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Executive Summary and Proposed Action Plan
The purpose of this white paper is to summarize the outcomes of a yearlong faculty, student, staff and community greenhouse gas emissions project, and to ask President Schlissel to deepen the university's commitment to emissions reductions going forward.

Executive Summary
Susan Hassol, Director of Climate Communication, describes climate change in 10 words: “It’s real. It’s us. It’s bad. Scientists agree. There’s hope.”

As the world’s largest cumulative emitter, the United States needs to reduce emissions by 70-80% by 2050 to meet the IPCC goal of reducing global temperature rise from climate change to two degrees C or less.¹ Working from a custom least-cost optimization model, Steve Skerlos (College of Engineering) forecast last year that new emissions reductions must be in place by 2025 (+/- 2 years) for the automotive sector and 2026 for the electricity sector (+/- 3 years). Otherwise, it is too late to meet the 70% by 2050 reduction goal.¹ Tony Reames (SEAS) focuses on the serious social and environmental inequalities that can be traced to energy consumption.² 50% of the housing within the City of Ann Arbor is rental housing, and the City has noted that U-M’s less affluent students often occupy older, less energy-efficient student housing with correspondingly higher energy bills.

As a public university, we have an obligation to not only participate in mitigating climate change, but to lead. Clean energy and sustainability must be strong components of the vision, curriculum, and campus infrastructure for institutions of higher learning to be able to recruit students and prepare them for the future. If we commit to reducing energy emissions more deeply, over time we will bring university-wide changes in how we build, renovate and power structures, campus transportation, and our culture. Careful analysis is needed to identify options for our unique institution. We have an opportunity to engage the campus and regional community as a living laboratory for research and teaching projects across multiple disciplines. Transitioning off fossil fuels is not an easy task. Purchased electricity from DTE could be 100% dedicated wind power fairly easily, but heat, steam, hot and chilled water and transportation represent more challenging areas to address. New policies that impact how we approach heating, cooling, and mobility are needed in addition to the LEED standard used for buildings.

University of Michigan students, faculty, alumni, and Ann Arbor residents are increasingly asking for university leadership action on this issue. Over the 2017-2018 academic year, students and student organizations, faculty, and staff fused into an informal working group called the “Clean Wolverines” to research deeper carbon emissions reductions at the University

² T. Reames, Targeting energy justice: Exploring spatial, racial/ethnic and socioeconomic disparities in urban residential heating inefficiency”, Energy Policy, 97, 549-558.
of Michigan. The effort culminated in a 120-guest conference on April 5th, 2018 with students, faculty, facility managers, representatives from the energy industry, sustainability practitioners from corporations, members of the local Ann Arbor energy community such as the City of Ann Arbor and the Ecology Center, and representatives from other universities. U-M students presented the results of their research into further emissions reductions at U-M. Various approaches to carbon neutrality were presented by Ohio State, Northwestern, Michigan State, the University of Illinois, General Motors, and Montgomery County, Maryland.

After the conference, the sentiment at U-M is that the work ideally continue, with support from University leadership. Climate change is urgent, and may be widely recognized - in as little as a few years - as the most pressing global issue. The time to act is now, and U-M’s first step should be a university-wide commitment to deeper emissions reductions.

Proposed Action Plan
We ask that President Schlissel consider the following actions toward reducing our greenhouse gas emissions:

1. **Set a University-wide carbon-neutrality goal as soon as possible:** Carbon neutrality is becoming an increasingly common greenhouse gas reduction goal for universities in the 2050 timeframe. Some schools also have carbon neutrality requirements for any new buildings.

If deeper carbon emissions reductions can be considered, establish a new structure, team and tracking system to deliver these goals to the President’s Office.

Potential evaluative steps:

- **Assess lengthening our return-on-investment (ROI) windows.** Opportunities exist to use energy-reduction and energy-generation technologies that will offer years of free use as well as benefit the environment.
- **Complete a financing assessment.** Look at how to pay for energy efficiency and onsite generation. Consider an internal carbon tax or system. Study approaches from other schools and companies on applicability to U-M. Also consider third-party, off-balance sheet financing and maintenance arrangements for new technologies.
- **Consider using triple bottom line decision-making** and include social and environmental impacts as well as ROI to make decisions. There are examples at other schools that could be considered as inputs to what we use.
- **Create a new U-M energy standard** for building renovation or new construction that facilitates much deeper carbon emissions reductions. A standard that is customized to U-M and can account for the different types of spaces on campus might make the most sense.
- **Create possible next steps in campus culture and raising awareness.** Much has been done in this regard, but there is more opportunity to change behavior and reduce demand for energy.

- **Harvest information from other universities and from industry.** Examine how other schools, especially those with carbon neutrality goals, are planning on executing for relevancy of those solutions to U-M. Talk to practitioners in the electricity industry to get their thinking on how to accomplish goals.

- **Identify interim carbon reduction goals & monitoring.** Set interim emissions reduction goals every 3 years with reports to the President twice annually.

2. **Endorse a campus faculty-student project for the 2018-2019 academic year: start a living laboratory:** The project would seek to create: 1) potential maps to U-M carbon neutrality by 2050, and 2) examine one to three campus buildings for possible inclusion of greenhouse-gas reducing strategies. The College of Engineering requested that Naval Architecture be a candidate; it will be renovated in two years. A historic central campus building and one other may also be analyzed. A third potential project could assess converting fleet vehicles to all-electric and installing support infrastructure on U-M properties, and/or recommendations for reducing transportation emissions. It would be motivating and rewarding if the President attends a 2-3 hour workshop in early April 2019 to hear student and faculty specific recommendations on these two topics.

The project would be carried out by U-M faculty and students, with a core collaborative team including leaders from SEAS, LS&A, COE, Ross, and the Energy Institute. By the end of AY18-19, this team will recruit up to 8 additional faculty members to provide leadership to students with the technological, financial, and social/cultural assessments of the above two tasks.

It is envisioned that this process will launch wider-scale adoption by faculty to use U-M as a living laboratory for new ways to power our lives and transition away from fossil fuels. The 2025 goal is to expand the living laboratory boundaries beyond campus walls. Members of the Ann Arbor and southeastern Michigan energy and climate change communities have been closely engaged with this project over the last year. There is specific interest in creating a U-M + City of Ann Arbor + Other Washtenaw County Communities + DTE + Auto Industry Partnership to completely rethink how we heat, cool, and travel.
Definitions of Scope 1, 2, and 3 Emissions
The U.S. EPA defines three categories of emissions which have been widely adopted for emissions tracking and control by a variety of organizations:

**Scope 1 Emissions**
Direct onsite emissions from owned or controlled sources: in-house power generation, vehicle fuels, process emissions, and fugitive emissions.

**Scope 2 Emissions**
Indirect emissions from purchased energy (electricity, natural gas), steam, and water.

**Scope 3 Emissions**
All indirect emissions that occur in the value chain of the organization that do not appear in Scope 2 including business travel, commuting, purchased goods and services, capital goods, waste generation, and grid transmission losses.

Brief History of Emissions Reductions Progress at U-M

- The University of Michigan’s greenhouse gas emissions reduction goal is 25% of scope 1 and 2 emissions by 2025. This is a Presidential Initiative via the Greenhouse Gas Committee, chaired by Facilities and the Energy Institute. We do not have a Scope 3 emissions goal at this time. The last Committee report was in 2015.
- The 2025 emissions reductions goal of 25% was set 7 years ago.
- As of the end of calendar year 2017, scopes 1 and 2 emissions have been reduced 5.6% relative to the 2006 baseline year, or 22% to target.

*Efficiency upgrades* were successful at avoiding increased emissions that would have resulted from increased campus square footage from 2011-2017. The constant addition of new buildings is part of the reason we are not meeting the emissions goal.

**Central Campus Power Plant Upgrade**
The infrastructure upgrades for the central campus power plant, which includes the addition of a new natural gas turbine,

![University of Michigan Greenhouse Gas Emissions Graph](chart.png)

- **GHG averted**
- **Emissions**
- **Goal (510,000)**
expected to decrease total campus scopes 1 and 2 emissions to approximately 12% relative to
the 2006 baseline year; this is short of the 25% goal by 2025.

It is anticipated that a wind power purchase agreement (PPA) agreement from DTE, which
would be 70 MW of dedicated new wind capacity, can close the gap. For reference, purchased
electricity accounted for 56.1% of U-M’s Scope 1&2 Emissions in FY 2016. DTE will likely
finance the regionally sited wind project at zero up-front cost for U-M. Electricity rates would be
fixed for the life of the contract (25 years expected). For the early part of the cycle, U-M would
likely pay slightly more for electricity relative to what we pay now, approximately an additional
$2M per year. In the later years, U-M could pay slightly less - it depends on what happens to
fossil fuel prices relative to today’s prices. DTE could also provide 200MW of wind and
transition all of U-M’s purchased electricity to renewables. Note that this wind energy will be
located elsewhere in the state, not on campus. U-M could retire the “renewable energy credits”
associated with the wind power so that we can claim it as ours.

U-M uses a guideline of LEED Silver for buildings with capital costs of $20M+. This standard is
broad and assesses point ratings for various categories, including location and transportation
(16 points max), sustainable site development (10 points max), water efficiency (11 points max),
energy and atmosphere (33 points max), materials (13 points max), indoor environmental
quality (16 points max), and miscellaneous areas (10 points max). The energy category focuses
heavily on reducing energy usage and efficiency. Renewable energy production is worth up to
three points; a demand response program is 2 points. To meet LEED Silver, 50-59 points total is
required. If U-M wants to make more progress on reducing greenhouse gas emissions, an
assessment of onsite renewables, geothermal, or other advanced energy systems is needed in
parallel to LEED at the central U-M planning level for all new and renovation building projects.
Note that some other Big Ten schools have square footage caps (MSU, Illinois); they tear down
old buildings or renovate them. Looking at the concept more closely for where there is
applicability to U-M would be helpful.

University of Michigan 4/5/18 Sustainability Conference Outcomes
On April 5, 2018, the University of Michigan (U-M) hosted the conference “Toward Carbon
Neutrality at the University of Michigan: 2025 and Beyond”, which had the following goals:

- Brief all key stakeholders of U-M and the Ann Arbor community about standing
greenhouse gas emissions goals and progress towards them.
- Learn from other universities, municipalities and private sector companies about their
sustainable energy aspirations and progress.
- Learn from faculty and students about sustainable energy options being
explored/analyzed across the Michigan campus.
- Learn from industry and other experts on options they see for U-M green power.
The symposium was organized by Adam Simon (Earth & Environmental Sciences), Susan Fancy (Energy Institute), Nick Soberal (Energy Institute), Steve Skerlos (Mechanical Engineering), Joe Arvai (Erb Institute, SEAS), Mark Lindquist (SEAS), and Jonathan Overpeck (SEAS), with help from alumnus Kevin Self (BS, MS, Engineering) who serves on the external advisory board for the U-M Energy Institute and the Erb Institute. “Clean Wolverines” undergraduate students presenting at the conference included Will Arnuk (Earth and Environmental Sciences), Elena Essa (Statistics), Grant Faber (Business), Julian Hansen (International Studies), Andrew Hatt (Program in the Environment), Nathan Houghteling (Electrical Engineering), Lydia Whitbeck (Program in the Environment), and Logan Vear (Environmental Engineering). Graduate Students included Tyler Fitch (SEAS), and Evan Granito (SEAS). Students volunteered their time over two semesters to work on the project. Key support was provided by Andy Berki (Office of Campus Sustainability), Ken Keeler (Office of Campus Sustainability), and Drew Horning (Graham Institute).

Sustainable Energy Concepts Presented by U-M Students
University of Michigan students considered the following areas for the U-M campus:

Campus Onsite Solar PV Potential: Using modeling tools from the U-M course EARTH 380, students analyzed most areas and buildings on campus for onsite solar photovoltaic generation. Taking into account the efficiency of larger arrays for scale and architectural desirability, students concluded that five parking areas are U-M’s best candidates for solar PV - NC51, SC4 and SC5, M71, SC7, and NC37. The combined solar potential of these areas, which cover 11 acres, is 7,400 MWh per year, or 1.5% of U-M’s purchased electricity. This would mitigate 0.93% of the University’s Greenhouse gas emissions, and the payback period would be 10-12 years. Solar PV can also be installed on new or renovated buildings if roof strength and aesthetics allow. Solar usually provides 1-5% of a commercial building’s load, but it can be more or less.

Geothermal Technology: Recommended by students as an option for on-campus heating and cooling, the capital cost is higher than traditional HVAC systems, but systems last longer and report 55% lower operating and maintenance costs, as well as lower emissions. Students were inspired by the Capitol building for the state of Michigan, which recently received geothermal on a retrofit basis with a capital cost of $4M and $300,000 in cost savings per year. Boston University recently retrofitted a 100 year-old building with geothermal sited directly underneath the foundation, and report a 7-10 year payback.

Campus Biodigester: A biodigester could generate 1,100 MWh annually from U-M waste, and two orders of magnitude more capacity if a partnership was created with the City of Ann Arbor to use City waste. Potential sites include Mcity or the Ann Arbor City landfill.

Wind Power Purchase Agreement for Electricity: A Power Purchase Agreement or PPA was recommended for U-M’s purchased electricity from DTE. To meet 100% of U-M’s current
electricity demand, 200 MW of wind would be needed, sited on 200 acres regionally. This would offset 290,000 metric tons of carbon dioxide representing 46% of our current total emissions.

**Fully Electrify All U-M Buses and Fleet Vehicles:** Students recommended shifting U-M’s fleet to all-electric.

**Sustainability Programs Presented by other Universities and Private Industry**

Also presenting at the conference were representatives from Michigan State University, Northwestern University, Ohio State University and the University of Illinois. Each of these universities has more ambitious emissions reductions goals, and each has made faster progress toward reaching their goals by a combination of on-campus efficiency upgrades and on- and off-campus renewable energy infrastructure development. The organizations presented their sustainability goals, progress toward meeting their goals, and described the administrative structure for sustainability at each institution. We also heard from the Director for Sustainable Workplaces Facility Engineering and Manufacturing Operations at General Motors - GM recently announced a carbon neutrality goal.

The chart below was created by the Energy Institute using website and/or Association for Advancement of Sustainability in Higher Education (AASHE) data.

<table>
<thead>
<tr>
<th>School</th>
<th>Emissions Reduction Goal</th>
</tr>
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<tbody>
<tr>
<td>University of Michigan</td>
<td>25% of 2006 baseline by 2025</td>
</tr>
<tr>
<td>University of Illinois (Urbana-Champaign)</td>
<td>40% of 2008 baseline by 2025; 100% by 2050</td>
</tr>
<tr>
<td>Indiana University</td>
<td>30% of 2010 baseline by 2020</td>
</tr>
<tr>
<td>Pennsylvania State University</td>
<td>35% of 2006 baseline by 2020</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>30% of 2012 baseline by 2030; 100% by 2050</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>100% of 2011 baseline by 2050</td>
</tr>
<tr>
<td>Michigan State University</td>
<td>45% of 2010 baseline by 2020; 65% by 2030</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>50% of 2008 baseline by 2020; 100% by 2050</td>
</tr>
<tr>
<td>University of Maryland (College Park)</td>
<td>50% of 2005 baseline by 2020; 100% by 2050</td>
</tr>
<tr>
<td>Rutgers University</td>
<td>None</td>
</tr>
<tr>
<td>University of Iowa</td>
<td>10% by 2020 (unclear baseline)</td>
</tr>
<tr>
<td>University of Nebraska (Lincoln)</td>
<td>None</td>
</tr>
<tr>
<td>Purdue University</td>
<td>None</td>
</tr>
<tr>
<td>University of Wisconsin (Madison)</td>
<td>100% by 2050 (proposed, not yet accepted)</td>
</tr>
</tbody>
</table>

The “baseline year” or reference year for emissions reductions goals varies by school, and the chart below represents the emissions reduction goal of XX% by year XXXX and progress
towards that goal - regardless of when the goal was set or the baseline year. Big 10 schools operate in a geographically and climatologically similar environment to U-M, and schools that are making faster progress can be studied for ideas that may be effective here for the difficult problem of reducing emissions.

Note: available performance year data vary by school

Despite the square footage differences among U-M, Illinois, MSU, Northwestern, and Ohio State, each of those institutions described key differences between their approach to reducing emissions and the strategy at U-M. First, at all four other institutions, the decision making authority for every aspect of sustainability resides at the highest level of university governance, either in the President’s or Provost’s office. This was described as critical owing to the need for every decision on campus that might increase emissions - from planning to dining services to building renovations - to be approved at the highest levels of campus leadership.

Private Industry Solutions for Campus Renewables and Energy Efficiency
At the April 5 emissions symposium, representatives from The Carlyle Group (an American multinational private equity, alternative asset management and financial services corporation), Anbaric Transmission (an American electric power transmission and microgrid development company), Engie (a French multinational electric utility company that operates in the fields of electricity generation and distribution, natural gas, nuclear and renewable energy), and Schneider Electric (a European multinational corporation that specializes in energy management, automation solutions, spanning hardware, software, and services) described their work with municipalities and universities to help them reach sustainability goals. The representatives from industry described using a combination of on-site efficiency upgrades with on-site and off-site renewables. Efficiency upgrades were described as the “lowest hanging
fruit”, representing the cheapest way to reduce energy consumption and, thus, reduce emissions. Efficiency was the focus of the presentation by the representative from Engie, who described the 50-year concession agreement and lease with Ohio State Energy Partners, a consortium made up of ENGIE North America and Axium Infrastructure, to take over and run OSU Facilities. The $1.165 billion deal includes a $1.015 billion payment to OSU and a $150 million commitment to support academics in specific areas requested by students, faculty and staff. Also required is for Engie/Axium to improve energy efficiency on the Columbus campus by at least 25 percent in the first 10 years.3

The topic of capital required for efficiency upgrades and renewable energy infrastructure development was discussed, and representatives from Anbaric and Carlyle described many successful examples of private capital being used by universities and municipalities for these actions. Importantly, the benefits of public-private partnership allow for the recovery of tax credits that reduce the cost of projects and work to lower the long term costs associated with projects.

**Overview of Peer University Strategies - Ideas for U-M To Consider**

A brief overview of the goals and strategies employed by selected peer universities is found in the table below, representing Big 10 and other peer institutions. Further detail on the schools in the table below can be found in Appendix 5 of this document. A more in-depth breakdown of available emissions data for the universities below, the other universities in the Big 10, and other peer institutions can be found in the Benchmarking GHG Emissions Summary v3.1, available upon request.

<table>
<thead>
<tr>
<th>School</th>
<th>Unique Strategy or Goal</th>
<th>Noteworthy Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford University</td>
<td>Stanford Energy Systems Innovation (SESI)</td>
<td>High percentage of renewables in local grid; aggressive state regulatory mandates</td>
</tr>
<tr>
<td>University of California, Berkeley</td>
<td>Scope 3 reduction goal in place</td>
<td>High percentage of renewables in local grid; aggressive state regulatory mandates</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>Emissions reduction “floor” based on what they believed their available strategies were</td>
<td>Solar PPA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>University of Minnesota</th>
<th>Developed framework for short, medium and long term goals with estimated savings, payback, and emissions reduction for all strategies listed</th>
<th>High percentage of renewables in local grid; recommissioned older plant on campus to run as more efficient cogeneration plant and use natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Illinois</td>
<td>Aggressive goals in place to purchase on- and off-campus renewables; frequent analysis of performance and adjustment of goals in response to rate of progress</td>
<td>Extensive policies in place to maximize energy efficiency, decrease runaway emissions from campus growth, etc.</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>Third-party partnership with ENGIE and Axium to meet energy and emissions goals</td>
<td>Large funding input from third-party partners</td>
</tr>
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APPENDICES

Appendix 1: U-M’s 25% by 2025 Emissions Reduction Goal History
A Campus Sustainability Integrated Assessment (CSIA) launched in January 2010 with the endorsement of U-M President Mary Sue Coleman and her Executive Officers. The Graham Sustainability Institute was charged with leading and supporting the CSIA in partnership with the Office of Campus Sustainability.

The CSIA directly involved more than 500 U-M students, faculty, and staff representing 101 organizational units and 27 academic programs to advance campus sustainability by: establishing goals and targets; developing strategic frameworks; identifying research and learning opportunities; educating the campus community; and sharing publicly what we have learned.

During two phases, seven faculty-led and student-staffed teams focused on: Buildings, Energy, Land & Water, Food, Transportation, Purchasing & Recycling, and Culture. In Phase 1, the Analysis Teams conducted literature reviews, benchmarked peers, and assessed U-M practices. During Phase 2, the teams conducted more detailed analyses on potential actions that included costs, benefits, technical guidance, evaluation of uncertainties, and implementation timeframes.

Following Phase 2, an Integration Team reviewed all team reports and developed this final report with recommendations. The report organized all ideas and contributions under four themes: Climate Action, Waste Prevention, Healthy Environments, and Community Awareness. Accompanying the themes are Guiding Principles to guide our long-range strategy, 2025 Goals that are time-bound and quantifiable, and Potential Actions that provide a menu of possible options for achieving the goals.

After reviewing the report in the fall of 2011, President Coleman and her Executive Officers adopted campus sustainability commitments in each of the areas analyzed in the CSIA. With regard to Climate Action, the following commitments were endorsed:

Guiding Principle: We will pursue energy efficiency and fiscally-responsible energy sourcing strategies to reduce greenhouse gas emissions toward long-term carbon neutrality.

2025 Goals:
1. Reduce greenhouse gas emissions (scopes 1&2) by 25% below 2006 levels.
2. Decrease carbon intensity of passenger trips on U-M transportation options by 30% below 2006 levels.
Appendix 2: Additional Energy and Climate Change Background

Fossil fuels (coal, oil, natural gas) play a dominant role in global energy systems. Fossil energy was a fundamental driver of the Industrial Revolution, and the technological, social, economic and development progress which followed. Carbon dioxide and other emissions from the burning of fossil fuels have created a “greenhouse” effect that act like a blanket, absorbing infrared radiation and preventing it from escaping into outer space. Over time, earth’s atmosphere and surface have gradually warmed, a process known as global warming or climate change.

Going forward, humanity must balance the role of energy in social and economic development with the need to decarbonize and reduce our reliance on fossil fuels.

The chart below describes changes in carbon dioxide emissions from fossil fuel usage, starting with the Industrial Revolution.

Gross domestic product (GDP) correlates with energy usage. The next chart reveals how much progress is needed in reducing carbon dioxide emissions globally in order to keep the planet below the 2°C acceptable global temperature rise identified as the target by the Intergovernmental Panel on Climate Change.

Source: Data from EIA Database 2008, chart from former DOE Undersecretary Steve Koonin August 2013

To further put this in perspective, global emissions reductions are needed while less wealthy countries are given the opportunity to increase their standard of living:

“Three-quarters of the global population uses just 10 percent of the world’s energy, 1 billion people lack access to electricity, and 3 billion cook their food over dung, wood, and charcoal, leading to millions of early deaths. These people are energy starved—and they need a feast, not a diet. People in Angola, Bangladesh, and Cameroon, for example, use about 250 kilowatt-hours of electricity per year, while people in the U.S. use 12,246.” Lisa Margonelli, The Carbon Diet Fallacy
Appendix 3: Origins of the “Clean Wolverines” Team at U-M

In January 2017, a staff member at the City of Ann Arbor approached Susan Fancy from the University of Michigan Energy Institute and requested a team of students to conduct a microgrid feasibility study of city-owned properties. Susan connected with Adam Simon of Earth and Environmental Sciences who teaches EARTH 380, which has students transition the University of Michigan “off-the grid” with hands-on modeling and discussion. With funding from the Energy Institute, three UROP students and two summer interns conducted research over the summer with guidance from Adam and Susan. A fall 2017 presentation to the City of Ann Arbor’s Energy Commissions completed the project.

An alumni and member of the Energy Institute’s advisory board, Kevin Self from Schneider Electric, visited the university in August 2017 to promote more aggressive emissions reductions work. Kevin routinely sees the sustainable energy progress at other universities because they have hired Schneider to do their work, and he saw us as falling behind. Around the same time and into the fall, other students and student groups became aware of the Ann Arbor microgrid project and approached Adam and Susan, wondering if the same type of project could be completed for the University. The “clean wolverines” arose organically, and quickly became a group of dedicated students supported by Adam, Susan, and Nick Soberal (also from the Energy Institute). This team met weekly on a volunteer basis to investigate options and, once the concept for an emissions conference was suggested, prepare for it. Other faculty joined including Joe Arvai from Ross, Steve Skerlos from the College of Engineering, and Mark Lindquist from SEAS. Jonathan Overpeck has been a touchpoint for key input along the way, and he moderated the closing session at the conference. Andy Berki and Ken Keeler from Facilities and the Office for Campus Sustainability were helpful as well, providing information when requested, and Andy moderated the schools session of the conference.

Kevin Self has continued to provide input and information along the way. The local climate change community also got involved - the City of Ann Arbor, Ecology Center, Huron River Watershed Council, Interfaith Power and Light, Washtenaw Bike and Walk as well as others - attending the conference, and providing other information to move the project forward. U-M is 30% of Ann Arbor emissions, and despite having an Ann Arbor climate action plan, our lack of progress hampers the community in meeting its own goals.
Appendix 4: EPA Green Power Program for Big 10 Schools
The EPA has a “Green Power” Program available to a wide range of organizations. Below is the current listing for the Big 10 schools. The energy that the University of Michigan purchases from DTE with state-mandated green power from the renewable portfolio standard does not qualify for this listing.

<table>
<thead>
<tr>
<th>School</th>
<th>Green Power (kWh)</th>
<th>% Green Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Ohio State University</td>
<td>105,651,613</td>
<td>18</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>100,370,800</td>
<td>39</td>
</tr>
<tr>
<td>University of Maryland</td>
<td>96,927,825</td>
<td>34</td>
</tr>
<tr>
<td>University of Wisconsin</td>
<td>72,168,457</td>
<td>16</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>57,800,000</td>
<td>16</td>
</tr>
<tr>
<td>University of Illinois at Urbana-Champaign</td>
<td>32,871,183</td>
<td>8</td>
</tr>
<tr>
<td>Michigan State University</td>
<td>17,400,000</td>
<td>7</td>
</tr>
<tr>
<td>University of Iowa</td>
<td>12,994,956</td>
<td>4</td>
</tr>
<tr>
<td>Indiana University, Bloomington</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pennsylvania State University</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Purdue University</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rutgers University</td>
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<td>-</td>
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<tr>
<td>University of Michigan</td>
<td>-</td>
<td>-</td>
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<tr>
<td>University of Nebraska</td>
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</tr>
</tbody>
</table>
Appendix 5: Peer University Strategies - Ideas for U-M To Consider

The following case studies represent strategies, ambitions and background for some peer institutions to the University of Michigan. While neither comprehensive nor directly relatable to strategies employed by the University of Michigan, these cases can indicate how our peers are meeting their goals and may offer insight into translatable practices for application in Michigan.

**Stanford University**

*Stanford Energy Systems Innovation (SESI) background:*

- Stanford employed a district energy system from 1987 to 2015 comprised of a gas-fired combined heat and power plant and power, steam, and chilled water distribution systems; this was efficient but was responsible for 90% of Stanford’s greenhouse gas emissions.
- Contract expiration in 2015 allowed the university to reevaluate and optimize costs and emissions.
- An analysis provided nine individual options with net present value estimates; from these options, the Board of Trustees decided in 2011 to purchase 100% of Stanford’s electricity from external sources and construct a sophisticated heat recovery plant to provide hot water via a hot-water distribution system. Coupled with decreased emissions due to renewable energy purchases, this plan decreased Stanford’s emissions substantially.

<table>
<thead>
<tr>
<th>#6, with NPV</th>
<th>Grid + heat recovery</th>
<th>Get electricity from grid; install new electricity-based heat recovery plant and hot water-based distribution system</th>
<th>Best overall option, with relatively low cost, GHG emissions, and water use</th>
<th>Higher up-front capital cost ($465 million) than retaining existing cogen with steam-based distribution, which is financed, owned, and operated by a third party</th>
</tr>
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<td>$1.170 billion</td>
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University of California, Berkeley

At a glance:

- UC Berkeley is one of 11 campuses in the University of California system. The entire University of California system conforms to an established set of policy guidelines for sustainable practices, which is reviewed regularly.
- Berkeley met a goal in 2012 to achieve reduction of scope 1, 2, and 3 emissions to 1990 levels by 2020, in compliance with the California Global Warming Solutions Act (California AB 32).
- After 1990 levels, the next available data for UC Berkeley were from 2007 (their emissions goal was created in 2004). Calculating the emissions reductions needed to decrease scope 1 and 2 emissions from 2007 levels to 1990 levels amounts to a 14.7% reduction; as of 2016, they had achieved a 15.9% reduction in scope 1 and 2 emissions.
- UC Berkeley has an additional goal to achieve net-zero emissions from scope 1 and 2 sources by 2025, which represents an 80% reduction of overall emissions for the campus.
- UC Berkeley also has a goal to achieve net-zero emissions from scope 3 sources by 2050, which represents a 20% reduction in overall emissions that are largely due to transportation.
- As part of their 2016 Carbon Neutrality Planning Framework, the university also evaluated what strategies already exist on campus, what new strategies could be pursued that would help achieve the 2025 neutrality goal, and additional thoughts on each strategy.
Massachusetts Institute of Technology

At a glance:

- MIT’s goals were set after an in-depth analysis of their 2014 baseline emissions. Unlike most other universities which chose ambitious goals competitive with peer institutions, MIT selected a reduction “floor” that they felt could realistically be attained through a strategic plan that was laid out in 2015.
- 96% of MIT’s 2017 emissions were due to energy used to heat, cool, and power buildings.
- Emissions due to on-campus sources remained unchanged from 2016 to 2017; the overall emissions reduction from 2016 to 2017 was due to the addition of a solar power purchase agreement to their portfolio.

University of Minnesota, Twin Cities

At a glance:

- Among the closest gross square footage to University of Michigan based on available data and inclusive of a medical system (36M square feet for Michigan compared to 23M square feet for Minnesota).
- Similar emissions per square foot in FY2017 (0.0172 MTCO\(_2\)e/square foot for Michigan, and 0.0175 MTCO\(_2\)e/square foot for Minnesota).
- Steam plant is a noteworthy source of emissions.


- As part of CAP, provided short (2011-2016), medium (2017-2021) and long term (2022 and beyond) mitigation strategies and goals.
- For all mitigation strategies, the university also provided the estimated savings, simple payback period, an estimated CO\(_2\) reduction.
At a glance:

- Another peer institution in the midwest, Illinois’ energy mix is comprised of 82.4% coal according to the U.S. Environmental Protection Agency’s Power Profiler tool, compared to Michigan’s 59.6% coal.
- University of Michigan emitted 636,956 MTCO$_2$e of adjusted scope 1 and 2 emissions in FY 2017, compared to University of Illinois' 424,797 MTCO$_2$e in fiscal year FY 2016.
  - Comparing emissions per square foot, University of Michigan emitted 0.0172 MTCO$_2$e per square foot in FY 2017, while University of Illinois emitted 0.0196 MTCO$_2$e per square foot in FY 2016.
- With a scope 1 and 2 carbon neutrality goal in place for 2050, University of Illinois has achieved a 20.9% reduction as of the end of FY 2016.

Strategies for meeting sustainability goals across campus:

- University of Illinois’ 2015 climate action plan (called iCAP) is 88 pages, divided into 13 chapters, and details goals for a variety of sectors on campus.
- While the anticipated sustainability topics such as water conservation, energy, efficiency, transportation, and agriculture are all represented within, there are also four chapters in the iCAP dedicated to finance feasibility, outreach, research, and curricular education.
- Every chapter outlines clear short- and long-term objectives and goals, and suggests strategies for achieving these goals; for example, the finance chapter has an objective to evaluate the feasibility of internally putting a price on carbon emissions by the end of FY 2016.
Ohio State University

At a glance:

- Another peer institution in the Midwest, the average fuel mix in Ohio State’s region is primarily comprised of coal (60%).
- At 24.9 million square feet of space on campus, Ohio State is the next largest campus reporting its emissions in the Big 10 after University of Michigan.

Strategies for meeting emissions goals

- Ohio State is one of the top three Big 10 green power purchasers in the EPA’s Green Power Program.
- Ohio State recently entered into a $1.165 billion, 50-year partnership with ENGIE and Axium to manage and maintain their energy infrastructure. The deal includes funding support for specific academic areas and a payment to the university.
  - To briefly summarize the deal, OSU signed an agreement with ENGIE such that, in exchange for OSU acting as a guaranteed customer for 50 years, ENGIE will work with OSU to meet emissions reduction, energy efficiency, and renewable energy integration goals. The deal is structured like a power purchase agreement (PPA) in which ENGIE leases land from OSU and sells OSU power.
- OSU Office of Energy and Environment personnel indicated during the April 5 emissions workshop that the university set aspirational goals before gathering benchmarking data on their performance, and then developed strategies for how to meet their goals after the fact.