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City of Ann Arbor

Dulcey Simpkins, Ph.D.	Department of Environmental Coordination Services
Nancy Stone	Solid Waste Department

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ABSTRACT

On October 20, 1997 the City of Ann Arbor joined the International Council for Local Environmental Initiative's (ICLEI) Cities for Climate Protection campaign (CCP). Under the obligation of the CCP campaign the City is required to create an inventory of energy consumption and greenhouse gas (GHG) emissions, set a reduction target, develop a strategy to reduce their GHG emissions, implement the necessary measures, and monitor their results.

The objectives of this Project are to: raise local awareness and understanding of the social, environmental, and economic benefits of reducing GHGs on a local and global scale; identify and quantify GHGs emitted by the City of Ann Arbor from 1990 to present, and project future emissions values to 2050 based on historic and future trends; identify and quantify the City of Ann Arbor's emissions reduction accomplishments since 1990; identify a politically and economically feasible GHG emissions reduction target for the City of Ann Arbor to achieve by 2020; identify strategies to reduce GHG emissions generated by Ann Arbor's transportation, residential, commercial, industrial, municipal solid waste sectors, the municipal government, and the University of Michigan's Ann Arbor Campus that meet the reduction target specified by this Project.

This Project sets a reduction target of 7% below 1990 GHG emissions by 2020 and develops 29 measures, collectively to reduce emissions to 3% below 1990 levels by 2020. The target reduction can be met by the City if full implementation of the 29 measures is achieved along a more aggressive timeline. Two alternative implementation paths, 2018 and 2015, achieve emissions reductions of 5% and 7% below 1990 GHG emissions levels respectively. The 29 measures are divided into four categories: Community Outreach and Education, Energy Conservation, Transportation, and Solid Waste Management. Each measure is evaluated for its potential to reduce GHG emissions, as well as its initial cost, annual cost, annual cost savings, and payback to the municipality.

EXECUTIVE SUMMARY

PROJECT OBJECTIVES

On October 20, 1997, the City Council of Ann Arbor voted to adopt the necessary statutes committing the City to the Cities for Climate Protection (CCP) campaign - an international program with the aim to reduce greenhouse gas (GHG) emissions by encouraging local action.[1] The International Council for Local Environmental Initiatives (ICLEI) developed the CCP campaign. In the winter of 2001, David Konkle, Ann Arbor's Energy Coordinator, sought the help of a Master's Project team to devise a strategy for the City to achieve its commitment to the CCP campaign. The Team developed this Master's Project to further the City's efforts to reduce local GHG emissions and set the groundwork for cultivating a viable Local Action Plan. The primary objectives of the Master's Project are as follows:

1. Raise local awareness and understanding of the social, environmental, and economic benefits of reducing GHGs on a local and global scale
2. Identify and quantify GHGs emitted by the City of Ann Arbor from 1990 to present, and project future emissions values to 2050 based on historic and future trends
3. Identify and quantify the City of Ann Arbor's emissions reductions accomplishments since 1990
4. Identify a politically and economically feasible GHG emissions reduction target for the City of Ann Arbor to achieve by 2020
5. Identify strategies to reduce GHG emissions generated by Ann Arbor's transportation, residential, commercial, industrial, municipal solid waste sectors, the municipal government, and the University of Michigan's Ann Arbor Campus that meet the reduction target specified by this Project

This Master's Project includes a detailed comparison of GHG emission reduction measures and identifies the cost to implement and operate (if quantifiable), the annual saving and years to repayment, and the CO_2 equivalent reduction potential for each measure. Overall, this Project does not provide the City of Ann Arbor with a direct action plan to reduce GHG emissions, but rather it provides a framework for implementing a GHG reduction plan as City policy.

[1] Appendix A: Resolution Regarding the City of Ann Arbor Participation in the "Cities for Climate Protection Campaign."

SYSTEM BOUNDARIES

Located approximately 40 miles west of Detroit, the City of Ann Arbor has 17,252 acres of city-zoned land and 114,024 residents, including University of Michigan students and staff.[2] As the major city within Washtenaw County, Ann Arbor residents participate in a wide variety of activities that generate GHG emissions.

GHG emissions are directly related to energy consumption. Ann Arbor's energy consumption is assumed to be provided by three major energy carriers: electricity, natural gas, and petroleum. These energy carriers require embodied energy as feedstock, plus processing energy. Total fuel cycle energy analysis encompasses the whole life cycle of energy production including mining and material extraction, the energy used to convert the feedstock into a fuel, the transportation energy associated with the movement of the fuel to the site of consumption, and the final consumption of the fuel. Although most of the activities prior to final consumption refer to upstream processes that are dealt with far from the City of Ann Arbor, the amount of energy consumed upstream can be significant. Therefore, the Team decided, for the purposes of this Project, to concentrate on on-site energy utilization consumed within the City of Ann Arbor plus upstream processes associated with each energy carrier. These figures are included in the greenhouse gas inventory as total fuel cycle energy consumption.

Moreover, the Team divided the City of Ann Arbor into six energy use sectors: residential, commercial, industrial, transportation, municipal government, and the University of Michigan. Additionally, municipal solid waste management is inventoried as an auxiliary source of GHGs. We determined that this categorization would be valuable in developing and evaluating GHG emission reduction measures and policies. The system boundaries for the Project are the city limits of Ann Arbor, Michigan. The system boundaries define what aspects of the system, for both the energy carriers and the energy use sectors (including municipal solid waste management), are either included or excluded from analysis. The energy use sectors are defined as follows:

Residential Sector: This sector consists of all private residences, whether occupied or vacant, owned or rented, including single family homes, multifamily housing units, and mobile homes.[3] Ann Arbor's residential sector includes 47,218 units of private residences, with an average of 2.22 persons per household.[4] The GHG emissions associated with Ann Arbor's residential electricity and natural gas consumption were inventoried for this Project.

Commercial Sector: This sector is comprised of business establishments not engaged in transportation, manufacturing, or other types of industrial activities such as agriculture, mining, or construction. Commercial establishments include hotels, motels, restaurants,

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[2] Census 2000 <http://www.census.gov/main/www/cen2000.html>.

[3] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2000*, ANNEX Z.

[4] Census 2000. <http://www.census.gov/main/www/cen2000.html>.

wholesale businesses, retail stores, laundries, and other service-oriented enterprises.[5] Again, electricity and natural gas consumption are inventoried to determine this sector's GHG emissions.

Industrial Sector: This sector encompasses manufacturing, construction, agriculture, and forestry, with manufacturing comprising the largest part of the sector. There were 132 industrial sites registered in the City of Ann Arbor in 1999.[6] The Team inventoried electricity and natural gas consumption to determine GHG emissions from this sector.

Transportation Sector: This sector includes all private vehicles, community vehicles, the City of Ann Arbor fleet, the University of Michigan fleet, Ann Arbor Public Schools fleet buses, and Ann Arbor Transportation Authority buses. Aircraft and railways that pass over or through the City limits are excluded from this Project. Ann Arbor's petroleum consumption, derived from total vehicle miles traveled (VMT), was inventoried to determine this sector's GHG emissions.

Municipal Government: This sector consists of ten major municipal departments in the City of Ann Arbor.[7] Electricity and natural gas consumption were inventoried to evaluate this sector's GHG emissions. Fleets vehicles owned and/or operated by the City of Ann Arbor, the University of Michigan, Ann Arbor Public Schools buses, and Ann Arbor Transportation Authority buses were not included in this sector, but were incorporated into the transportation sector.

University of Michigan: In 2000, The University of Michigan (U of M) Ann Arbor campus had 38,248 students including undergraduate, graduate, and doctorate students. including faculty and staff, the total population totaled 62,750 in 2000.[8] The campus includes 214 major buildings and 221 apartment buildings within a land area of 26,912,087 square feet. The University of Michigan's electricity is purchased from both private electricity providers[9] and by its own electricity generating facility – the Central Power Plant (CPP). Natural gas is purchased directly from private natural gas suppliers for heating purposes. The GHG emissions associated with electricity production are attributed to the electricity produced at the CPP and not for the mixture of fuels used to produce the electricity.[10] As mentioned previously, emissions from the U of M fleet are accounted for in the transportation sector.

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[5] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2000*, ANNEX Z.

[6] See Appendix D

[7] Detailed information for ten municipal departments is described in Appendix D.

[8] *Sustainability Assessment and Reporting for the University of Michigan's Ann Arbor Campus.*

[9] The U of M Central Campus and Hospital receive their electric power from Engage Energy, a subsidiary of Duke Energy Trading and Marketing Company. The U of M North Campus receives its electric power from WPS (Wisconsin Public Service).

[10] The Project used this method to avoid double counting emissions associated with electrical production at the CPP. Table 33 compares the fuel mixtures at the CPP and DTE. Table 42 shows the accounting of GHG for electrical production at the CPP. Natural gas consumption listed in Table 42 is not associated with the production of electricity at the CPP. It is inventoried as use for other purposes on campus.

Municipal Solid Waste Management: This sector includes the methods (landfilling and/or resource recovery) used in Ann Arbor to transport and manage all waste generated by Ann Arbor citizens. Petroleum consumption from the collection and subsequent transportation of materials to end-of-life management, and methane generation from the decay of landfilled organic materials were inventoried. The upstream emissions generated from mining and processing materials to generate products were also included.[11]

[11] The U.S. Environmental Protection Agency greenhouse gas coefficients for solid waste management incorporate upstream emissions.

ENERGY CONSUMPTION

Electricity

Each of energy use sectors in the City of Ann Arbor (Residential, Commercial, Industrial, and Municipal government) receives electricity from DTE except for the University of Michigan.[12] The U of M acquires electricity from the CPP and private suppliers (Engage Energy Company and Wisconsin Power Service).[13] The CPP is a facility located on the central campus providing electricity, heating, cooling, and hot water to approximately 130 university facilities on campus using primarily uses natural gas, a less carbon intense fuel, to operate the boilers and gas turbines. GHGs from the CPP tend to be low compared to coal and oil fired power plant.

On the other hand, DTE supplies electricity to most of the consumers within Ann Arbor city limits. Due to cheap and abundant resources in the heart of the Midwest, DTE's fuel mixture relies heavily on coal to generate electricity. Table ES-1 shows the fuel mixture for DTE, CPP compared to the U.S average. As shown in the Table ES-1, the difference in fuel mixtures explains why DTE's electricity emissions profile is far more carbon intensive than most electricity emissions profiles across the country.

Table ES-1: Comparison of Fuel Mixture

	Coal	Natural Gas	Oil	Nuclear	Hydropower	Renewable
U.S. Average[14]	51.8 %	15.7 %	2.9 %	19.9 %	7.2 %	2.2 %
DTE[15]	76.7 %	3.2 %	0.6 %	18.1 %	0.1 %	1.3 %
CPP[16]	0 %	98.7 %	1.3 %	0 %	0 %	0 %

Figure ES-1 indicates historical electricity consumption in the City of Ann Arbor. Total electricity consumption was 1,214,897,204 kWh in 1990, and 1,500,778,261 kWh in 2000. The average annual growth rate was 2.1% during this period. Per capital usage was 11,086 kWh in 1990 and 13,162 kWh in 2000. Compared to the U.S. average of 12,810 kWh per

[12] The electricity suppliers have been diversified since 2001 due to the Customer Choice and Electric Reliability Act (2000 PA 141) in order to promote competition between generating companies supplying electricity in Michigan. There are 25 alternative electric suppliers in Michigan including Engage Energy Company and WPS Energy Services Inc. <http://www.cis.state.mi.us/mpsc/electric/restruct/esp/> However, the energy inventory for this Project focuses on electricity consumption before 2000. The Project assumes that the City of Ann Arbor is supplied primary by electricity from Detroit Edison.

[13] The U of M Central Campus and Hospital receive their electric power from Engage Energy, a subsidiary of Duke Energy Trading and Marketing Company. The U of M North Campus receives its electric power from WPS (Wisconsin Public Service).

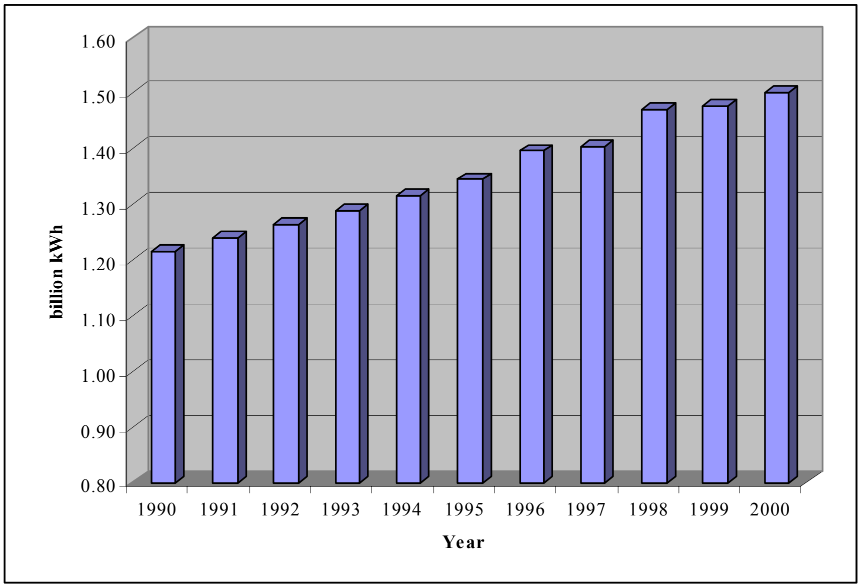
[14] AER2000 Table 8.2

[15] DTE website <http://www.dteenergy.com/community/environmental/fuelMix.html>.

[16] Data for CPP refer to the average from 1996 to 1999 UM Utilities website <http://www.plantops.umich.edu/utilities/Utilities/CentralPowerPlant/>.

person in 2000,[17] electricity consumption in Ann Arbor was slightly higher than the national trend.

Figure ES-1: Historical Electricity Consumption in Ann Arbor



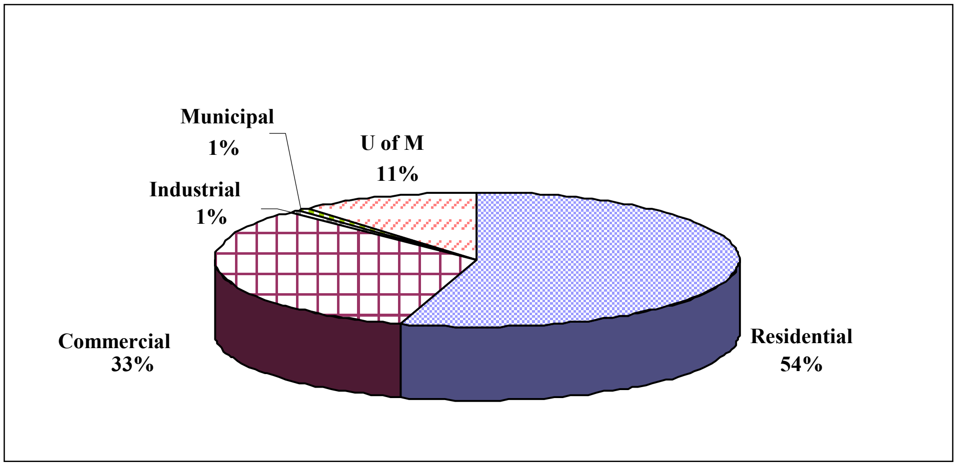
Natural Gas

Natural gas use has spread throughout most major urban areas and many rural areas in the U.S. because of increased natural gas pipeline construction during the 1950's. Since then, natural gas has joined petroleum as one of the dominant energy carriers in the U.S. After having idle periods in the 70's and early 80's due to shortages and major price increases, natural gas consumption has increased nationwide.

In 2000 the U.S. residential sector natural gas consumption accounted for about 24% of all end-use natural gas consumption in the market. Commercial, industrial, and electricity generation sectors accounted for 16%, 39%, and 21%, respectively, of natural gas consumption.[18] On the other hand, as can be seen in Figure ES-2, natural gas consumption in the City of Ann Arbor is dominated by the residential and the commercial sectors. This trend may be due to the fact that Ann Arbor's industrial sector is relatively small compared to the size of the residential and commercial sectors. The residential and commercial sectors consume natural gas for space heating, water heating, cooking and other natural gas-fueled appliances. Consumption levels in these sectors are influenced by climate patterns associated with space heating.

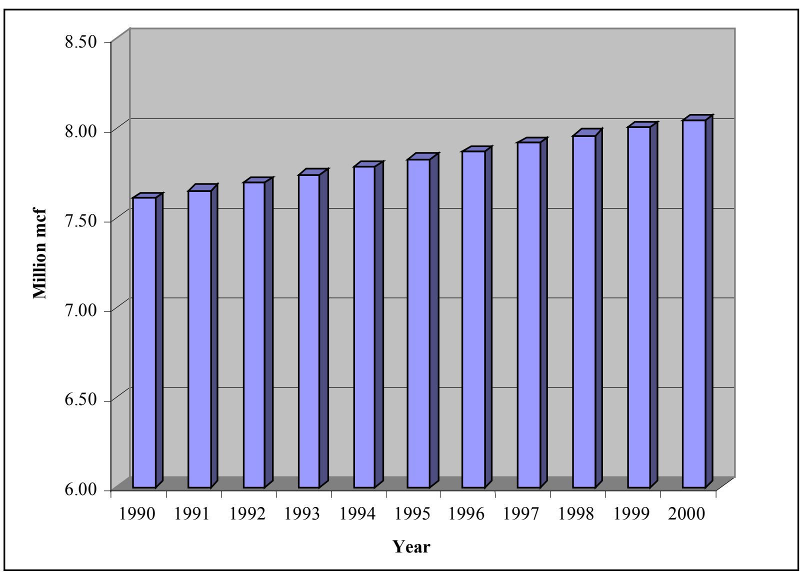
[17] *AER 2001*, Table 8.1.
[18] Energy Information Administration, U.S. Natural Gas Markets: Recent Trends and Prospects for the future, <http://tonto.eia.doe.gov/FTPROOT/service/oiaf0102.pdf>.

Figure ES-2: Natural Gas Consumption in 2000 by Sector



As revealed by Figure ES-3, natural gas consumption in the City of Ann Arbor increased from 7,610,335 thousand cubic feet (mcf) to 8,046,649 mcf between 1990 and 2000. These figures indicate a 5.7% increase for the ten-year time period between 1990 and 2000, or 0.6% per year. In comparison, the national average annual growth rate is approximately 2.4%.[19] The increase in natural gas consumption in Ann Arbor seems to be relatively steady. On a per person basis, the national average for natural gas consumption in 2000 was 80,875 cubic feet per person per year[20], while per capita natural gas consumption in Ann Arbor was 70,570 cubic feet per person per year.

Figure ES-3: Historical Natural Gas Consumption in Ann Arbor[21]



[19] Energy Information Administration, U.S. Natural Gas Markets: Recent Trends and Prospects for the future, <http://tonto.eia.doe.gov/FTPROOT/service/oiaf0102.pdf>.
[20] Energy Information Administration, 2001)
[21] The specific numbers described in this table are shown in Appendix I.

Petroleum

Automobiles are the most widely used mode of transportation in regions of the United States where population densities and/or financial support do not make public transportation systems, such as railways and buses, easily accessible and/or convenient. Although there are a significant number of people in Ann Arbor, including many students, who do not drive motor vehicles on a daily basis, many Ann Arbor residents need to drive to their office, work, or school. Numerous local activities are highly dependent on the use of motor vehicles including freight trains and passenger buses. In 1997, approximately 81,000 vehicles traveled throughout the City of Ann Arbor at 10,761 miles/vehicle/year. These motor vehicles traveled approximately 873 million miles within Ann Arbor city limits in 1997.[22]

Table ES-2 illustrates the historical changes in VMT in Ann Arbor. VMT is an important indicator that shows the amount of petroleum consumption corresponding to total mileage traveled by all vehicles. Ann Arbor's VMT amounted to 6,968 miles per person in 1990, and 7,979 miles in 2000; an average increase of 1.4% per year. Compared to the U.S. average VMT, Ann Arbor's is slightly lower. However, Ann Arbor's average growth rate is very close to the national average growth rate.

Table ES-2: VMT Comparison between Ann Arbor and the U.S.

	Vehicle Miles Traveled per Capita	
Year	**Ann Arbor**	**U.S. Average[23]**
1990	6,968	8,596
2000	7,979	9,995
Growth Rate per Year	1.4 %	1.5 %

Assuming an average fuel economy during vehicle operation, petroleum consumption can be calculated based on VMT values between the baseline year 1990 and 2000.[24] Petroleum consumption has increased from 47,725,748 gallons in 1990 to 55,094,895 gallons in 2000; an average annual increase of 1.6%. This increase is understandable in light of the annual increase in VMT and population. Petroleum consumption numbers represent a combination of gasoline and diesel fuel use.

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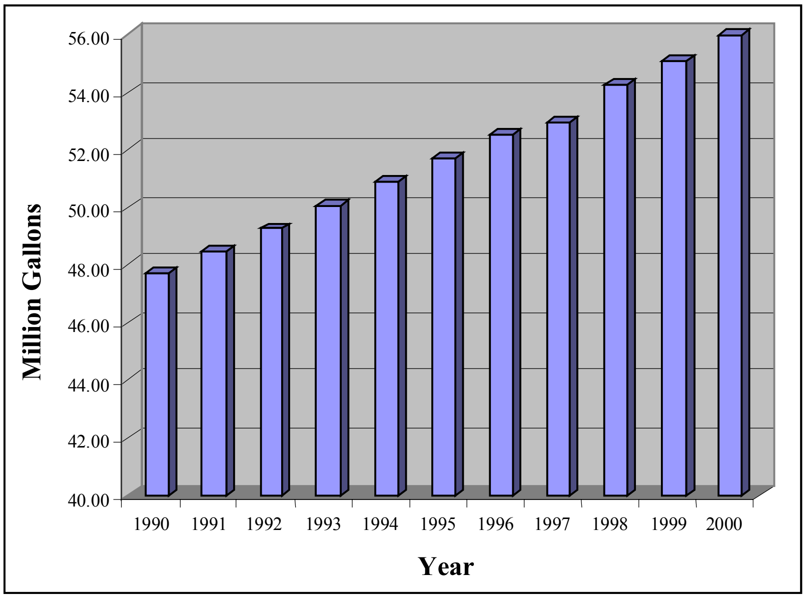
[22] Detailed data are described in Appendix J.

[23] U.S. Average U.S. Department of Energy, *Transportation Energy Data Book*, Edition 22, September 2002, Table 11.2 <http://www-cta.ornl.gov/data/>.

[24] The specific numbers described in this table are shown in Appendix J.

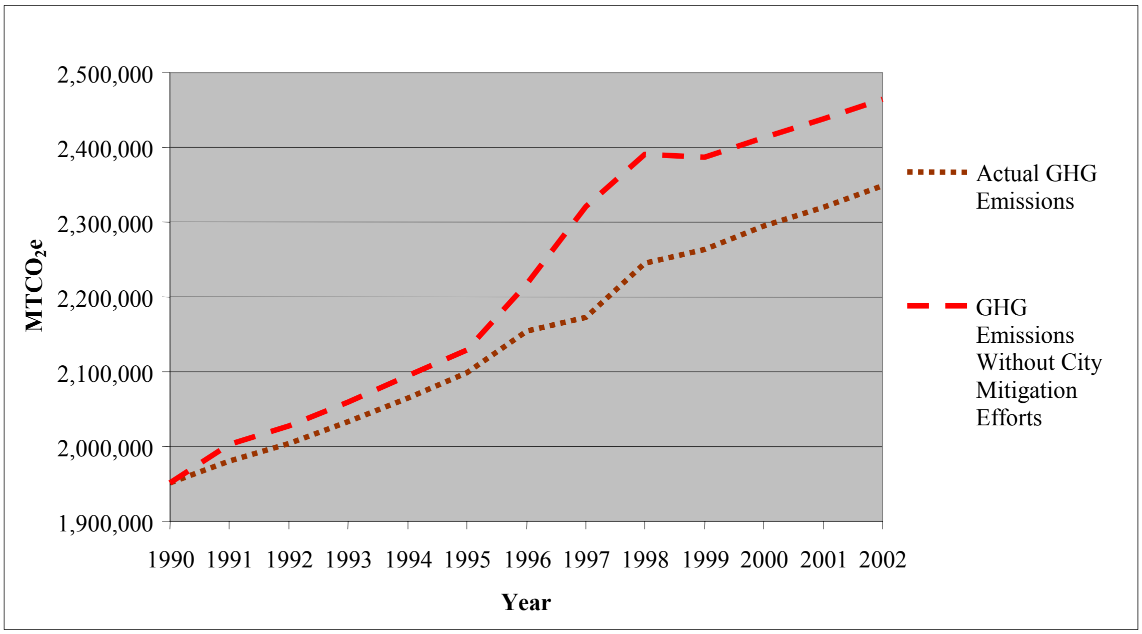
Figure ES-4: Historical Petroleum Consumption between 1990 and 2000 in Ann Arbor



ANN ARBOR'S GHG MITIGATION ACCOMPLISHMENTS, 1991-2002

Combined, all of the City energy savings programs initiated between the years 1991 and 2002 have noticeably reduced GHG emissions. If these measures had not been implemented, the City would have emitted 2,419,670 metric tons of CO_2 equivalents rather than the actual 2,348,631 metric tons of CO_2 equivalents emitted in 2002; a difference of 71,039 metric tons of CO_2 equivalents.[25] Overall, between 1991 and 2002, the City avoided releasing a total of 922,619 metric tons of CO_2 equivalents.

Figure ES-5: Greenhouse Gas Emissions 1991-2002 with & without City Mitigation Efforts[26]



City programs have reduced GHG emissions in the following 3 sectors: transportation, municipal, and municipal solid waste management. The majority of total reductions can be attributed to the City's Landfill Gas Recovery and recycling/composting efforts. As made apparent in Figure ES-6, the Landfill Gas Recovery project reached its peak, one year after initiation, in 1997. Since then, the methane recovery rate has declined steadily every year. The reductions attributed to this project will continue to decline from present date until all methane in the Ann Arbor landfill is exhausted. Therefore, in order to maintain or further reduce GHG emissions from MSW management, the City must increase resource recovery efforts. It is important to note that landfill gas was extracted at an expedited rate. Without this project, methane from the landfill would have been emitted naturally over a much longer timeline. The above graph (Figure ES-5) does not accurately reflect this fact.

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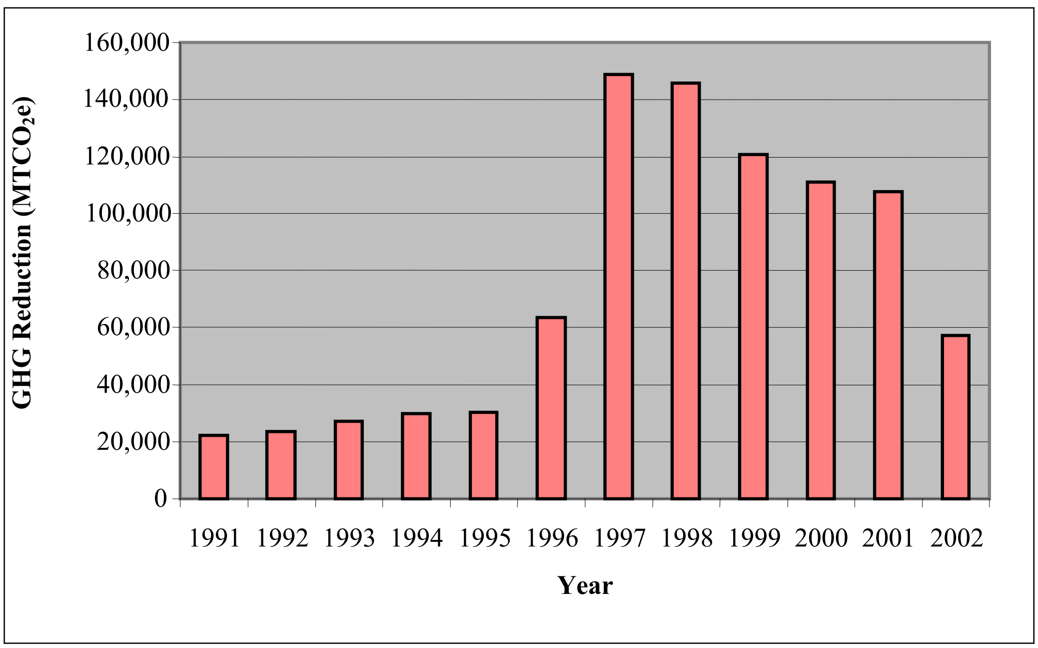
[25] 2002 recycling and composting data was not available, so the emissions reductions from these programs were not included in the total reductions from that year.

[26] Since 2002 recycling and composting data was not available during the production of this Project, the Team assumed that recycling and composting tonnages would be the same in 2002 as in 2001 for the purposes of producing a more accurate graph.

Table ES-3: GHG Emissions Reductions from City Programs, 1991-2002 ($MTCO_2e$)[27]

Year	Municipal	Transportation	MSW	Total
1991	0.00	0.00	21,960.47	21,960.47
1992	0.00	0.00	23,432.47	23,432.47
1993	0.00	0.00	27,161.36	27,161.36
1994	0.00	0.00	29,836.15	29,836.15
1995	0.00	0.00	30,227.84	30,227.84
1996	0.00	0.00	63,612.47	63,612.47
1997	0.00	2.30	148,698.24	148,700.54
1998	220.91	3.66	145,628.13	145,852.70
1999	393.62	3,242.19	120,751.05	124,386.86
2000	422.89	6,481.50	111,022.05	117,926.44
2001	790.20	9,840.58	107,851.39	118,482.16
2002	837.15	13,098.43	57,103.53	71,039.11
TOTAL	**2,664.76**	**32,668.66**	**887,285.15**	**922,618.57**

Figure ES-6: Municipal Solid Waste Management GHG Reductions, 1991-2002



The most influential City transportation program that has reduced GHG emissions to date has been the AATA Get! Downtown public transportation program. Overall, annual GHG reductions have grown every year since transportation programs were first implemented in 1997 (as shown in Figure ES-7).[28] Without the Get! Downtown program, these reductions would have been minimal. The City must consider increasing efforts to reduce transportation GHG emissions, since presently, this sector's emissions alone, account for nearly 25% of Ann Arbor's total GHG emissions.

[27] Metric tons of CO_2 equivalents.

[28] The transportation reductions for 1997 and 1998, 2.3 and 3.7 metric tons of CO_2 equivalents respectively, do not show up on the graph because they are so small.

Figure ES-7: Transportation GHG Emissions Reductions 1997-2002

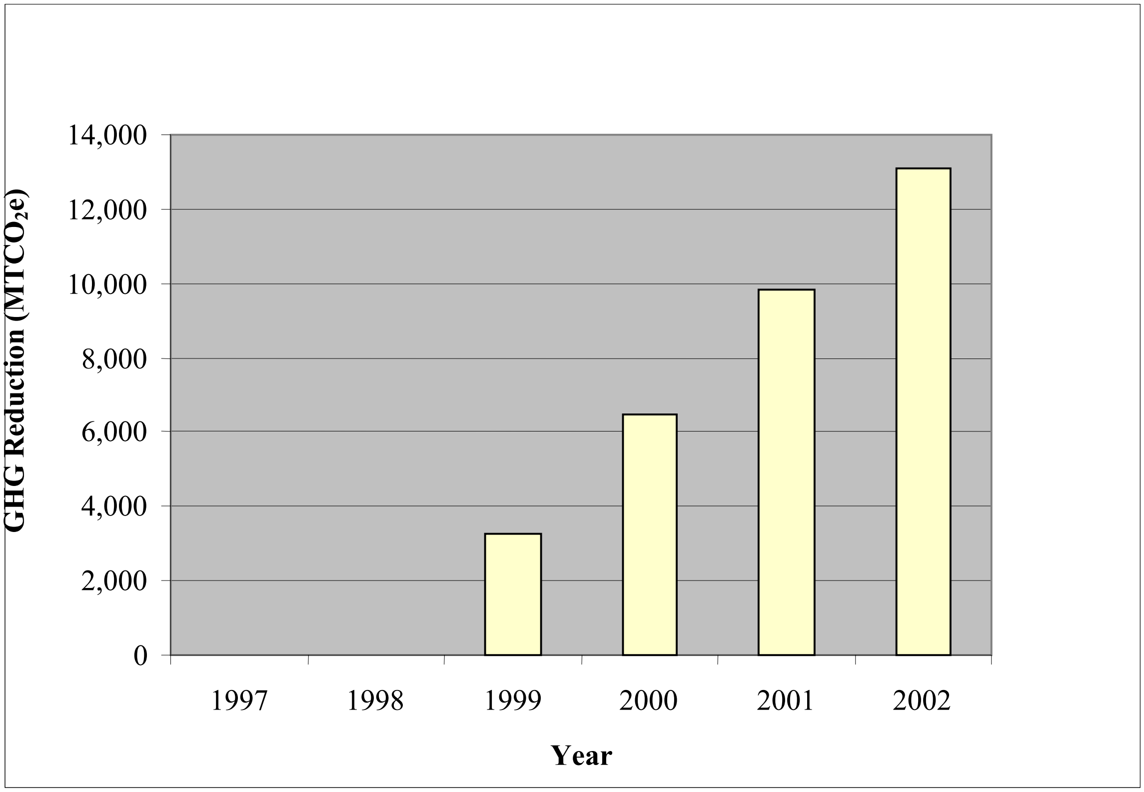
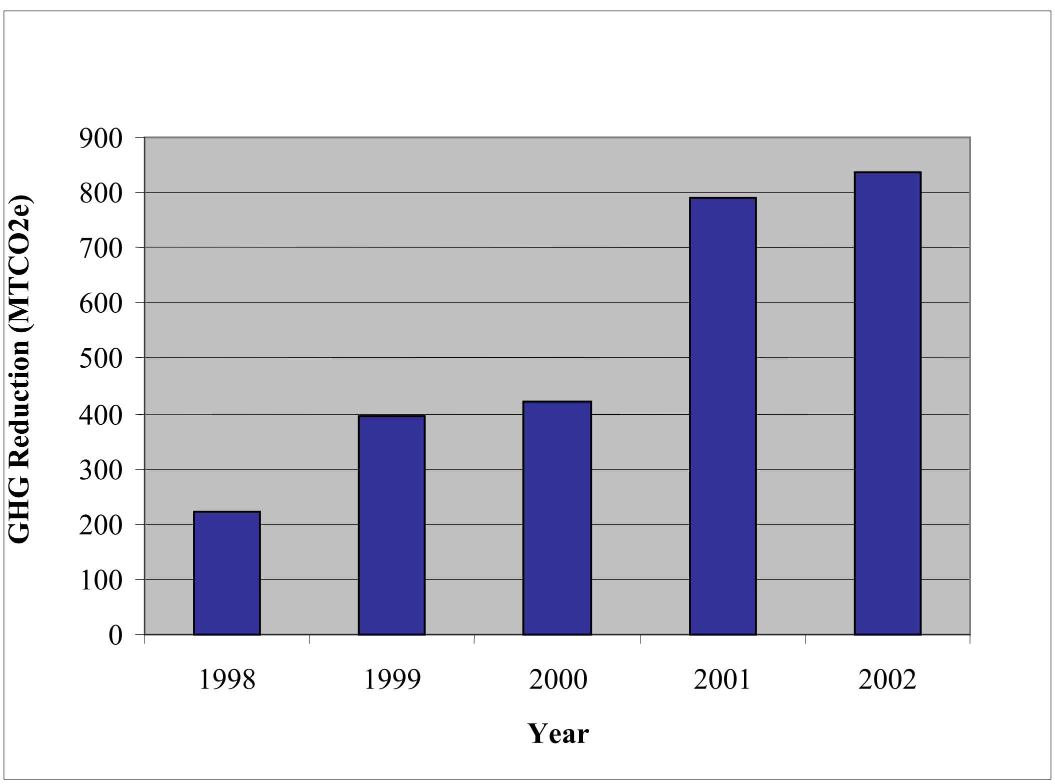


Figure ES-8: Municipal GHG Emissions Reductions, 1998-2002



Programs implemented to improve the municipality's energy efficiency have increasingly reduced GHG emissions since 1998 (see Figure ES-8). Although significant reductions have not been achieved, these efforts reduced the City's GHG emissions in 2002 by 1.8%. The increase in reductions between 2000 and 2001 was due primarily to switching over a large proportion of traffic lights to LED light technologies.

Although clearly the City has reduced GHG emissions throughout the last decade, Ann Arbor is far from curbing their annual growth trend. Further programs and policies must be implemented to reduce these emissions, and the City should focus on targeting sectors with high GHG emissions levels and growth (residential, commercial, industrial, transportation, and U of M). The success of the City's efforts to reduce GHG emissions to date has provided the municipality with evidence that these programs have recognizable impacts. The logical next step for the City is the adoption of an emissions reduction target and action plan.

TWO SCENARIO METHODOLOGY

The Team developed two scenarios, the *Current Scenario* and *Progressive Scenario*, in order to analyze current emission levels and examine the effectiveness of possible mitigation measures and strategies for future GHG reductions. This "scenario-based approach" allowed the Team to examine actual GHG emissions in the City in order to establish long-term goals and objectives for GHG emissions reductions. It also allowed the Team to investigate the potential benefits and impacts of the Team's recommended mitigation measures for the City of Ann Arbor.

Current Scenario

The largest GHG emitter between the years 1990 and 2002 was Ann Arbor's residential sector followed by transportation, commercial, U of M, industrial, municipal, and MSW management. Even so, during this time period, the sector to experience the largest growth in GHG emissions was the University of Michigan, at 36.9%. This is likely due to the continual expansion of the University campus. Other sectors to experience large growth rates during this time period included the commercial (28.1%) and transportation (24.4%) sectors.

Table ES-4: Greenhouse Gas Emissions for Residential, Commercial, Industrial, and Transportation Sectors (*Current Scenario*)

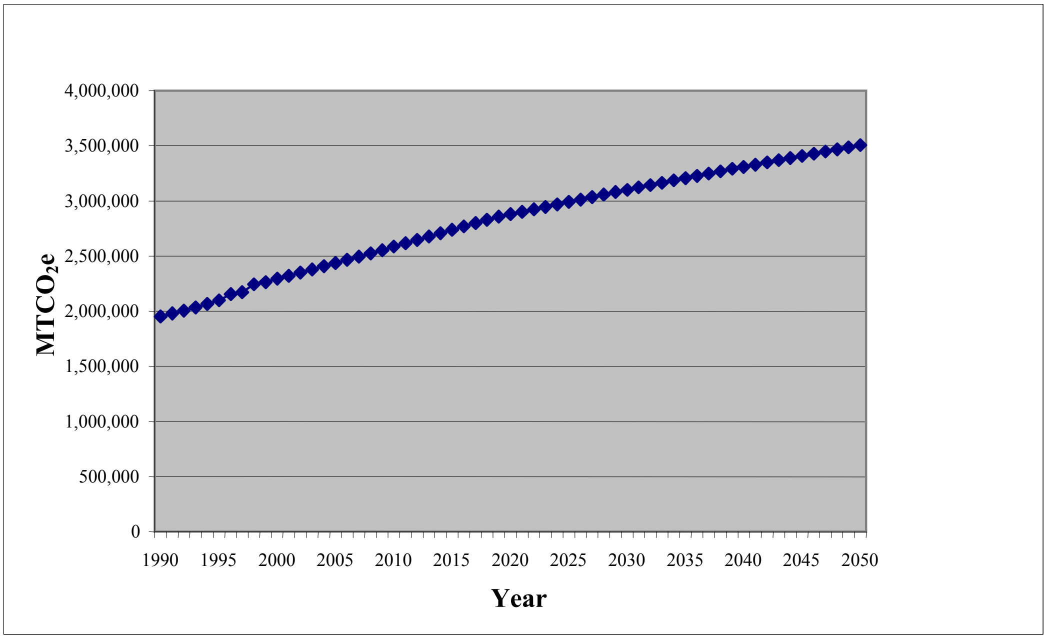
	Residential		*Commercial*		*Industrial*		*Transportation*	
Year	*$MTCO_2e$*	*Growth*	*$MTCO_2e$*	*Growth*	*$MTCO_2e$*	*Growth*	*$MTCO_2e$*	*Growth*
1990	486,957	N/A	339,857	N/A	316,968	N/A	415,652	N/A
2000	528,863	0.83%	420,383	2.15%	352,756	1.08%	501,766	1.90%
2010	556,988	0.52%	494,181	1.63%	385,664	0.90%	580,176	1.46%
2020	585,357	0.50%	571,087	1.46%	424,128	0.96%	655,930	1.23%
2030	608,244	0.38%	644,227	1.21%	463,506	0.89%	677,349	0.32%
2040	626,573	0.30%	712,627	1.01%	503,542	0.83%	702,536	0.37%
2050	640,841	0.23%	775,424	0.85%	543,712	0.77%	734,857	0.45%

The Team projects that GHG emissions will grow at variable rates for each sector between the present date and 2050 (see Tables ES-4 and ES-5). Currently, the largest GHG emitter in Ann Arbor is the residential sector followed by transportation, U of M, commercial, industrial, municipal, and MSW management respectively.

Table ES-5: Greenhouse Gas Emissions for Municipal, University of Michigan, and Municipal Solid Waste Sectors (*Current Scenario*)

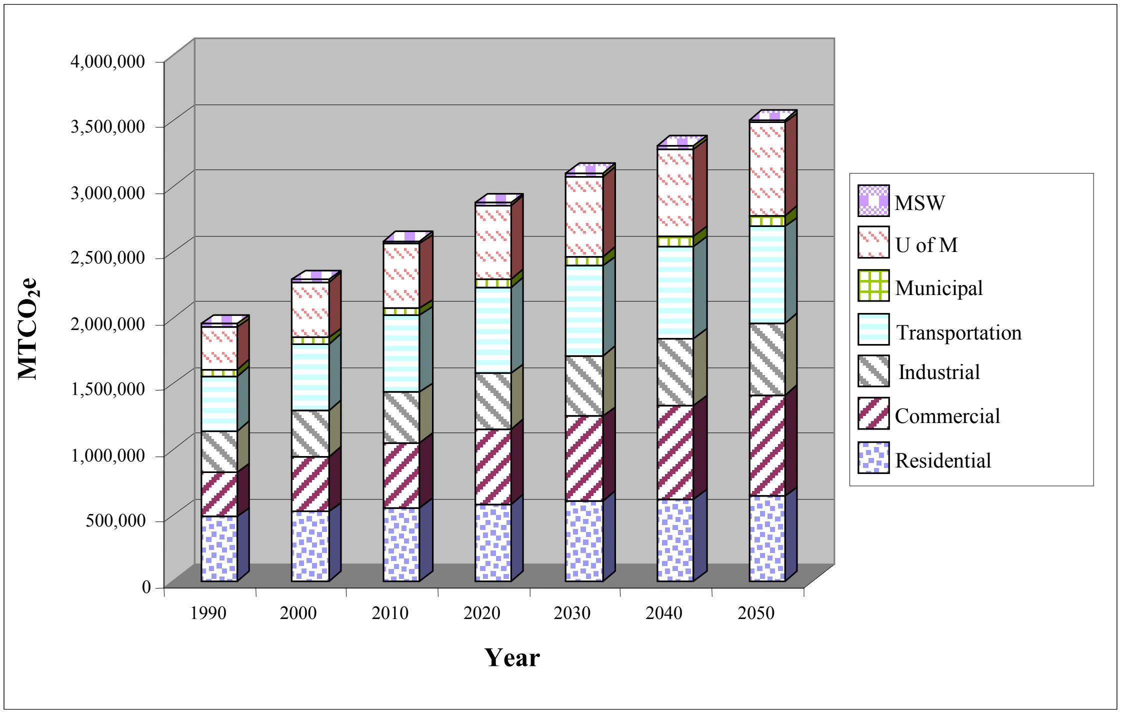
	Municipal		*U of M*		*MSW*		*Total*	
Year	*$MTCO_2e$.*	*Growth*	*$MTCO_2e$*	*Growth*	*$MTCO_2e$*	*Growth*	*$MTCO_2e$*	*Growth*
1990	47,866	N/A	319,713	N/A	24,845	N/A	1,951,858	N/A
2000	45,367	-0.53%	427,193	2.94%	18,487	-2.91%	2,294,814	1.63%
2010	53,970	1.75%	494,789	1.48%	18,850	0.19%	2,584,618	1.20%
2020	63,133	1.58%	559,550	1.24%	19,555	0.37%	2,878,741	1.08%
2030	71,693	1.28%	615,706	0.96%	20,246	0.35%	3,100,971	0.75%
2040	79,532	1.04%	663,382	0.75%	20,918	0.33%	3,309,110	0.65%
2050	86,565	0.85%	703,278	0.59%	21,554	0.30%	3,506,232	0.58%

Figure ES-9: Projection of GHG Emissions in the City of Ann Arbor (*Current Scenario*)



By 2050 this order, again, is predicted to shift to some degree. In 2050 the Team projects that the commercial sector will be the largest GHG emitter followed by transportation, U of M, residential, industrial, municipal, and MSW management. Overall, between 2003 and 2050, the municipal sector's GHG emissions are predicted to experience the largest growth (81.5%) among all sectors, even though they only account for a small proportion of the City's total GHG emissions. Similarly, the Team estimates that the commercial sector's GHG emissions will also experience a similar growth rate between these years (75.2%).

Figure ES-10: GHG Emissions by Sector (*Current Scenario*)



Based on these findings, the Team believes that the City's mitigation measures should focus primarily on reducing GHG emissions from the largest sector emitters. These would include foremost the following sectors: commercial, transportation, residential, industrial, and U of M. By targeting these sectors specifically, larger future reductions can be achieved.

Progressive Scenario

The *Progressive Scenario* is a framework that can be used by the City for the development of a GHG Reduction Action Plan. While the *Current Scenario* details the course the City took between 1990 and today, and predicts where the City will be in 2020 and beyond, the *Progressive Scenario* illustrates a series of options the City can implement to reduce GHG emissions. The *Progressive Scenario* will redirect the path of the City towards a future where total GHG emissions are lower in 2020 than they were in 1990.

Prior to developing a set of mitigation measures, the Team set the goal of achieving a GHG reduction of 7% below 1990 emissions levels in 2020. Total GHG emissions in 1990 were 1,951,858 metric tons CO_2 equivalents. Projected 2020 total GHG emissions will be 2,878,741 metric tons of CO_2 equivalents. The following equation was used to establish the quantity of GHG emissions reductions needed to meet the specified target (986,602 tons of CO_2 equivalents).

The Team then established a Start Year when the City will begin implementing reduction measures and a Target Year when all mitigation measures should be fully implemented.

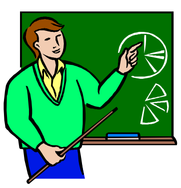
Recognizing that the City will need time to develop and initiate implementation strategies, the Team set the Start Year for 2005 and the Target Year for 2020.

Through research of other strategies the Team developed 29 viable mitigation measures for the *Progressive Scenario*. These measures were developed based on the following criteria:

1. Measures cannot pre-exist; and,
2. Measures must make geographic and political sense for the City of Ann Arbor; and
3. Measures must be relatively cost effective with a reasonable payback; or,
4. Measures must make use of progressive technology; or,
5. Measures must have significant greenhouse gas reduction potential

It is important to note that the list of possible programs from which the Team selected the 29 measures to include in this Project was not an exhaustive list. Aside from the 29 proposed measures, there are many other GHG reduction programs that the City could implement. Clearly, more aggressive GHG mitigation programs do exist that work beyond those proposed by the Team, e.g., in the areas of building retrofits and further clean transportation fuel substitution options. But the Team chose these 29 measures in order to provide the City of Ann Arbor with a framework to develop implementable programs. In creating the list of 29 measures, the Team passed over many opportunities for significant GHG reductions and omitted many programs if they did not conform to the five criterions listed above.

Measures are divided into five broad categories: Community Outreach and Education, Energy Conservation, Transportation, Solid Waste Management, and Other.



Community Outreach and Education: These measures encourage the development of programs, which educate the community about climate change drivers, and the impact of personal behavior on GHG emissions. It is important to note that while the direct quantifiable benefits of Community Outreach and Education programs may be small and depend upon voluntary participation, the long-term, unquantifiable benefits can be substantial. Significant research and analysis beyond the scope of this Project is necessary to understand these hidden benefits.

Energy Conservation: These measures encourage sectors to replace older, less efficient technology, with newer, less energy intensive models. Other methods to decrease building energy consumption, as well as programs to effectively switch from carbon-based fuels to non-carbon based renewable sources of energy, are also examined. Programs detailed in this category often employ incentive and volunteer-based methods to promote these changes.

Transportation: These measures reduce transportation sector GHG emissions in three different ways. First, programs create incentives for individuals to find alternatives to low-occupancy transportation options, which are mainly passenger cars, and light duty trucks (both averaging less than two occupants). By encouraging people to use high-occupancy transportation options (trains, buses, and carpools) the impact of GHG emissions is divided among each occupant by encouraging high-occupancy transportation options (trains, buses, carpools, etc.), the greater the occupancy, the lower the GHG emissions per occupant. The second type of program encourages people to use less carbon intensive fuel sources, or alternatives to conventional fuels that have no direct GHG emissions. Examples of these types of programs include the transition toward natural gas (NG) powered vehicles or encouragement of bicycle use. The third type of program encourages participants to simply consume less fuel. For example, driving a car fewer miles per year or purchasing an hybrid electric vehicle (HEV) will decrease GHG emissions by reducing the amount of gasoline expended. All three strategies result in either a reduction in the number of vehicle miles traveled, or a reduction in the quantity of fuel consumed.

Solid Waste Management: These measures attempt to address methods to reduce the total amount of landfilled materials each year by increasing Ann Arbor's waste recovery efforts. Waste recovery efforts include: source reduction, reuse, recycling, and composting. Expanding waste recovery efforts reduces the associated upstream life cycle GHGs emitted through the acquisition of virgin raw materials and manufacturing.

Other: These measures are unquantifiable programs that the City has no authority over, but should publicly support. These measures are typically state and federal programs that will reduce GHG emissions on a larger, geographic, scale. At the local level, the City should support the efforts of state and federal decision-makers working to implement these measures. For example, the City could draft a letter of support to Congressional lawmakers articulating their support for increasing the Corporate Average Fuel Economy (CAFE) for all passenger cars and light trucks

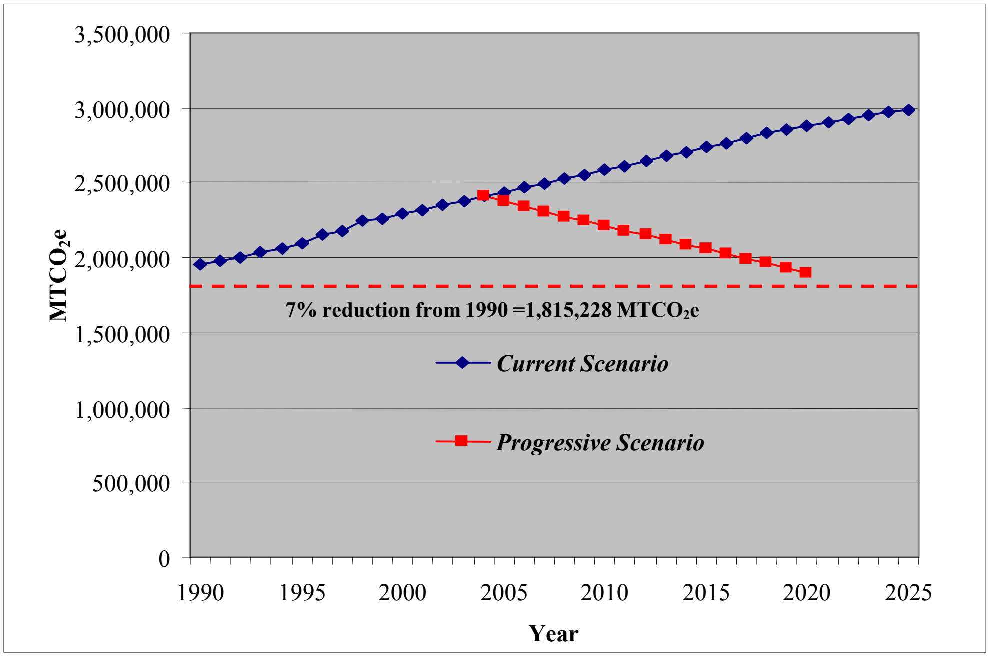
Results

If implemented in full over the course of 16 years, all of the Team's recommended emissions reduction measures presented in the *Progressive Scenario* would amount to a total reduction of 986,485 metric tons of CO_2 equivalents in 2020. This would lower Ann Arbor's GHG emissions to 1,892,256metric tons of CO_2 equivalents, or 3.1% below 1990 levels. This is considerably less than the original reduction target of 7% below 1990 emissions. Based on the measures recommended this is the most feasible GHG emissions reduction if the City implements all programs in full by 2020 as shown in Figure ES-11.

Table ES-6: *Progressive Scenario* GHG Emissions Reductions by Program

GHG Emissions Programs	GHGs Reduced ($MTCO_2e$) 2010	2015	2020
Community Outreach and Education			
Heating and Cooling Education Program	16	29	43
Tree Distribution and Planting Partnership	85	238	415
Green Youth Corps Program	113	316	550
Climate Change Education Program	306	561	816
Green Building Design Seminars	1,366	2,504	3,643
Total	**1,886**	**3,649**	**5,466**
Energy Conservation			
University of Michigan Residential Housing Utility and Rent Separation	418	766	1,114
Compact Fluorescent Bulb Program	478	877	1,275
0% Interest and Rebate Program For Residential Sector Appliances	489	896	1,304
Energy Efficient Window Replacement	1,013	1,858	2,702
Water Conservation	1,582	2,900	4,219
Energy Efficient Building Codes	3,438	6,304	9,169
Solar Powered Street Lights	7,711	14,137	20,563
Energy Efficiency Officer	10,620	19,470	28,321
WWTP Anaerobic Digester Gas Power	15,091	27,667	40,243
Energy Efficiency Rental Units	16,593	30,421	44,249
Renewable Portfolio Standard	289,205	530,209	771,212
Total	**346,639**	**635,505**	**924,371**
Transportation			
City Employee Telecommuting	12	22	32
City Employee Flex-Time	12	22	32
Alternative Transportation to Work Day Program	63	115	167
Smart Growth Initiative Program	180	183	177
Hybrid Electric Vehicle Parking Incentive Program	368	675	982
UM Student Go! Passes	1,033	1,895	2,756
Hybrid Electric Vehicle Rebate Program	1,474	2,702	3,930
Traffic Flow Study	1,555	2,851	4,147
Anti-Idling Ordinance	1,598	2,930	4,261
Bike Encouragement Program	4,095	4,449	4,834
Fuel Switching and Hybrid Electric Vehicle Purchase Program	4,165	7,636	11,107
Total	**14,555**	**23,479**	**32,424**
Solid Waste Management			
Waste Reduction Mandate	9,083	16,652	24,221
Total	**9,083**	**16,652**	**24,221**
Aggregate Total	**372,164**	**679,286**	**986,485**

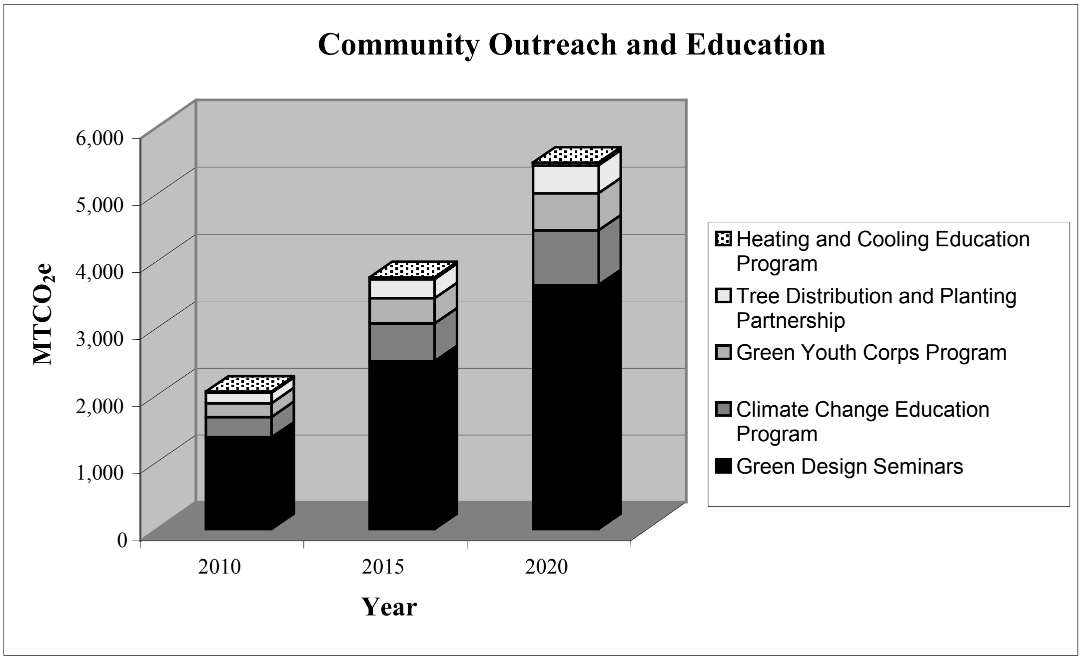
Figure ES-11: *Current* vs. *Progressive Scenario*



Figures ES-12, ES-13, ES-14, and ES-15 display the GHG reductions attributed to each of the Team's programs or policy recommendations. Of the program types recommended, the Energy Conservation programs reduce the largest proportion of GHG emissions (see Table ES-6); the reductions from these programs alone account for nearly 925,000 metric tons of CO_2 equivalents in 2020. Meanwhile, the Team's recommended Transportation measures reduce GHG emissions by 32,424 metric tons of CO_2 equivalents in the year 2020, followed by Solid Waste Management at 24,222 metric tons of CO_2 equivalents, and Community Education and Outreach programs at 5,466 metric tons of CO_2 equivalents.

Within the Community Outreach and Education programs, the Green Design Seminars are expected to have the greatest impact on reducing the City's GHG emissions followed by the Climate Change Education Program, the Green Youth Corps, the Tree Distribution and Planting Partnerships, and the Heating and Cooling Education Program as shown in Figure ES-12.

Figure ES-12: ***Progressive Scenario*** **GHG Emissions Reductions: Community Outreach and Education**



Even though the GHG reductions from these programs in total are not large when compared to the other program types, successful education programs can have broader, more substantial, long-term impacts on human behavior. The Team found it particularly difficult to predict the reductions attributed to these education programs and, therefore, attempted to make safe assumptions in order to not overestimate their benefits. This, in turn, may have caused the Team to underestimate the potential GHG reductions from these programs.

Within the Energy Conservation programs (and all programs in general), the Renewable Portfolio Standards clearly has the greatest GHG emissions reduction impact by switching to renewable, non-carbon based energy sources. Programs responsible for moderate reductions in GHG emissions include: Energy Efficiency in Rental Units, the WWTP Anaerobic Digester Gas Power, the Energy Efficiency Officer, and the Solar Powered Street Lights programs. All other Energy Conservation programs achieve lesser reductions by 2020.

Figure ES-13: *Progressive Scenario* GHG Emissions Reductions: Energy Conservation

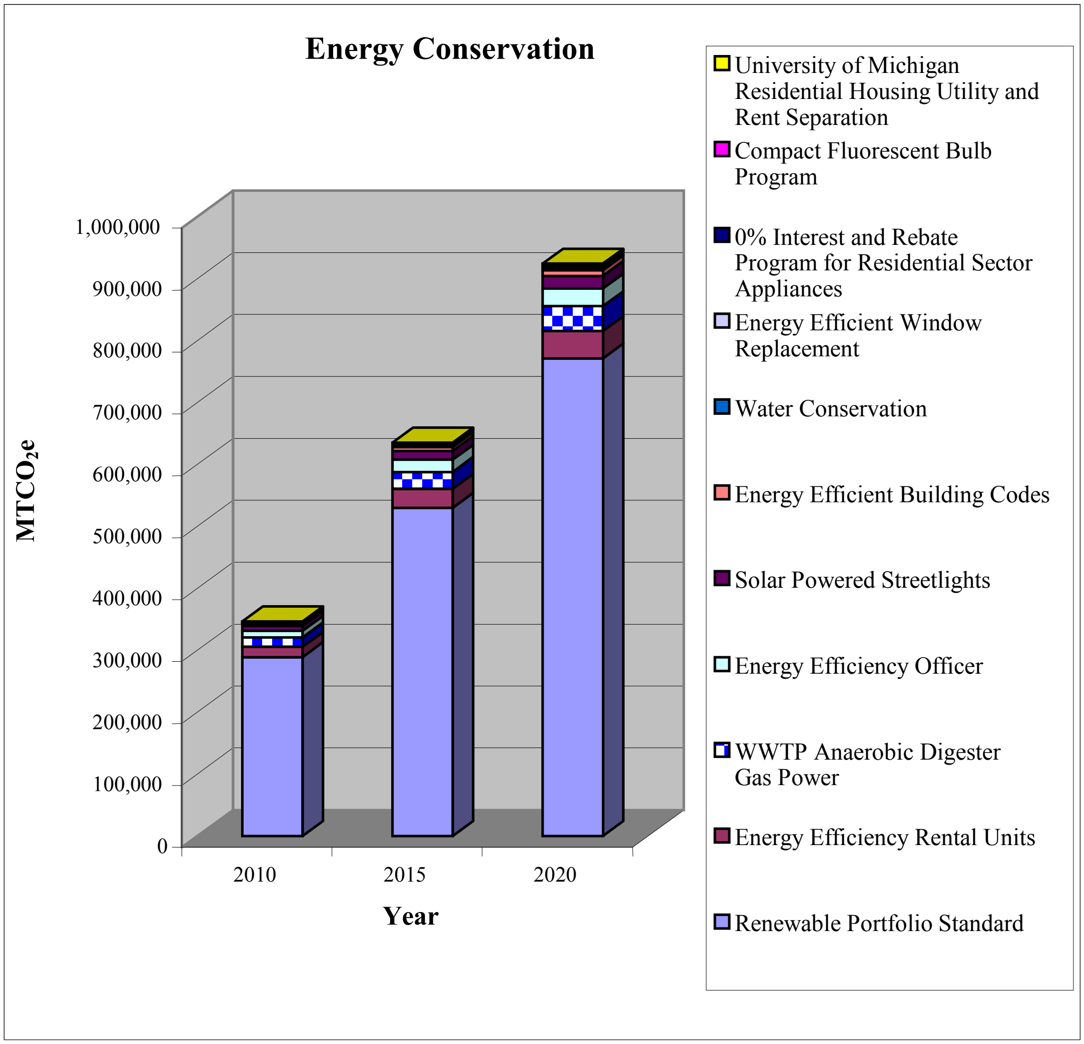
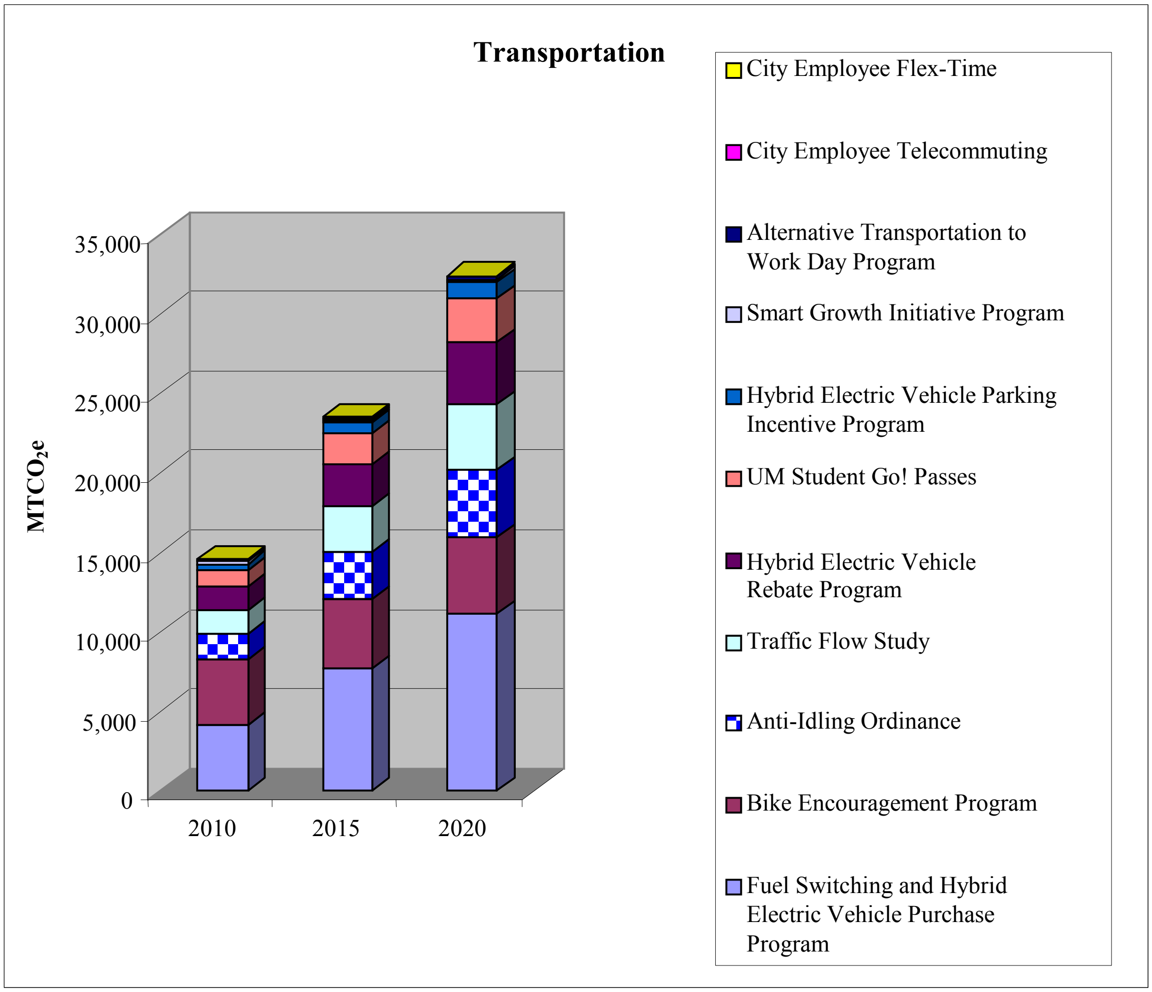
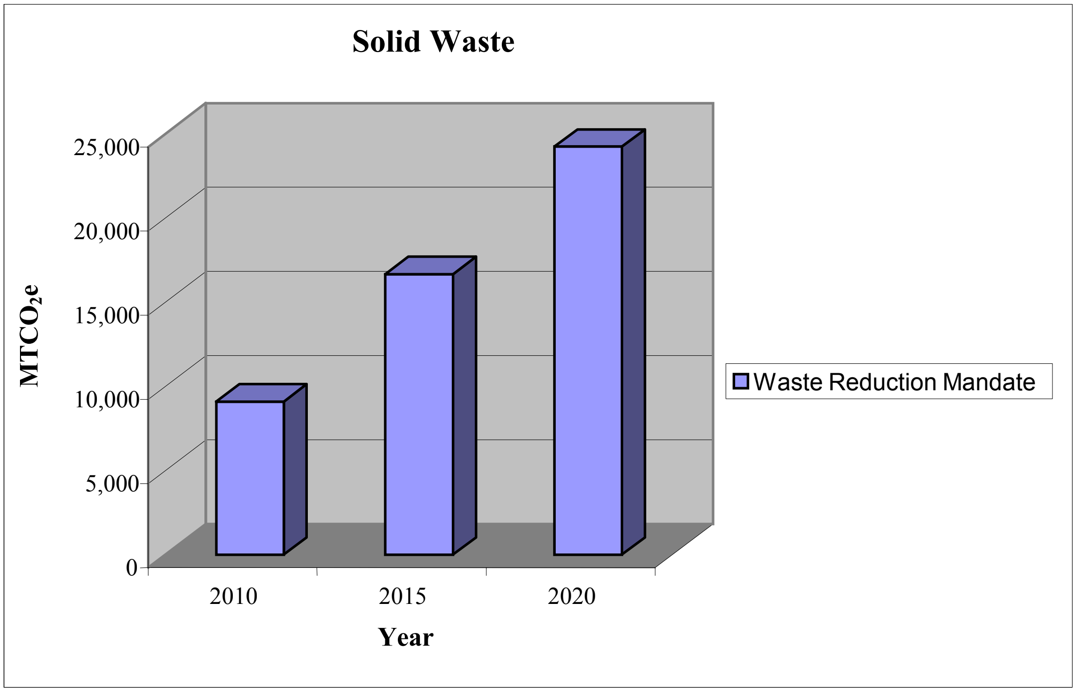


Figure ES-14: *Progressive Scenario* GHG Emissions Reductions: Transportation



The aggregation of transportation measures reduces GHGs at a moderate level in 2020, with the Fuel Switching and Hybrid Electric Vehicle Purchase Programs having the greatest impact in this sector.

Figure ES-15: ***Progressive Scenario*** **GHG Emissions Reductions: Solid Waste Management**



Lastly, based on a 75% waste reduction strategy, solid waste related GHG emissions would be limited drastically.[29] In fact, according to the U.S. Environmental Protection Agency's WARM Model, this program, in effect, would sequester CO_2 (the emissions reductions from waste reduction surpass the emissions generated from landfilling the material) as demonstrated in Figure ES-16. This occurs primarily in the WARM Model because the software assumes that recycled materials are made into 100% recycled products (no virgin materials are included) in order to account for the savings in upstream emissions. The software also does not account for emissions generated from transporting recyclable materials from Material Recovery Facilities to manufacturing facilities. In addition, the CO_2 emissions originally estimated for landfilling solid waste are low because the sequestration potential of the material in the landfill is included in the software's coefficients. Either way, the Team strongly believes that the WARM software both underestimates GHG emissions from solid waste management and overestimates the emissions reductions from recycling. The Team used WARM, because it is the standard software used for these types of applications.

Overall, the Team's measures targeted all sectors as shown in Tables ES-7 and ES-8. The tables display the total reduction for each sector's GHG emissions in the years 2005, 2010, 2015, and 2020, and the percent below (or above) 1990 emissions levels by that sector in that year.

[29] The 75% waste diversion goal was based on similarly aggressive targets recently set in California. Since Ann Arbor currently diverts more than 40% of its waste without having initiated food waste programs, a strong commercial recycling program, or upgrading recycling collection services to offer larger recycling bins to residents, the Team feels that this is an achievable goal.

Figure ES-16: GHG Emissions from MSW Management Including *Progressive Scenario*

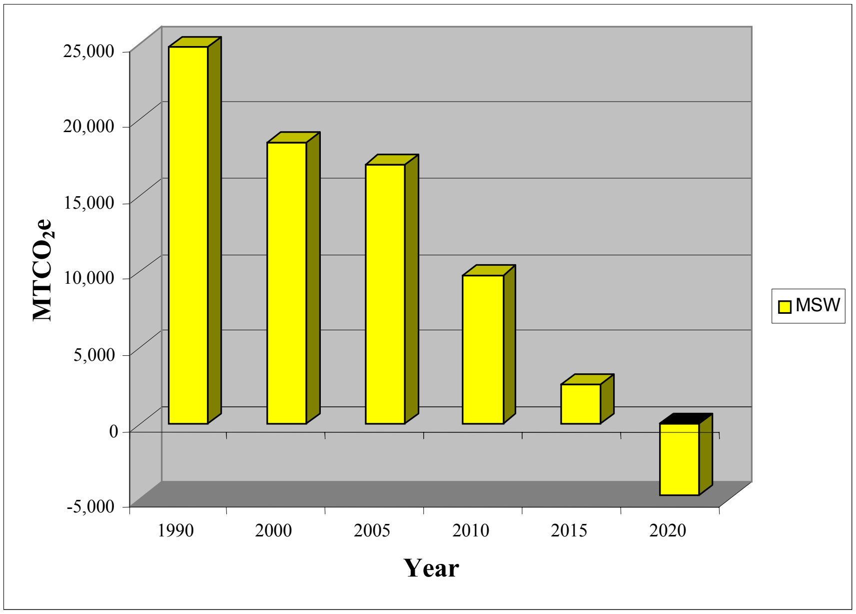


Table ES-7: GHG Emissions Reduced for Residential, Commercial, Industrial, and Transportation Sectors (*Progressive Scenario)*

Year	*Residential*		*Commercia*		*Industrial*		*Transportatio*	
	MTCO₂e	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*
2005	17,121	8.1%	13,119	30.7%	10,428	13.1%	5,583	28.4%
2010	99,869	-6.1%	80,421	8.9%	61,939	2.1%	14,555	36.1%
2015	178,503	-19.2%	150,494	-9.0%	112,932	-7.9%	23,479	43.8%
2020	253,496	-31.9%	223,012	-23.9%	163,841	-17.9%	32,424	50.0%

Table ES-8: GHG Emissions Reduced for Municipal, University of Michigan, and Municipal Solid Waste Sectors (*Progressive Scenario)*

Year	*Municipal*		*U of M*		*MSW*		*Total*	
	MTCO₂e	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*	*MTCO₂e*	*% Reduction Below 199(*
2005	2,705	-2.3%	14,699	39.2%	1,514	-31.3%	65,169	21.5%
2010	16,489	-21.7%	89,808	26.7%	9,083	-60.7%	372,164	13.4%
2015	30,670	-41.6%	166,555	13.1%	16,652	-89.7%	679,285	5.4%
2020	45,184	-62.5%	244,305	-1.4%	24,222	-118.8%	986,485	-3.1%

Figures ES-17 and ES-18 illustrate each sector's GHG emissions under the *Current* and *Progressive Scenario* in the year 2020. The size of each pie graph indicates the quantity of total GHG emissions in that year under the respective scenario. Clearly the most significant change is the growing percentage contribution to total emissions from the transportation sector. While total GHG emissions in this sector are lower in 2020 under the *Progressive Scenario* when compared with projected *Current Scenario* GHG emissions for the same year, the Team predicts that a third of total GHG emissions will be generated by this sector when all proposed measures reach full implementation.

Figure ES-17: *Current Scenario* Greenhouse Gas Emissions by Sector in 2020

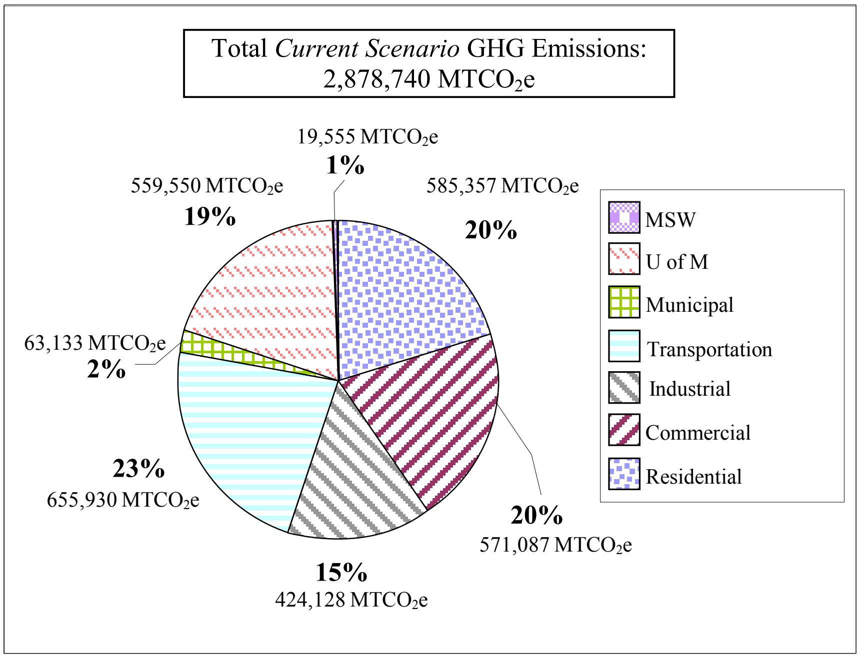


Figure ES-18: *Progressive Scenario* Greenhouse Gas Emissions by Sector in 2020

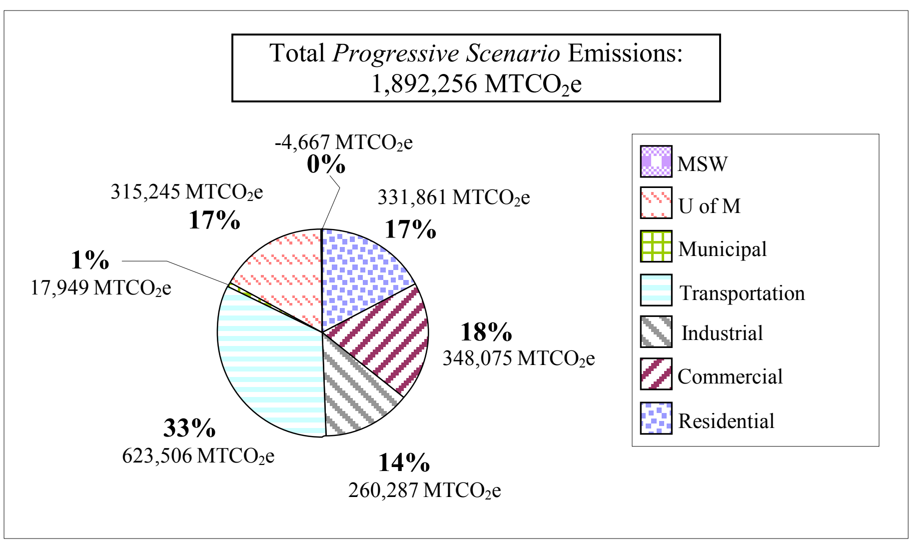


Table ES-9: 2020 *Progressive Scenario* Percent Change Compared with *Current Scenario* GHG Emissions Levels in the Same Year

Residential ($MTCO_2e$)	Commercial ($MTCO_2e$)	Industrial (($MTCO_2e$)	Transportation ($MTCO_2e$)	Municipal ($MTCO_2e$)	U of M ($MTCO_2e$)	MSW ($MTCO_2e$)	Total ($MTCO_2e$)
43%	39%	39%	5%	72%	44%	124%	34%

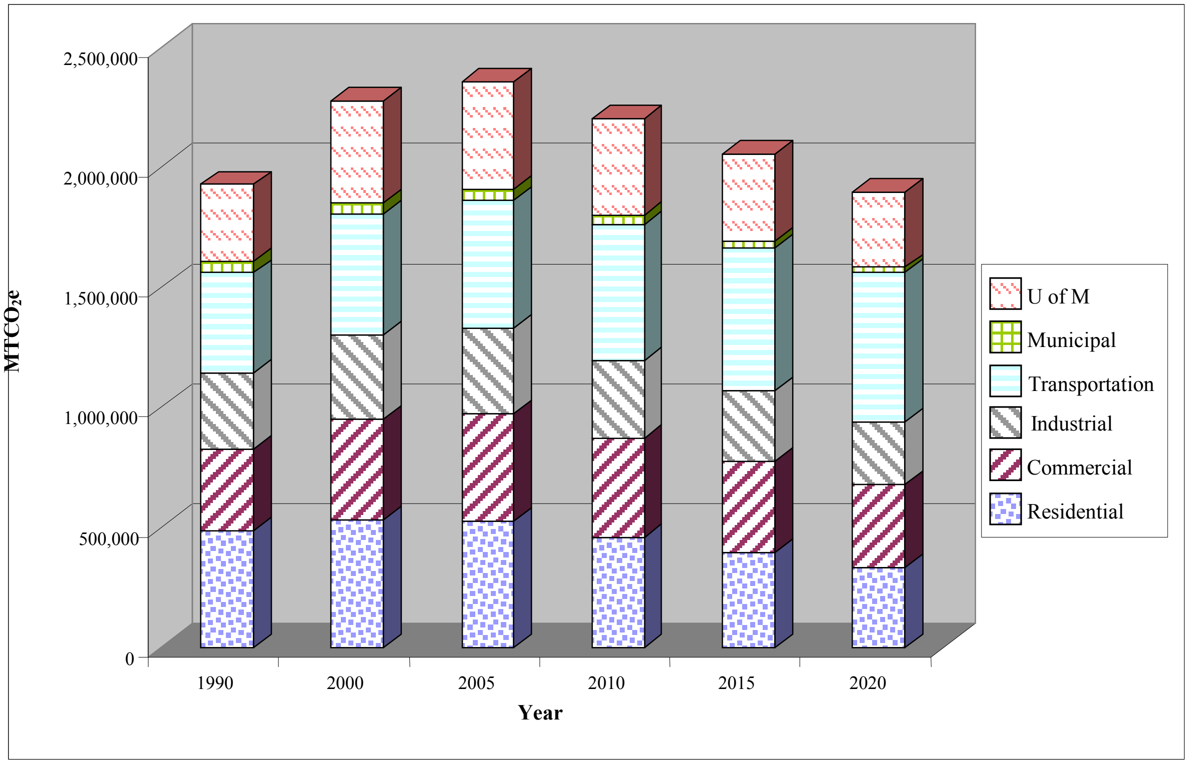
As indicated by Table ES-9, three of the seven sectors appear to have significant changes in emissions levels. As addressed earlier, municipal solid waste becomes a net GHG emissions sink under the *Progressive Scenario.* As a result, MSW sector emissions decrease by 124% below 2020 *Current Scenario* GHG emissions. Municipal sector emissions decrease by 72% below 2020 *Current Scenario* projections; relying heavily on GHG reductions from the Renewable Portfolio Standard. While the transportation sector's GHG emissions decrease under the *Progressive Scenario*, measures that target this sector barely outpace growth in the quantity of vehicles on the road and VMT. The transportation sector does not benefit from the significant GHG reductions achieved through the Renewable Portfolio Standard mitigation measure. This measure accounts for the majority of all GHG emissions reductions in the residential, commercial, industrial, municipal and U of M sectors.

Although the largest reductions in GHG emissions (in terms of metric tons of CO_2 equivalents) are achieved in the residential, U of M, and commercial sectors, it is important to note that solid waste management and the municipal government achieve the greatest percent reduction relative to each sector's 1990 emissions. The total GHG emissions for each sector, including the *Progressive Scenario*, are displayed in Figure 37.

Although the largest reductions are achieved in the residential, U of M, and commercial sectors, relative to each sector's 1990 emissions, solid waste management and municipal achieved the greatest % reduction. The total GHG emissions for each sector, including the *Progressive Scenario*, are displayed in Figure ES-19.

Although clearly, under the *Progressive Scenario*, GHG emissions were reduced in all sectors, the Team recognizes that some sector's emissions could be targeted more aggressively. For example, although the Team generated methods and programs to reduce the University of Michigan's natural gas and electricity consumption, the Team could not adequately address all areas for improvement. Since U of M functions independently within the City, the Team believes the University would benefit from conducting its own study to generate a viable, yet aggressive, GHG emissions reduction target and action plan. In addition, as made apparent in Figure ES-19, the Team's recommended measures limited the transportation sector's growth, but failed to actually make significant reductions to this sector's emissions. The City should consider further efforts to effectively reduce this sector's GHG emissions. Considering that the majority of Ann Arbor is built, there exists tremendous opportunity to reduce GHG emissions by retrofitting existing structures so they consume less energy. Overall, the transportation, commercial, and residential, and U of M sectors would benefit from increased programs and policies to reduce GHG emissions.

Figure ES-19: GHG Emissions by Sector Including *Progressive Scenario*, 1990-2020



Further efforts to reduce GHG emissions will be necessary if the City intends to continue a downward sloping emissions curve beyond the year 2020. Beginning in 2021, emissions reductions will remain constant while the actual emissions will continue to grow, albeit slightly. This trend can be assumed to continue unless further mitigation efforts are developed by either federal, state, or local governments.

CONCLUSION

Re-inventing the wheel has long been a phrase to describe the unnecessarily redundant methods with which we often construct new models and strategies. Climate change science is evolving and our understanding of the long-term effects is still distant. The importance of approaching such an issue with a certain degree of synergy cannot be over-stated and in order to achieve this goal it is crucial that the communities seeking to reduce their greenhouse gases rely on one another for input and feedback. Although all communities differ to some degree in character and geography it is highly valuable to ascertain specific assumptions and draw particular parallels from communities that garner at least some of the same character and geography as Ann Arbor. Having access to actual Local Action Plans developed by other cities for the CCP (and other programs) allows for a firm understanding of what techniques, programs, and projects are currently under implementation, offering plan writers a set of plausible measures to begin strategy development. Furthermore, it is extremely helpful to speak with plan writers and gain their perspective. By understanding the various problems and roadblocks that they have encountered, many unnecessary problems and difficulties can be avoided. Drawing together all member cities under the premise of shared resources is certainly one of the major accomplishments of ICLEI under the CCP campaign.

In order to achieve the long term goals set out in modern climate change policy, that is reducing emissions and maintaining that level far into the future, it is vital that governments and policy-makers understand that energy efficiency is not the answer, only a temporary solution. Evaluating Ann Arbor's baseline data and existing measures clearly articulates this simple truth. Implementing energy efficiency may reduce the consumption of specific appliances or other infrastructure, but such measures are incapable of realizing the greater need to reduce overall energy use. Achieving the goal of reducing our need for energy is truly a vital and dynamic challenge that lies ahead. History clearly states that changing ones culture and behavior is far beyond the scope of everyday policy-making.

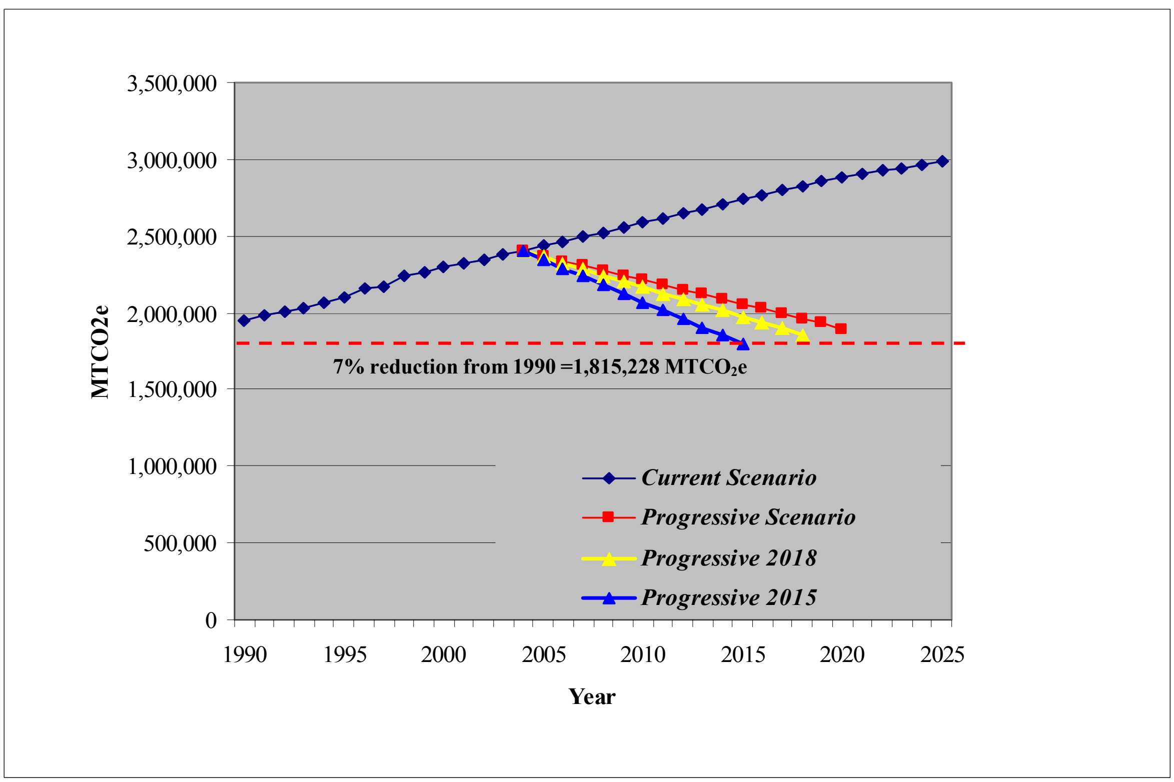
How can we achieve this grandiose objective that seems distant and unobtainable? It can be attained through education. At first glance, community outreach programs appear to have negligible impact on a greenhouse gas emissions reduction strategy. However, the long-term consequences of changing people's perception are best described by changes in their patterns. It is not so lofty to believe that in the very near future climate change science and policy will be commonplace in primary education curricula, after all as, John Gibbons once stated: "climate change is the surrogate of all other environmental issues."

However, we do not need to rely on generations still too young to understand the science that is threatening them; we can achieve equilibrium on a more expeditious timeline. Presently, we are highly dependent, both socially and economically, on fossil fuels – the primary source of greenhouse gases. Less carbon-intensive energy sources and carriers exist, offering society an option to reduce impact now rather than assuming the next generation will be less complacent. Although many forms of renewable energy are considered prohibitively expensive in today's markets, this trend is devolving, and continues to do so with the emergence of new technology and the restructuring of energy markets. Clearly there exists a great void, one that will require an expansive bridge in order to enable our society and markets to relinquish dependency on fossil fuel based energy systems. The transformation does not have to be abrupt, and can be made without negatively impacting our economy. Programs such as renewable energy portfolio standards and landfill gas recovery systems provide good examples of using the existing language of economics and market sensitivity to articulate just how feasible it is to power our lives with renewable energy systems.

The final Milestone in the CCP campaign requires each member city to "…monitor and verify the results of implementation."[30] In order to effectively achieve this final goal, thus meeting all requirements of the CCP campaign, the City needs to initiate vigilant data management and tracking techniques. By thoroughly collecting and cataloguing data on energy and GHG emissions the City will be empowered to adjust and implement programs as the need arises.

Since the measures recommended do not address the original reduction target specified by this Project, two alternative implementation paths were developed that allow the City achieve greater reductions by employing a more accelerated timeline.

Figure ES-20: Three Implementation Pathways for the City of Ann Arbor



By implementing all of the measures recommended, the City will effectively reduce the amount of GHGs emitted in Ann Arbor and meet the goals required of them by the CCP campaign. The figure above indicates three timelines by which the City can choose to initiate the recommended measures, therefore offering three separate reduction targets. The

[30] ICLEI, "CCP Participants" <http://www3.iclei.org/co2/ccpmems.htm>.

first target sets a moderate reduction target of 7% emissions reduction below the 1990 baseline in 2020. It is this implementation path that was used to calculate the actual reductions of each recommended mitigation measure. This timeline is highly feasible, but not necessarily considered aggressive compared with other community action plans. Ann Arbor's emissions level in 2020 will be 1,892,256 metric tons of CO_2 equivalents, which is approximately 59,602 metric tons of CO_2 equivalents less than the 1990 emissions level and 986,485 metric tons of CO_2 equivalents less than the *Current Scenario*.

Figure ES-21: Implementation Path Emissions

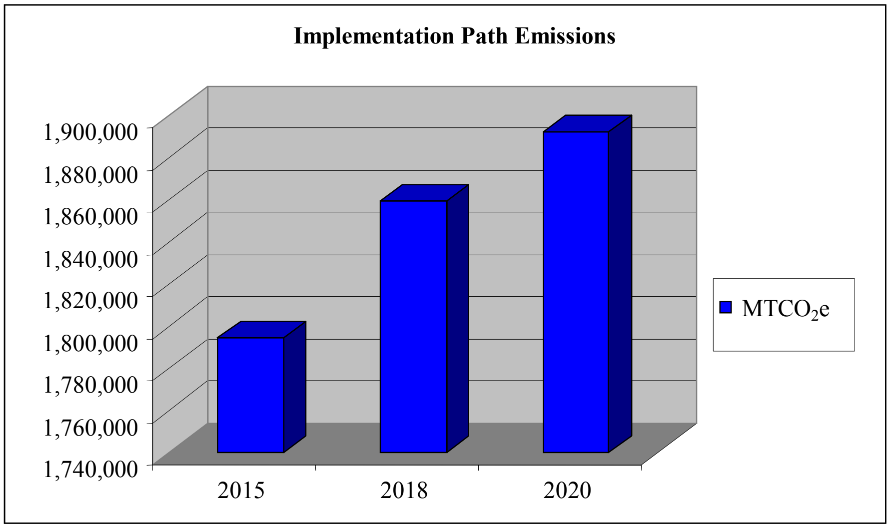


Table ES-10: Implementation Paths and Associated GHG Emissions Reductions

Year	***Current Scenario*** **Emissions** ($MTCO_2e$)	**Implementation Path Emissions** ($MTCO_2e$)	**Reduction Below 1990** (%)	**Reduction Below 1990** ($MTCO_2e$)	**Reduction Below** ***Current Scenario*** ($MTCO_2e$)
1990	1,951,858	-	-	-	-
2015	2,736,788	1,794,387	8.1	157,471	942,401
2018	2,827,911	1,859,527	4.7	92,331	968,384
2020	2,878,741	1,892,256	3.1	59,602	986,485

By implementing the recommended measures on a slightly more aggressive timeline the City can achieve an emissions reduction of nearly 5% below 1990 levels by 2018. This implementation path will result in a reduction of 92,331 metric tons of CO_2 equivalents less than the 1990 levels and 968,384 metric tons of CO_2 equivalents less than the *Current Scenario*. The third implementation path would be considered moderately progressive in comparison with the 7% reduction that would have been required of the U.S. under the Kyoto Protocol. It will result in an 8% reduction below 1990 emissions level by 2015, reducing 157,471 metric tons of CO_2 equivalents below the 1990 level and 942,401 metric tons of CO_2 equivalents below the *Current Scenario*. Initiating this implementation path would be considered more progressive relative to other communities and enable Ann Arbor to distinguish themselves as a leader in reducing local impacts on climate change.

Integrative decision-making is vital in successfully implementing a strategy that cuts across as many sectors and fields as a greenhouse gas emissions reduction plan. In order to achieve any of the targets described above, the City will need the participation and cooperation of several, if not all City departments, engaging stakeholders and interested parties who may not have been previously affiliated with one another. Seeking the recommendation and council of other communities, those already in the process of implementing their action plans, may prove highly valuable. In the end, by implementing a strong, progressive greenhouse gas emissions reduction strategy, the City can set itself apart in the arena of local environmental initiatives, bidding other communities to follow suit and leading by example.

GHG Emissions Reductions Measures

Matrix of Recommended Measures

Name of Measure	Residential	Commercial	Industrial	U of M	Municipal	Description	CO2 Reduction ($MTCO_2e$)	Initial Cost	Annual Ongoing Cost	Annual Savings	Payback (Years)
Community Outreach and Education											
Green Youth Corps Program	X	X	X	X	X	Develop a summer employment program to hire City teens to work on City beautification and tree planting projects.	550	$3,200.00	$86,650.00	$0.00	N/A
Tree Distribution and Planting Partnership	X	X	X	X	X	Develop a partnership with local growers to distribute native trees to the community	415	$2,480.00	$0.00	$0.00	N/A
Heating/Cooling Education Program	X					Develop an outreach program to educate residents on efficient heating and cooling practices	43	$0.00	$7,200.00	$0.00	N/A
Climate Change Education Program	X					Encourage a climate change curriculum in public schools	816	N/A	N/A	N/A	N/A
Green Design Seminar	X	X	X	X	X	Develop a course for builders, contractors, and developers on energy efficient building design and encourage developers to seek Leadership in Energy and Environmental Design (LEED) certification for new construction	3643	$0.00	$7,200.00	$11,638.59	N/A

Name of Measure	Residential	Commercial	Industrial	U of M	Municipal	Description	CO2 Reduction ($MTCO_2e$)	Initial Cost	Annual Ongoing Cost	Annual Savings	Payback (Years)
Energy Conservation											
Water Conservation	X	X	X	X	X	Develop a city-wide program to encourage/facilitate the installation of water-conserving fixtures, and appliances	4,219	$0.00	$7,200.00	$121,838.78	0
Energy Efficiency in Rental Units	X			X		Develop an incentive-based program to encourage landlords to install energy efficient heating and air conditioning systems, hot water heaters and appliances in their units	44,249	$0.00	$0.00	$0.00	0
0% Interest and Rebate Program For Residential Sector Appliances	X	X	X			Create a tax or rebate-based incentive program to reimburse the cost differential for the replacement of non-energy efficient appliances with *EnergyStar* models and develop a zero interest loan program to enable residents to borrow funding to finance high cost energy efficiency projects.	1,304	$472,100.00	$0.00	$0.00	N/A
Energy Efficient Building Codes	X	X	X	X	X	Improve building code's energy efficiency standards for new construction	9,169	$18,000.00	N/A	$20,567.50	0.88

Name of Measure	Residential	Commercial	Industrial	U of M	Municipal	Description	CO2 Reduction ($MTCO_2e$)	Initial Cost	Annual Ongoing Cost	Annual Savings	Payback (Years)
University of Michigan Residential Housing Utility and Rent Separation				X		Encourage the U of M to change their practice of including utility costs with monthly rent to increase energy-conscious habits	1,114	$0.00	$0.00	$0.00	N/A
Compact Fluorescent (CFL) Bulb Program	X					Partner with CFL manufactures to create a program where coupons for the purchase of CFLs are distributed to Ann Arbor residents	1,275	$0.00	$12,500.00	$0.00	N/A
Energy Efficiency Officer	X	X	X	X	X	Hire a City employee to work with the municipality, residents, business and industry to enhance energy efficiency	28,321	$0.00	$72,000.00	$62,831.53	N/A
Energy Efficient Window Replacement	X	X	X	X	X	Encourage the replacement of old windows with more energy efficient models in all sectors	2,702	N/A	$7,200.00	$11,283.00	N/A
Waste Water Treatment Plant Anaerobic Digester Gas Power	X	X	X	X	X	Anaerobic digestion/gasification of waste water treatment plant residue to provide methane for a fuel cell	40,243	$1,300,000.00	N/A	$353,151.09	3.68
Solar Powered Street Lights					X	Retrofit or replace streetlamps with solar powered models	20563	$4,024,917.00	$0.00	$222,850.00	18.1

Name of Measure	Residential	Commercial	Industrial	U of M	Municipal	Description	CO2 Reduction ($MTCO_2e$)	Initial Cost	Annual Ongoing Cost	Annual Savings	Payback (Years)
Renewable Portfolio Standard	X	X	X	X	X	Require all electricity sold within the City of Ann Arbor of come from 50% renewable sources	771,212	N/A	N/A	N/A	N/A
Transportation											
Anti-idling Ordinance	X	X	X	X	X	Adopt a citywide ordinance banning all vehicle idling longer than a specified length of time	4,261	N/A	N/A	N/A	N/A
Traffic Flow Study	X	X	X	X	X	Conduct a city-wide traffic flow study to maximize efficiencies	4,147	$7,200.00	$0.00	N/A	N/A
Hybrid Electric Vehicle Rebate Program	X	X	X	X		Offer tax credits or purchase incentives/rebate programs for hybrid electric vehicles	3,930	$3,426,000.00	N/A	N/A	N/A
Hybrid Electric Vehicle Parking Incentive Program	X					Provide free parking in the city for hybrid electric vehicles	982	$7,707.33	N/A	N/A	N/A
Alternative Transportation to Work Day Program	X					Promote Ann Arbor residents' use of alternative transportation one day a week from May - September.	167	$0.00	$7,200.00	$0.00	N/A
Fuel Switching and Hybrid Electric Vehicle Purchase Program				X	X	Adopt a policy by the City of Ann Arbor and the University of Michigan that all newly purchased sedans be hybrid electric vehicles; all diesel fuel purchased should be switched to a blend of 20% biodiesel.	11,107	$262,000.00	$240,000.00	$31,458.00	N/A

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City Employee Telecommuting					X	Enable City employees to telecommute a specific number of days per week	32	N/A	$7,200.00	N/A	N/A
UM Student Go! Passes	X					Expand free bus pass program to all U of M students (both graduate and undergraduate)	2,756	N/A	N/A	N/A	N/A
Bike Encouragement Program	X				X	A collaborative effort between the City and the U of M to annually give away free bikes that are recovered; expand bike lanes; increase bike rack capacity on buses (U of M and City); and augment police bike patrols	4,834	$59,175.00	$0.00	$31,349.53	1.89
Smart Growth Initiative Program	X					Develop Smart Growth Initiative to maintain or reduce VMT/per Ann Arbor resident over time	177	$0.00	$0.00	$0.00	N/A
City Employee Flex-Time					X	Offer flex-time work schedule for city employees	32	$0.00	$7,200.00	N/A	N/A
Solid Waste Management											
Waste Reduction Mandates	X	X	X	X	X	Reduce waste across all sectors by 70% by the year 2020	24,222	N/A	N/A	N/A	N/A
Other											

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Existing State and Federal Programs	X	X	X	X	X	Participate in one or more of the following programs: a. Environmental Protection Agency *Urban Heat Island Reduction Initiative:* Encourages the use of highly reflective materials for roofing b. Environmental Protection Agency *EnergyStar Buildings:* Help small businesses purchase energy efficient office products c. Environmental Protection Agency *Water Alliances for Voluntary Efficiency (WAVE):* Provides universities develop cost-effective water conservation programs d. Department of Energy *EnergySmart Schools: Provides school retrofit and conservation education assistance* e. Department of Energy *Municipal Energy Management Program (MEMP):* Assist urban areas to achieve energy efficiency					

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Support for Light Rail Transit System					X	Ann Arbor's Mayor and City Council should generate a statement of support for a light rail transit system connecting Lansing and Ann Arbor, and Metro Airport and Detroit					
Corporate Average Fuel Economy (CAFE)						Raising CAFE standards will increase the national fuel economy of the U.S. fleet. A higher fuel economy will reduce the amount of petroleum-based fuels consumed.					