UNIVERSITY OF MICHIGAN
SUSTAINABILITY GOAL REPORTING GUIDELINES

GREENHOUSE GAS REDUCTION

SECTION 1: Introduction

As an institution comprised of nearly 400 buildings covering over 38 million square feet, the University of Michigan (U-M) requires a significant amount of energy to meet the educational, research, and operational needs of the campus. An innovational leader, U-M strives to set the standards for sustainability, both in the classroom and through its physical operations. These reporting guidelines pertain to U-M's 2011 goal to reduce scope 1 and 2 greenhouse gas emissions 25% by 2025—which the university achieved in 2022—and have been updated to support U-M's carbon neutrality commitments. In 2021, U-M announced a carbon neutrality commitment to eliminate *all* scope 1 & 2 emissions by 2040. Achieving a goal such as this will require the development of new technology, improvement of existing technology, and behavioral changes within the University community.

The university's sustainability goals will be periodically reevaluated and may be adjusted based on variables such as changes in technology, the State of Michigan energy platform, economics, and peer university goals.

SECTION 2: Emissions Overview

Greenhouse gas (GHG) emissions are a direct result of burning fossil fuels to generate energy. At U-M, the Central Power Plant (CPP) provides energy in the form of steam and electricity to the Medical Center and Central Campus by burning natural gas. Outlying boilers, also fueled with natural gas, provide steam and hot water to more than 100 buildings not serviced by the CPP. The natural gas fueled North Campus Research Complex (NCRC) Central Energy Plant provides steam, chilled water and electricity to the 2.7 million square feet NCRC campus.

SECTION 3: Emission Calculations

Scope 1 emissions include any stationary and mobile source emissions, while scope 2 refers to emissions related to purchased electricity. All data is verified through an in-house data review process prior to publication.

Stationary source emissions have been calculated from information provided by U-M Utilities Summary of Annual Utilities Purchases, and incorporates CO_2, CH_4, and N_2O emissions associated with the combustion of natural gas, fuel oil, and liquefied petroleum (LP) gas. Conversion factors and Global Warming Potential values are sourced from the EPA Emission Factors for Greenhouse Gas Inventories.

TABLE 1: Stationary Source Emission Conversion Factors

	Carbon Dioxide (CO_2)			**Methane (CH_4)**			**Nitrous Oxide (N_2O)**		
Fuel Source	Conversion Factor		Global Warming Potential	Conversion Factor		Global Warming Potential	Conversion Factor		Global Warming Potential
Natural Gas (ccf)	0.00544	MT/ccf	1	1.03E-07	MT/ccf	25	1.00E-08	MT/ccf	298
Fuel Oil (gal)	0.01021	MT/gal	1	4.20E-07	MT/gal	25	8.00E-08	MT/gal	298
LP Gas (gal)	0.00568	MT/gal	1	2.80E-07	MT/gal	25	6.00E-08	MT/gal	298

Stationary Source Emissions =

Natural Gas Purchase (ccf) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Natural Gas Purchase (ccf) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Natural Gas Purchase (ccf) * N_2O Conversion Factor * N_2O Global Warming Potential
+ Fuel Oil Purchase (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Fuel Oil Purchase (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Fuel Oil Purchase (gal) * N_2O Conversion Factor * N_2O Global Warming Potential
+ LP Gas Purchase (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ LP Gas Purchase (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ LP Gas Purchase (gal) * N_2O Conversion Factor * N_2O Global Warming Potential

Mobile source emissions are calculated from information provided by U-M Logistics, Transportation and Parking, which accounts for emissions generated by the combustion of unleaded gasoline, diesel, B-20 and B-5 biodiesel, and E-85 and E-70 ethanol used to fuel U-M's transportation fleet. Note that B-20 is a mixture consisting of 20% biodiesel and 80% diesel, B-5 is a mixture consisting of 5% biodiesel and 95% diesel while E-85 is a mixture of 85% ethanol, and 15% unleaded gasoline and E-70 is a mixture of 70% ethanol, and 30% unleaded gasoline. Conversion factors below refer to the specific fraction of the fuel mixtures.

TABLE 2: Mobile Source Emission Conversion Factors

Fuel Source	Carbon Dioxide (CO_2)			Methane (CH_4)			Nitrous Oxide (N_2O)		
	Conversion Factor		Global Warming Potential	Conversion Factor		Global Warming Potential	Conversion Factor		Global Warming Potential
Unleaded Fuel (gal)	0.00878	MT/gal	1	3.8E-07	MT/gal	25	8.00E-08	MT/gal	298
Diesel Fuel (gal)	0.0102	MT/gal	1	4.20E-07	MT/gal	25	8.00E-08	MT/gal	298
Biodiesel (gal)	0.00945	MT/gal	1	1.40E-07	MT/gal	25	1.00E-08	MT/gal	298
ULS Diesel (gal)	0.0102	MT/gal	1	4.20E-07	MT/gal	25	8.00E-08	MT/gal	298
Ethanol (gal)	0.00575	MT/gal	1	9.00E-08	MT/gal	25	1.00E-08	MT/gal	298

Mobile Source Emissions =

Unleaded Fuel (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Unleaded Fuel (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Unleaded Fuel (gal) * N_2O Conversion Factor * N_2O Global Warming Potential
+ Diesel fuel (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Diesel fuel (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Diesel fuel (gal) * N_2O Conversion Factor * N_2O Global Warming Potential
+ ULS Diesel (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ ULS Diesel (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ ULS Diesel (gal) * N_2O Conversion Factor * N_2O Global Warming Potential
+ Biodiesel (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Biodiesel (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Biodiesel (gal) * N_2O Conversion Factor * N_2O Global Warming Potential
+ Ethanol (gal) * CO_2 Conversion Factor * CO_2 Global Warming Potential
+ Ethanol (gal) * CH_4 Conversion Factor * CH_4 Global Warming Potential
+ Ethanol (gal) * N_2O Conversion Factor * N_2O Global Warming Potential

Scope 2 emissions are calculated from information provided by the U-M Utilities Summary of Annual Utilities Purchases. The University of Michigan calculates and reports two scope 2 emission numbers: one with a "location-based" method and another with a "market-based" method. The location-based method is designed to disclose what is physically put into the air, and the market-based method represents emissions U-M is responsible for while considering its overall electricity contract. Both pieces of information tell an important story about the University's carbon footprint and carbon reduction strategy.

Calculations associated with the Location-based reporting use conversion factors for electricity produced in the Michigan region as published by the EPA's Emissions & Generation Resource Integrated Database (EGRID). Market-based reporting uses a conversion factor based on the fuel mix of the DTE electricity provided to us. Because our Power Purchase Agreement (PPA) Renewable Energy Credits (RECs) are bundled into our power purchase agreement, the market-based method also accounts for the PPA RECs. RECs are considered to save the GHGs associated with that number of MWhs as generated from the DTE non-renewable fleet. This includes electricity generated through the burning of coal, natural gas, fuel oil, and nuclear fuel.

Location-Based GHG Emission Calculation:

= MWh purchased electricity * EGRID Emission Factor ($MTCO_2e/MWh$)

Market-based GHG Emission Conversion Factor Calculation:

Purchased Electricity Emission Factor:

DTE Fossil Fuel Fleet ($MTCO_2/MWh$) * % DTE Fossil fuel Fleet Generation * % DTE Provided Electricity

+

Regional Fossil Fuel Fleet ($MTCO_2/MWh$) * % Regional Fossil fuel Fleet Generation * % Regional Provided Electricity

+

CH_4 ($MTCO_2e/MWh$) + N_2O ($MTCO_2e/MWh$)

REC Associated Emission Factor:

DTE Fossil Fuel Fleet ($MTCO_2/MWh$) *(% DTE Fossil fuel Fleet Generation / (% DTE Fossil fuel Fleet Generation + % DTE Nuclear fuel Fleet Generation)) * % DTE Provided Electricity

+

Regional Fossil Fuel Fleet ($MTCO_2/MWh$) * (% Regional Fossil fuel Fleet Generation / (% regional Fossil fuel Fleet Generation + % Regional Nuclear fuel Fleet Generation)) * % Regional Provided Electricity

+

CH_4 ($MTCO_2e/MWh$) + N_2O ($MTCO_2e/MWh$)

Market-based GHG Emissions:

= (MWh purchased electricity * Purchased Electricity Emission Factor) –

(REC purchases * REC Associated Emission Factor)

Market-based GHG Emissions Factor (MTCO2e/MWh):

Market-based GHG Emissions / MWh purchased electricity

2022 Market-based Emissions Calculation Example:

Electricity Purchase (MWh)		482,797	
REC Purchase		148,262	
DTE % renewable	9.09	Regional % renewable	9.34
DTE % nuclear	23.59	Regional% nuclear	27.82
DTE % Fossil Fuel Fleet	67.32	Regional % Fossil Fuel Fleet	62.84
DTE Fossil Fuel Fleet MTCO2/MWh	0.9712	Regional Fossil Fuel Fleet MTCO2/MWh	0.5138
% DTE electricity	83.41	% Regional electricity	16.59

Purchased Electricity Emission Factor:
(0.9712 $MTCO_2$/MWh * 0.6732 * 0.8341) + (0.5138 $MTCO_2$/MWh * 0.6284 * 0.1659) = 0.599 $MTCO_2$/MWh
+ 0.000760 + 0.002433 = 0.602 $MTCO_2e$/MWh

REC Associated Emission Factor:
[0.9712 $MTCO_2$/MWh * (0.6732/ (0.6732 + 0.2359)) * 0.8341] + [0.5138 $MTCO_2$/MWh * (0.6284/ (0.6284 + .02782)) * .1659] = 0.659 $MTCO_2$/MWh
+ 0.000760 + 0.002433 = 0.662 $MTCO_2e$/MWh

Market-based GHG Emissions:
(482,797 MWh * 0.602 $MTCO_2e$/MWh) - (148,262 MWh * 0.662 $MTCO_2e$/MWh) = 192,514 $MTCO_2e$

Market-based GHG Emissions Factor ($MTCO_2e$/MWh):
192,514 $MTCO_2e$ / 482,797 MWh = 0.399 $MTCO_2e$/MWh

TABLE 3: Scope 2 Emission Conversion Factors

Fiscal Year	EGRID ($MTCO_2$/MWh)	Market Based ($MTCO_2$/MWh)
2010	0.743	0.764
2011	0.743	0.747
2012	0.715	0.739
2013	0.715	0.772
2014	0.700	0.721
2015	0.700	0.714
2016	0.580	0.701
2017	0.580	0.663
2018	0.599	0.669
2019	0.543	0.680
2020	0.526	0.649
2021	0.526	0.527
2022	0.526	0.399
2023	0.526	0.438

SECTION 4: 2025 Goal Reporting

In 2011, the Ann Arbor campus set a goal to reduce greenhouse gas emissions 25% by 2025, compared to a 2006 baseline of 680,000 $MTCO_2e$. FY2006-FY2011 emissions have been adjusted to include university expansion at NCRC. An estimate of 60,000 $MTCO_2e$ is based upon data provided by the previous owner of the facility. Calculations were completed using the following equations:

FY2006 baseline:
Emissions as reported in the U-M Annual Sustainability Report (ASR) + NCRC adjustment
= 620,000 + 60,000 = 680,000 $MTCO_2e$

FY2007 = ASR + NCRC adjustment - RECs
= 600,000 + 60,000 – 0 = 660,000 $MTCO_2e$

FY2008 = ASR + NCRC adjustment - RECs
= 615,000 + 60,000 – 0 = 675,000 $MTCO_2e$

FY2009 = ASR + NCRC adjustment - RECs
= 592,000 + 60,000 – 0 = 652,000 $MTCO_2e$

FY2010 = ASR + NCRC adjustment – NCRC emissions associated with partial activity - RECs
= 672,000 + 60,000 - 41,000 – 2,500 = 688,000 $MTCO_2e$

FY2011 = ASR + NCRC adjustment – NCRC emissions associated with partial activity - RECs
= 722,000 + 60,000 - 51,000 – 8000 = 720,000 $MTCO_2e$

FY2012 (and future) = ASR reported value (NCRC relocations will be assumed to be completed)

U-M achieved this goal in 2022 by reducing net greenhouse gas emissions to a maximum of 510,000 $MTCO_2e$/year.

Continued monitoring of emissions levels will be conducted annually and reported to the public at planetblue.umich.edu.