Provide low-carbon ground transport options and incentives for U-M faculty, staff and students*

**Preliminary Draft Recommendation:** *Promote video conferencing as an alternative to in-person meetings*

**Preliminary Draft Recommendation:** *Implement a carbon price for faculty, staff and students who travel on University business, with the revenue being used to support the reduction or offsetting of U-M emissions*

**The following evaluation criteria pertain to the three recommendations above.**

*Carbon Neutrality Impact*

Key to the university-sponsored travel recommendations is the creation of a centralized system to provide baseline data, evaluate emissions reduction potential and to provide the capability to travel emissions reduction progress. With this system in place and the above strategies to reduce and provide alternatives to university travel, the university travel analysis team estimates a reduction in overall air travel by 20% over 5 years with 10% abstaining from or switching to ground travel and 10% replacing travel with videoconferencing. Given U-M's current travel carbon footprint of approximately 45,000 Mt CO2e/year, this would result in a reduction of 9,000 MtCO2e/year. Further reduction may be possible depending on the level of behavior change and should be actively pursued. Additional reductions would occur with the implementation of a travel offset program.

*Equity and Justice Considerations*

No individual should be asked to pay for the use of videoconferencing. Similarly, it will be necessary for U-M to make exceptions for ground transportation for those who may be unable to use alternative modes of travel for accessibility reasons. The university-sponsored travel carbon price should be implemented in a

*Regional Community Involvement*

As these recommendations are for internal university-travel policies, there would be limited need for broader engagement around implementation. However, there would be opportunities to discuss the U-M's university-travel programs and incentives with other organizations with an eye toward education and potential replicability. Additionally, should U-M expand its offerings of low-carbon ground transport, there will be opportunities to partner with alternative transit operators such as the Michigan Flyer, Amtrak, regional bus system, and suppliers of low-carbon vehicles for U-M rental.

*Scalable and Transferable*

U-M could become a leader in the space of video conferencing and low-carbon transit. Few universities both quantify and aggressively address the Scope 3 emissions from university-sponsored travel. Following this recommendation, U-M would be a model for peer institutions in how to effectively address emissions from university-sponsored travel.

*U-M Community Participation and Accountability*

It may be challenging to transition units that use an alternate travel tracking system to adopt Concur. Individual accountability will be enhanced through the centralized tracking system providing access to carbon footprint information to each traveler. This will bring the environmental impact of travel to bear on the traveler's mind.

To gain acceptance for a reduction of air travel among the campus community, a shift in culture will need to occur. A culture change could be bolstered by strategic news articles and presentations to individual units/departments. A broader culture shift within academia will also need to occur in order for expectations within units and among faculty members to change, at risk of disadvantaging faculty due to limited travel. The success of these initiatives depend on behavior change at the individual level. U-M will need to work hard to educate and empower its faculty, staff and students to make educated and carbon-friendly decisions. More on educational programming can be found in the Organization and Culture section.

*Financial Considerations*

The financial costs of implementing a centralized tracking system will depend on several factors, including Concur's pricing, the structural aspects of the system, which would affect how many people oversee the creation and maintenance of the system, and the availability of departments or groups to undertake the project. The savings such a system would bring are likely to be large, as not having a standardized procedure to quantify greenhouse gas emissions have led to travel unfettered by environmental impact considerations, resulting in longer flights, car, train, and bus routes.

The ongoing cost associated with the proposed reduction strategies are minimal. Potential costs include educational programming, low-carbon vehicles, and videoconferencing hubs. Individual units and travelers could incur additional costs due to the university-sponsored travel carbon price recommendation.

## Appendix M: University-Procured Food Emissions Reduction Strategies Evaluation Criteria

### University-Procured Food

**Preliminary Draft Recommendation:** *Establish and standardize food purchasing data collection to facilitate carbon footprint calculations and provide feedback to community members on the impacts of their food procurement and consumption.*

**Preliminary Draft Recommendation:** *Pursue plant-forward food procurement and consumer diets across all three U-M campuses*

*Carbon Neutrality Impact*

The food analysis team estimates that achieving a 25% reduction in greenhouse gas emissions associated with food is possible with appropriate changes to menus and procurement practices. See the food analysis report, appendix B and C, for full carbon emissions calculations.

*Equity and Justice Considerations*

Menu changes must be responsive to the needs and capacities of the diverse food operations across the University on all three campuses as well as the preferences and cultures of individuals. The University should prioritize and maintain affordable food options on campus for students, faculty and staff.

*Regional Community Involvement*

Any changes that the university makes to its food procurement will undoubtedly impact its vendors and their supply chains. The university could expand its potential to positively change major food vendors through partnerships with regional institutions who procure food from the same vendors. Such requirements enacted broadly across multiple institutions have the potential to effect significant change across the industry.

*Scalable and Transferable*

Of the 33 U.S. universities surveyed by the food analysis team, only 2 have established a goal for greenhouse gas emissions reductions related to food procurement. If U-M were to develop a robust accounting system and establish a carbon emission reduction goal for its food system, it would be a leader among peer institutions.

*U-M Community Participation and Accountability*

The proposed changes will require consumer acceptance and behavior change to be successful. These changes need to be implemented over a reasonable timeline to ensure that consumer demand aligns with the alternative food options. This process can be accelerated through required sustainability courses, online training, and orientation activities to develop sustainability competencies among students. On-boarding and ongoing training for faculty and staff should include modules on the impact of food systems and diets on climate change and specific actions that can be carried out to reduce food-related emissions.

*Financial Considerations*

A majority of the actions recommended above will require a relatively low investment at the University level. The recommendation will require an investment in cultural change, educational programming and institutional capacity building. Shifting to a plant-forward menu has the potential to either reduce or increase costs depending on the alternatives selected for each food service operation.

## Appendix N: Purchased Goods Recommendations Evaluation Criteria

**Preliminary Draft Recommendation:** *Request production emissions data from vendors to strengthen guidance for low-carbon procurement at U-M. These data can be used in purchasing decisions in addition to cost and performance criteria, as well as in emissions reduction tracking.*

*Carbon Neutrality Impact*

Emissions data for purchased goods are only available on a very limited basis. The FY19 complete financial statements line item for purchased supplies and services was $2.5 billion. Using a low-impact category (travel services) with an emission factor of 146t $CO_2e$ /$1 million results in a GHG emission estimate of 290 kt $CO_2e$. Using a high-impact category (paints and coatings) with an emission factor of 680t $CO_2e$ /$1 million) results in a GHG emission estimate of 1,360 kt $CO_2e$. For reference, total U-M Scope 1 and 2 emissions in 2018 were 750 kt $CO_2e$. The scale of emissions from purchased goods has the potential to be quite large relative to U-M's other emissions categories, and thus reduction potential is quite large through conscious and sustainable purchasing across the institution.

*Equity and Justice Considerations*

U-M has an opportunity to use its buying power to effect positive change in the supply chains from which it purchases goods and services. This is an area where U-M can ensure that the suppliers and manufacturers it purchases goods and services from are not engaged in unlawful or unconscionable environmental practices.

*Regional Community Involvement*

U-M has the opportunity to partner with like-minded institutions to amplify the positive effects on the supply chains and manufacturers from which they procure goods and services. U-M should also prioritize local and regional goods and services when available.

*Scalable and Transferable*

Purchased goods and services are a challenging emissions category to get a handle on. It is a diverse and decentralized category, especially at an institution the size of U-M. With this in mind, if U-M were to establish a robust system to provide guidance on low-carbon procurement, such policies would be applicable to many other large and like-minded institutions.

*U-M Community Participation and Accountability*

Purchasing decisions are made at the unit- and individual-level throughout the institution. Clear guidance for low-carbon procurement will empower the individuals making purchasing decisions on a daily basis to make choices that advance the university's carbon neutrality goals.

*Financial Considerations*

At this point, it is unclear whether low-carbon procurement will increase costs or reduce costs. It likely depends on the specific good or service of interest. The financial implications will likely vary.

## Appendix O: Waste and Wastewater Recommendations Evaluation Criteria

**Preliminary Draft Recommendation:** *Reduce and divert food waste from landfills by scaling up food waste diversions and reductions, and increasing capacity for composting on U-M's campuses and launching a campus-wide composting program at UM-Dearborn and UM-Flint.*

*Carbon Neutrality Impact*

Current practices on the Ann Arbor campus in FY19 avoided 13,010 mtCO2e. The proposed actions would result in an improved diversion rate which would avoid more carbon emissions.

*Equity and Justice Considerations*

Unfunded mandates would in-equitably affect smaller and under-resourced units (e.g., Dearborn and Flint). Efforts to scale up diversion and reduction must be responsive to the needs, capacities, and advances already made within different units and buildings on-campus; significantly increasing food donations could improve regional and student food security.

*Regional Community Involvement*

The university could partner with local food banks and student food pantries to increase food donations. Food that cannot be donated could be provided to local and regional livestock farmers to collect food scraps for their operations.

*Scalable and Transferable*

Peer institutions are adopting ambitious goals, some pledging to become "Zero Waste campuses" by striving for more than 90% diversion rates. If U-M achieved diversion rates between 59-62%, it would put U-M in the top two institutions among large-scale universities. U-M could act as a model and leader in this space for other institutions. To approach such levels would require disaggregating food waste from other streams, particularly clinical care waste, for accounting purposes. Approximately 50% of non-regulated waste generated on the AA campus is generated from clinical care activity, and progress in diverting this waste remains challenging due to a lack of recycling markets for this unique waste stream.

*U-M Community Participation and Accountability*

Effective and comprehensive education to staff, faculty and students. Willingness of staff, students and faculty to divert food waste and avoid contamination.

*Financial Considerations*

This recommendation will require an up-front investment in culture change and institutional capacity building efforts. Additionally, funding will be required to create a composting program on the Dearborn and Flint campuses.

**Preliminary Draft Recommendation:** *Explore improved water efficiency and site design standards for all new construction to reduce both upstream and downstream emissions from water treatment.*

*Carbon Neutrality Impacts*

As of FY19, the U-M Ann Arbor campus consumed 1,210,297,948 gallons of potable water which equates to 1,784 MTCO2 emissions. Currently, CO2 emissions associated with water are not included in U-M's carbon accounting. Occupant behavior is a large factor in actual water use, so it is difficult to project a direct correlation between fixture efficiency and emissions reductions. Changes related to rainwater harvesting and greywater reuse offer potential reductions in wastewater discharge quantities coupled with heat recovery opportunities. Specific water volumes were not calculated given the unknown nature of the relationship of building footprint to parcel for future consideration.

*Equity and Justice Considerations*

Affordability and access to water is an issue of environmental equity and social justice in our region and globally. This is playing out as a public health crisis in Flint with lead contamination and in Detroit with increased COVID-19 spread rates due to lack of access to water for hand washing. Efforts made to conserve water and rethink distribution and treatment infrastructure have the potential for meaningful equity impacts.

*Regional Community Involvement*

There are significant opportunities for U-M to partner with the communities surrounding the three U-M campuses to improve water quality, and distribution and treatment infrastructure. The Flint campus currently engages with the broader Flint community to build solutions to and bring the community together around the Flint water crisis.[40] The Dearborn campus receives its water from and sends its wastewater to the City of Detroit water treatment facilities. The Ann Arbor campus receives its water from and sends its wastewater to the City of Ann Arbor's water treatment facilities. As U-M explores water efficiency standards across all three campuses, engagement with the Flint community, Dearborn and broader Detroit community and the City of Ann Arbor should be expanded to improve water quality, distribution and treatment infrastructure.

*Scalable and Transferable*

U-M current has many researchers invested in issues of water conservation, water quality and water infrastructure. Work from the research realm could more directly impact the implementation of new approaches to "One Water" on the U-M campuses.

*U-M Community Participation and Accountability*

Water is a highly visible natural resource that has a strong and established campus culture that cuts across research, teaching, and campus life. While the metrics of emissions reductions in water conservation efforts are not as significant as those related to building energy operations recommendations, the visibility and cultural impact can be more direct and visible.

*Financial Considerations*

As stated in the building standards analysis team report, low flow, high efficiency fixtures can have higher initial costs than less efficient alternatives. However, this cost is compensated by savings in water bills. Rainwater harvesting and greywater reuse strategies have initial upfront

[40] University of Michigan-Flint. (2020, January 1). *Campus and Community Engagement*. UM-Flint Campus Water. Retrieved December 7, 2020, from https://www.umflint.edu/campus-water/campus-community-engagement

cost driven by the complexity of a building's plumbing infrastructure and the target capture volumes. Water storage tanks have been demonstrated to account for approximately 50% of additional upfront costs but can also play an important visual role by displaying the systems at play in low emissions buildings.

## Appendix P: Methane Emissions and the University of Michigan Memo

Methane Emissions and the University of Michigan
Daniel Raimi, Eric Kort, Austin Glass
August 2019

Executive Summary: Natural gas is primarily composed of methane, and combustion of natural gas, like all fossil fuels, produces carbon dioxide. Because methane is itself a much more potent greenhouse gas than carbon dioxide, losses of methane along the natural gas supply chain can compromise the climate benefits of switching from coal-fired to natural gas-fired power plants. Although the latest data show methane emissions exceed U.S. EPA estimates, natural gas power generation, as is planned in the UM power plant upgrade, creates fewer emissions than coal-based power generation. In the long term, achieving carbon neutrality will require eliminating all emissions, including those from natural gas, but in the short term, this transition provides clear climate benefits, even when accounting for the latest science on methane emissions.

Oil and natural gas production have increased rapidly in the United States in recent years due to advances in technologies such as horizontal drilling and hydraulic fracturing ("fracking"). This growth has reduced domestic natural gas prices and encouraged broader use of the fuel for power generation and other purposes. Because combustion of natural gas produces approximately half as much carbon dioxide ($CO_2$) as combustion of coal for the same amount of electricity generated, displacement of coal by gas in the power sector has reduced U.S. $CO_2$ emissions.

*Methane's climate impact*

Methane—the primary component of natural gas—is itself a potent greenhouse gas, and a gram of methane ($CH_4$) traps more heat than a gram of $CO_2$. However, methane is chemically active in the atmosphere, and as a consequence its lifetime is roughly a decade, much shorter than the effective lifetime of hundreds of years for the relatively chemically inert $CO_2$. Because of these differing effects, the relative climate impacts of methane and $CO_2$ vary with the chosen time horizon.

The heat-trapping effectiveness of methane relative to $CO_2$ is conveyed through its "Global Warming Potential" (GWP). The most recent Assessment Report (AR5) from the IPCC applies what is currently considered the most representative GWP of methane: 34 over a 100-year time frame, and 86 over a 20-year time frame. These GWP values indicate that one ton of methane traps 34 times more heat than one ton of $CO_2$ over a 100-year time frame, and 86 times more heat over a 20-year time frame.[41]

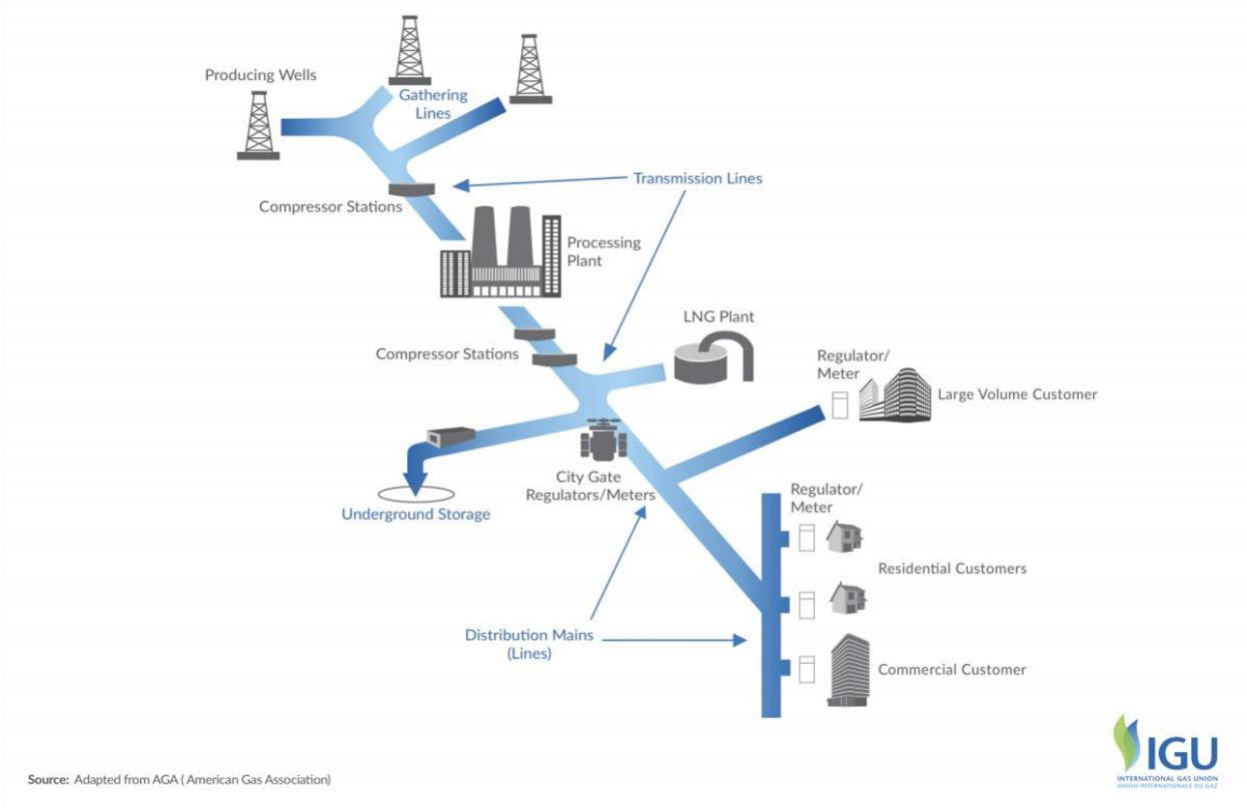
[41] G. Myhre, D. Shindell, F.-M. Breon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, G. Stephens, T. Takemura, H. Zhang, *Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, Cambridge ; New York, 2013).

The warming associated with methane contributes significantly to the overall climate impact of natural gas, as methane may be released into the atmosphere prior to combustion. If more than approximately 8% of natural gas escapes into the atmosphere before it is burned and converted into $CO_2$, the climate benefits of switching from coal to natural gas for electric power vanish over a 100-year time frame, and if approximately 4% escapes, those benefits disappear over a 20-year period.[42]

*Estimating methane emissions*

Methane emissions can occur at virtually every stage of the natural gas system (Figure P-1).

Figure P-1.




Methane can escape from leaky valves or malfunctioning equipment at oil and gas well sites, natural gas pipelines, gas processing facilities, and elsewhere. Because there are over 1 million active oil and gas wells, thousands of natural gas processing facilities, and over 2 million miles of natural gas pipelines in the United States, it is difficult to precisely measure the scale of emissions from the whole system.

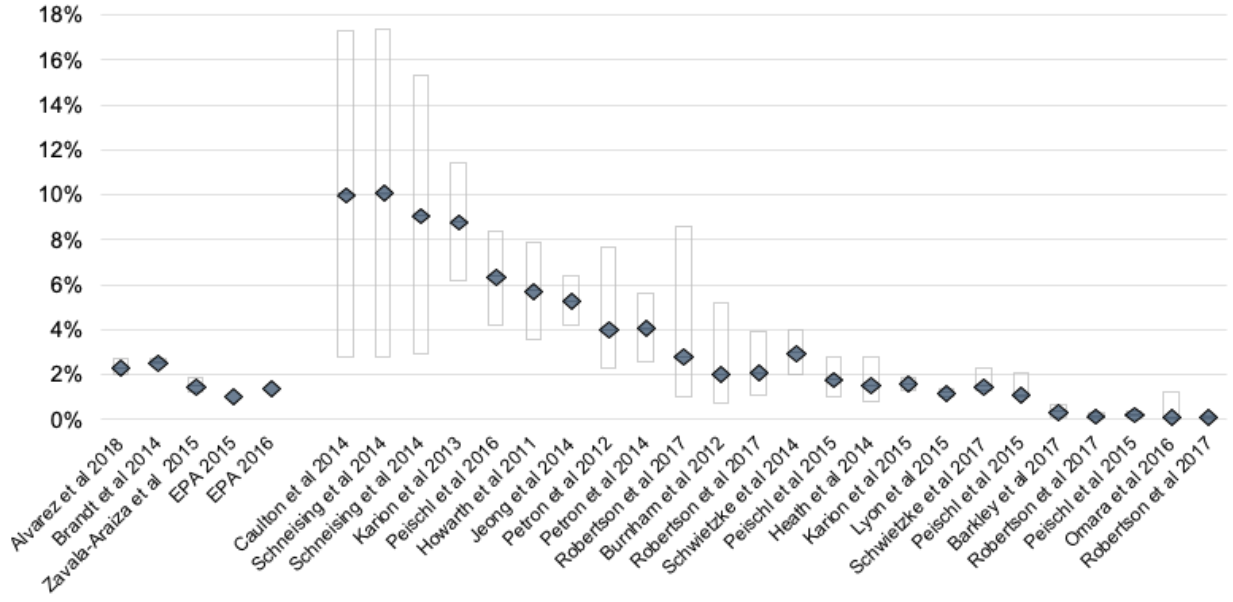
The U.S. EPA, which estimates oil- and gas-related methane emissions each year, had, until recently, relied on outdated emissions factors in its accounting protocols.[43] In an effort to provide better data, dozens of studies have been carried out in recent years to measure

[42] R. A. Alvarez, S. W. Pacala, J. J. Winebrake, W. L. Chameides, S. P. Hamburg, Greater focus needed on methane leakage from natural gas infrastructure. *PNAS*. **109**, 6435–6440 (2012).

[43] EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2016" (EPA 430-P-18-001, U.S. Environmental Protection Agency (EPA), Washington, DC, 2018), p. various, (available at https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf).

emissions in a variety of locations and from a variety of sources. These studies have yielded a wide range of results, with estimates in some regions as low as 0.1 percent, and others as high as 10 percent or more (Figure P-2).

Figure P-2.




The best available summary of this work comes in a recent study from Alvarez et al. (including UM co-authorship),[44] which synthesizes the results of numerous studies (many involving UM researchers) carried out across the U.S. This study estimates that roughly 13 Teragrams of methane were emitted to the atmosphere by U.S. oil and gas systems in 2015, equivalent to roughly **2.3%** of domestic production in that year. This is roughly 60% higher than the EPA's estimate for that same year. This is the current best-estimate of the loss rate from the U.S. natural gas supply chain.

Some uncertainty remains in this estimate. Emissions estimates may continue to be revised upwards if new research shows that natural gas storage, local distribution systems, and other downstream infrastructure are 'leakier' than currently estimated. Recent work from UM has indeed shown that cities are 'leakier' than currently estimated, however these results do not change the overall assessment of using natural gas for power plants.[45]

As summarized by Alvarez et al., although many studies have shown that methane emissions are greater than previously estimated by the EPA, natural gas power plants have a lower climate impact than coal plants of the same power output. Further, these studies have highlighted opportunities for reducing loss of methane in the natural gas supply chain.

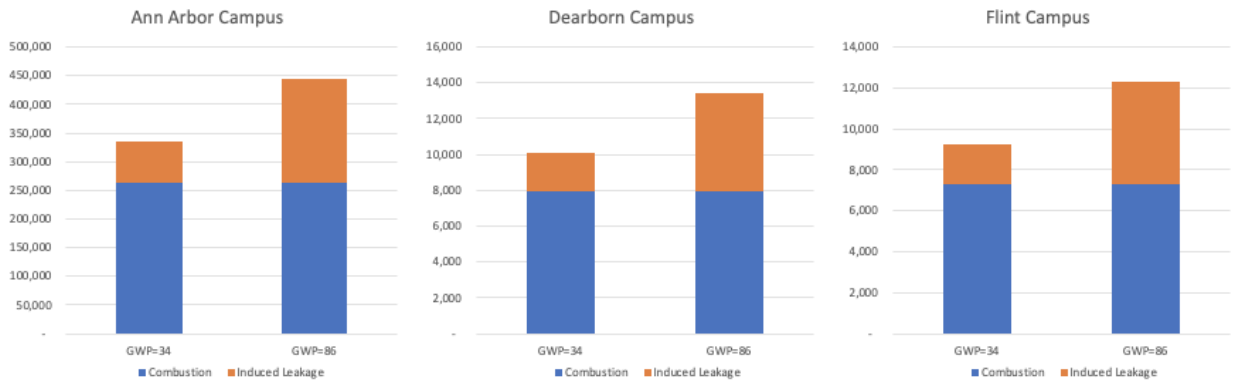
[44] R. A. Alvarez, D. Zavala-Araiza, D. R. Lyon, D. T. Allen, Z. R. Barkley, A. R. Brandt, K. J. Davis, S. C. Herndon, D. J. Jacob, A. Karion, E. A. Kort, B. K. Lamb, T. Lauvaux, J. D. Maasakkers, A. J. Marchese, M. Omara, S. W. Pacala, J. Peischl, A. L. Robinson, P. B. Shepson, C. Sweeney, A. Townsend-Small, S. C. Wofsy, S. P. Hamburg, Assessment of methane emissions from the U.S. oil and gas supply chain. *Science* (2018), doi:10.1126/science.aar7204.

[45] G. Plant, E. A. Kort, C. Floerchinger, A. Gvakharia, I. Vimont, C. Sweeney, Large fugitive methane emissions from urban centers along the US East Coast. *Geophysical Research Letters*. **0**, doi:10.1029/2019GL082635.

*Implications for the University of Michigan*

The above analysis suggests that for every 100 tons of $CO_2$ emitted from the combustion of natural gas at the University of Michigan or elsewhere, methane emissions contribute an additional 27 tons of $CO_2$-equivalent assuming a 100-year GWP, and an additional 68 tons of $CO_2$-equivalent assuming a 20-year GWP. Figure P-3 illustrates the effect of adding both metrics to the existing $CO_2$ footprint of the University's annual natural gas use.

Figure P-3.




*Opportunities*

This analysis assumes the natural gas used at UM is lost at the average U.S. rate. Further work could be done to track the sources of the natural gas used at UM, and create a custom loss rate for UM's natural gas supply chain. This could involve tracking the natural gas chain for campus and using production-basin-specific loss rates, and could involve new measurements along the supply chain, from the production field to end-use in Ann Arbor, in order to directly observe loss rates. At this point it is unclear if tracing the origin of natural gas used at UM is tractable, or if the nature of the natural gas supply chain too thoroughly obfuscates the originating production basin.

Options for measurement action that could be taken in Ann Arbor range from practical to more experimental. Examples include:

A vigorous Leak Detection and Repair (LDAR) program.
An LDAR would be executed by facilities personnel and the natural gas supply company. This is a mechanism for finding and reducing losses with large mitigation potential, though without the ability to directly quantify the system-wide loss rate. LDAR programs come with some upfront hardware costs, though typically the deployment of personnel for monitoring and repairs represents the bulk of costs.

Atmospheric monitoring (aircraft, stationary ground sites, repeat vehicle surveys).
Atmospheric measurements provide the potential to quantify total methane emissions from a region, and/or to pinpoint locations with large losses. These measurements can be made via

discreet aircraft campaigns, through continuous observations from ground-measurements, or from regular vehicle surveys. Perhaps most relevant here would be regular vehicle surveys to map methane values in and around campus, where persistent peaks are indicative of local leaks (https://www.edf.org/climate/methanemaps). Depending on objectives, such a program could involve students or researchers to support the work and hardware costs from ~$10,000 to >$100,000.

## Appendix Q: Leased Buildings Recommendations Evaluation Criteria

**Preliminary Draft Recommendation:** *Develop guidance for GHG reductions in leased buildings (and apply emissions reduction recommendations for UM-owned buildings to leased buildings, where possible).*

**Preliminary Draft Recommendation:** *Prioritize leasing arrangements that allow the university to pay electric and gas utility bills directly. This model simplifies accounting for GHG emissions and creates an incentive for U-M units to reduce their energy usage and to include these emissions in a carbon price, per PCCN recommendations (link). In cases where this model is not possible, U-M should include a provision in lease agreements to supply monthly utility use data for UM-occupied space (including electricity, heating fuel(s), and water).*

**Preliminary Draft Recommendation:** *Develop and implement language in all leasing policy documents that requires high energy efficiency and a low GHG footprint, ideally in alignment with U-M building standards. Require property owners/managers to provide detailed information pertaining to their efforts to implement energy efficiency and emissions reductions.*

**Preliminary Draft Recommendation:** *Optimize space utilization in leased properties to use energy more efficiently and decrease GHG footprints. To the degree possible, U-M should strive to meet additional space needs through better utilization of permanent space and through leased spaces that are intentionally designed as flexible co-working facilities for staff across multiple units who, for example, telecommute three or more days per week.*

*Carbon Neutrality Impacts*

Although leased buildings have a smaller carbon footprint relative to the other Scope 3 emissions categories, the above recommendations will have a positive impact on U-M's carbon footprint. Exact carbon reduction potential is unclear at this point.

*Equity and Justice Considerations*

None stated.

*Regional Community Involvement*

If the above recommendations are taken, the university will work closely with local and regional property owners and managers to adjust their energy efficiency and sustainability protocols prior to leasing.

*Scalable and Transferable*

Language requiring high energy efficiency and low GHG footprint developed for leasing policy documents should be publicly available for other institutions, organizations and municipalities to utilize when leasing space. Such language is largely transferable and should be a resource for all.

*U-M Community Participation and Accountability*

Prioritizing leasing agreements that allow the university to pay the electric and gas utility bills directly empowers individual units to reduce their electric and gas bills. It also will enable the university to include these emissions in a carbon price, which further incentivizes individual units to reduce their electric and gas consumption.

*Financial Considerations*

Financial costs of these recommendations will be negligible. Limiting leased space will save the university money.

## Appendix R: Carbon Offsets Peer Institution Examples

Organizations can adopt a wide range of philosophies to guide their use of carbon offsets. For example, a “neutrality first approach” contends that an organization has a moral responsibility to become immediately carbon neutral, and that offsetting is a credible means of achieving that result. Alternatively, a “least-cost approach” compares the cost of offsets alongside the marginal cost of abatement for internal mitigation projects, and favors the option that is less costly. Organizations may also adopt a “scope-specific approach”, where different characteristics across emission scopes lead to prioritizing direct mitigation activity in one scope and offsetting activity in another.

Notable examples of other university approaches to using offsets include:

- The University of California (UC) system’s draft carbon offsets policy acknowledges the urgency of near-term reductions, but seeks to prioritize direct reductions and use offsets as a transitional strategy.[46] Their draft policy advocates for using high-quality, scalable offsets that will advance research and student education, have health and justice benefits for the UC community, and consider health and social impacts on low-income communities and communities of color.

- Duke University’s (Duke) Carbon Offsets Initiative prioritizes carbon offsets projects that provide educational opportunities, provide environmental, economic, and societal co-benefits to their local, state and regional community, and serve as a resource for other institutions.[47] For example, Duke recently acquired the rights to a 10,000 acre “carbon farm” that, once fully operational, will store enough carbon to help the university meet its carbon neutrality goals.[48]

- Massachusetts Institute of Technology (MIT) partnered with the Boston Medical Center and Post Office Square Redevelopment Corporate on a 25-year solar Virtual Purchase Power Agreement (VPPA) in North Carolina.[49] The Renewable Energy Certificates associated with this purchase counterbalance 40 percent of MIT’s Scope 2 emissions associated with its electricity use — similar to the expected result from U-M’s participation in DTE’s MiGreenPower program.

- In Ohio State University’s (OSU) hierarchy of greenhouse gas emissions reduction strategies, using carbon offsets is an effort of last resort.[50]

[46] University of California Office of the President. *Energy Services*. https://www.ucop.edu/energy-services/carbon-offsets/index.html

[47] Duke Carbon Offsets Initiative. *Guide to Carbon Offsets and Co-benefits*. Duke Office of Sustainability. https://sustainability.duke.edu/sites/default/files/cobenefitsguide.pdf

[48] Duke University, Nicholas School of the Environment. (2018, October 11). Duke University Begins Work on 10,000-Acre 'Carbon Farm' in Eastern N.C. *Duke University, Nicholas School of the Environment*. https://nicholas.duke.edu/news/duke-university-begins-work-10000-acre-carbon-farm-eastern-nc

[49] Massachusetts Institute of Technology. (2016, October 1). Summit Farms: Investing in off-site renewable energy. *Massachusetts Institute of Technology Sustainability*.

[50] Ohio State University. (2020, April 8). *Ohio State University Climate Action Plan 2020*. OSU Climate Action. https://si.osu.edu/sites/default/files/CAP_Final_04082020.pdf

## Appendix S: Bio sequestration Recommendation Evaluation Criteria

**Preliminary Draft Recommendation:** *U-M should identify opportunities for biosequestration projects on U-M lands that have significant carbon sequestration potential and seek meaningful achievements across prioritized co-benefit categories.*

*Carbon Neutrality Impacts*

U-M owned natural lands currently sequester at a rate of 41,000-78,500 $mtCO_2e$ per year. There is potential for increased sequestration through the purchasing and protection of contiguous undeveloped sites.

*Equity and Justice Considerations*

The university should explicitly consider women and minority-owned businesses to provide services for the bio sequestration projects. The access to natural lands and green spaces is correlated with socioeconomic standing, but natural lands also provide cultural benefits, and accessibility is important.

*Regional Community Involvement*

If the university chooses to pursue bio sequestration projects on U-M lands in a way that achieves the prioritized co-benefits, there are many opportunities for collaboration with the regional community. Such projects should be accessible to organizations and other institutions for research and educational programming. The university should partner with the surrounding community to engage with the local municipalities, tribal leadership, and non-profits/organizations that advocate for and accelerate the preservation of natural lands.

*Scalable and Transferable*

The university should share the outcomes, best practices and lessons learned of such projects with peer institutions to advance the scalability and transferability of this recommendation.

*U-M Community Participation and Accountability*

To ensure the university community is aware of such projects, because they are mostly off-campus, U-M must implement effective signage and communication, experiential learning opportunities for students, and research opportunities.

*Financial Considerations*

Sustainable management practices to optimize ecosystem service outcomes will incur additional costs and/or reallocation of funds or person hours. The increased biosequestration occurring from proper management of lands could be used as a counterbalance against emissions in other arenas. Purchasing and protecting additional lands will create upfront and increase ongoing costs.

## Appendix T: Leadership Structures Recommendation Evaluation Criteria

**Preliminary Draft Recommendation:** *The university must institutionalize its commitment to carbon neutrality by providing the necessary leadership and organizational support to achieve its goals. This includes implementing mechanisms to integrate responsibility and accountability at the unit level throughout the university, and creating a position that assists, advises and reports directly to the President to facilitate carbon neutrality progress across the entire university.*

*Carbon Neutrality Impacts*
N/A

*Equity and Justice Considerations*
Throughout the established leadership structure, there will need to be regular collaboration and engagement with the university DEI Office, as well as integrated and thoughtful consideration of environmental justice issues as the university begins decarbonization of its three campuses.

*Regional Community Involvement*
A key responsibility of a direct report to the President is to be a clear point of contact that formally represents the U-M administration on university-wide carbon neutrality issues for external stakeholders. This recommendation is integral to the success of all other recommendations to partner and collaborate with the local and regional community. The leadership structures put in place must actively engage and partner with the cities of Ann Arbor, Dearborn, and Flint to work towards shared carbon neutrality goals.

*Scalable and Transferable*
The direct report and leadership structure will be charged with building and accelerating partnership networks, internally and externally, to collaboratively design and implement scalable strategies. Engagement with the regional community and peer institutions will also be integral to ensure proper sharing of knowledge, best practices and lessons learned.

*U-M Community Participation and Accountability*
This recommendation prioritizes both centralized leadership, and decentralized commitments and strategies at the unit level. This leadership structure is meant to empower and support faculty, staff and students engaging in carbon neutrality work to effect positive change in their areas of influence and responsibility.

*Financial Considerations*
Implementing and sustaining robust leadership structures will require investments in personnel and support systems to propel U-M on its carbon neutrality path. Fortunately, U-M has many organizational pieces already in place to facilitate the transformation, and these resources should be leveraged to keep additional costs to a minimum.

## Appendix U: Research and Education Recommendations Evaluation Criteria

**Preliminary Draft Recommendation:** *Make significant investments in research on routes to achieving carbon neutrality.*

**Preliminary Draft Recommendation:** *Expand and prioritize sustainability curriculum, training and literacy programs to all members of the U-M community across all three campuses*

**Preliminary Draft Recommendation:** *Invest in institutional structures to expand and support carbon neutrality focused "living-learning labs" across all three U-M campuses.*

*Carbon Neutrality Impacts*
N/A

*Equity and Justice Considerations*
Research projects should focus on solutions that are socially equitable. Educational programming should focus on carbon neutrality citizenship skills required to analyze and problem solve sustainability challenges in an equitable way. The U-M community should understand the basics of climate change, climate justice and environmental justice.

*Regional Community Involvement*
All three of the research and education recommendations are internal to the institution, however, frequent educational cues will likely positively affect the surrounding community, specifically those who frequently engage with the university through its health services, athletics and arts programs. Additionally, there is an opportunity to partner with the surrounding communities on living-learning laboratory programming.

*Scalable and Transferable*
The carbon reduction multiplier effect is relevant here. This effect includes the immediate and long-term emissions reductions as thousands of students, faculty, staff and visitors gain a deep understanding of sustainability while at U-M that will lead to a self-sustaining culture that will carry forward once they leave campus. Rather than simply pushing habits onto the community, educational programming will hopefully foster intellectual capacities.

*U-M Community Participation and Accountability*
Such research programs and funding will empower the university community to dive into the issue of climate change and develop decarbonization solutions. This is a direct way to engage the university in carbon neutrality work through U-M's core mission of education and research. Further, expanded carbon neutrality educational programming and accessible living-learning labs will ensure that the U-M community is interacting with and learning about carbon neutrality, and the solutions U-M is employing throughout their time on the university's three campuses. Such programming will empower students to make educated and informed choices each day while on- and off-campus.

4290 *Financial Considerations*

The Commission recommends that the university scale up their current $5 million research fund to $10 million to support proposals from the university research community. Educational programming will need to be equitably supported on all three U-M campuses

## Appendix V: External Collaboration Recommendations Evaluation Criteria

**Preliminary Draft Recommendation:** *Conduct targeted network mapping related to all carbon neutrality strategies and pursue intentional engagement with key stakeholders to inform implementation.*

**Preliminary Draft Recommendation:** *Tailor carbon neutrality communication and education for specific audiences, and expand opportunities for stakeholder input.*

*Carbon Neutrality Impacts*
N/A

*Equity and Justice Considerations*
As the university implements this recommendation, it should be certain to identify missing groups from its stakeholder community, such as under-represented communities and constituencies related to the Dearborn and Flint campuses. U-M will need to engage significantly with its stakeholder community at each stage of implementation to ensure that its actions towards carbon neutrality are equitable and just, specifically to historically marginalized groups. Inclusivity considerations should be prioritized alongside technical and commercial considerations.

*Regional Community Involvement*
These two recommendations focus on how to effectively and thoughtfully engage with the regional community to form sustainable and mutually beneficial partnerships.

*Scalable and Transferable*
If external collaboration is done well, U-M's carbon neutrality strategies and solutions will stretch much further than its geographic scope.

*U-M Community Participation and Accountability*
N/A

*Financial Considerations*
A robust external collaboration model will take additional time and resources to execute, but U-M has many quality organizational engagement resources already in place that should be leveraged to keep additional costs to a minimum.

## Appendix W: Carbon Accounting Model Summary

The Carbon Accounting Subgroup developed and implemented a comprehensive carbon accounting model for the University of Michigan (Ann Arbor, Dearborn, and Flint campuses). The model integrates existing work completed by Internal Analysis Teams (IATs), External Analysis Teams (EATs), the Electrification Subgroup, and Office of Campus Sustainability, supplemented with additional analysis by the Carbon Accounting Subgroup. The model provides guidance and informs the Commission on emissions reduction strategies (including both technical and policy strategies) and their reduction potential over time, the development of carbon neutrality pathways, and selection of neutrality goal years. The Carbon Accounting Subgroup also developed an iterative analysis and goal setting process for the PCCN incorporating the carbon accounting model.

The carbon accounting model evaluates the University's GHG emissions on an annual basis over the period 2018-2050 and tracks the GHGs emissions of carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). The model calculates emissions separately for Scope 1 (direct on campus), Scope 2 (purchased electricity), and Scope 3 (indirect, e.g., commuting, business travel, fuel and electricity upstream emissions) for all three UM campuses (AA, Dearborn, & Flint) plus several field and research stations. Global Warming Potential ($GWP_{100}$) values and emission factors are sourced from Argonne National Lab's GREET model. DTE and Consumers Energy provided projected fuel mixes and generation plans through 2050. We also sourced data from EPA and EIA on model parameters and technology forecasts. Upstream emissions include methane leakage and other emissions resulting from fuel processing, as characterized in GREET (using EDF estimates).

The dynamic carbon accounting model characterizes and simulates GHG emissions for 29 carbon reduction strategies and includes over 100,000 data points and over 500 carbon reduction strategy parameters. Examples of strategies included are efficiency improvements, HVAC system replacement, vehicle electrification, and shifts in diet. The model characterizes the transition from existing heating and cooling systems to the proposed geoexchange system while also incorporating decarbonization of grid electricity. The model compares the University's progress to both neutrality and to the Intergovernmental Panel on Climate Change (IPCC) 1.5°C targets. Full details on model calculations, assumptions, and parameters are documented in the Carbon Accounting Subgroup report.

The modeling process begins with calculation of 2018 baseline GHG emissions (by Scope) and then calculation and plotting the business-as-usual (BAU) emissions trajectory from 2018 through 2050. The BAU trajectory illustrates annual GHG emissions in the absence of any additional University action to reduce emissions. Three sets of emissions reduction strategies (called Cases) were implemented in the carbon accounting model and annual emissions reductions from BAU were calculated and plotted, resulting in three Case emission trajectories. These trajectories reveal the emissions gaps remaining in any year to achieve neutrality, which were monetized using recent RGGI permit prices to understand the potential cost of offsetting emissions.

The Carbon Accounting Subgroup developed recommendations for improving carbon accounting systems for tracking progress and implementation of strategies for emissions reduction. The lack of data in several areas, mostly related to Scope 3 activities, highlight the need for improved accounting systems. This pertains especially to purchased goods and services, as is more fully detailed in the Carbon Accounting Subgroup report. The carbon accounting model will require annual updating and refinement and additional work will be required to transition the PCCN carbon accounting tool to an operational OCS tool for planning,

tracking, reporting, and verification.  In addition, it is recommended that emissions accounting be conducted at the building-level to more fully engage academic units in achieving carbon neutrality.

Refer to the full Carbon Accounting Model Project draft report for additional information on the model.