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Section A1

GHG Forecast Assumptions

Bloomington Business as Usual GHG Methodology

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Bloomington GHG Emissions Today

Bloomington's 2008 and 2018 greenhouse gas (GHG) inventories as recorded in the ICLEI ClearPath online tool and shown in Table 1 are the starting point for projecting future communitywide emissions.[1] The largest share of GHG emissions today come from electricity use, followed by transportation and natural gas use.

Table 1. Bloomington GHG Inventories 2008 & 2018

	GHG Emissions ($MTCO_2e$)	
	Year	
Source	2008	2018
Electricity	1,045,212	777,859
Natural Gas	92,245	100,082
Other Industrial Energy	57,785	84,540
Transportation	184,030	198,141
Waste	69,899	81,786
Water & Wastewater	21,380	14,751
Other	61,567	33,334
Total	1,532,117	1,290,493

Business as Usual to 2050

Business as Usual (BAU) GHG emissions are modeled by applying demographic and other trend data to the emissions inventory to develop projected emissions levels that could occur in 2025, 2030 and 2050 without additional climate action in Bloomington. These years were chosen because they are the years of Bloomington's emissions reduction targets.

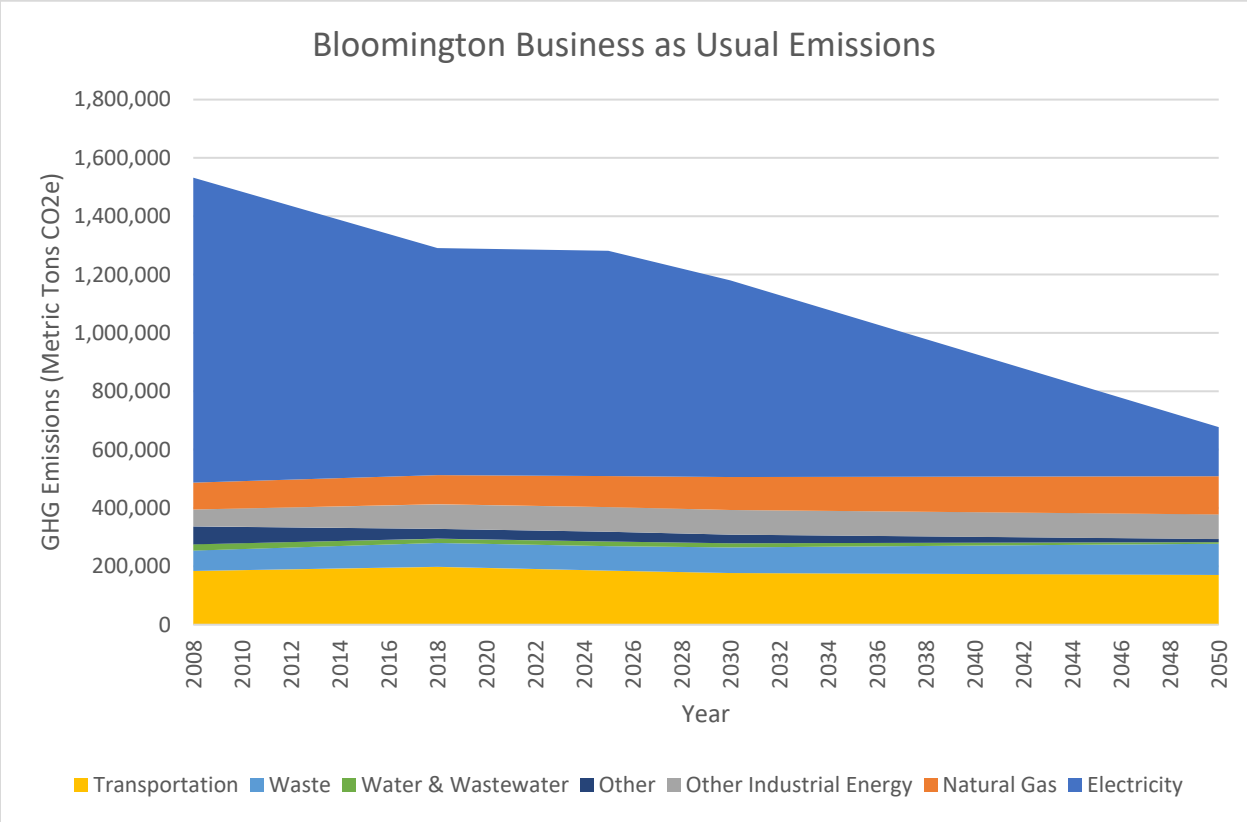
The BAU shows that the city's community-wide emissions footprint could fall to 677,164 metric tons of carbon dioxide equivalent ($MTCO_2e$) by 2050 (Figure 1 & Table 2). This would be less than half of Bloomington's 2008 emissions. These changes come from a national move away from fossil fuels in the electricity grid, increased automobile and appliance efficiencies, and changes energy demand. These trends are due to technology improvements, corporate climate commitments, federal regulations, climate shifts, and other systemic changes. The projected emissions decrease will be important in supporting Bloomington's climate commitments, but Bloomington will not meet its stated goals without taking further action to reduce emissions.

The BAU projection is meant to be a guide for action planning by showing the general direction of emissions by sector. There is significant uncertainty in the BAU. Furthermore, the BAU is not a replacement for regular emissions tracking and program evaluation. As Bloomington implements

[1] Bloomington ClearPath Account. Data accessed August 2020.

climate action it should inventory emissions and make sure climate strategies are achieving intended savings.

Figure 1. Bloomington Business as Usual GHG Projection (MT CO_2e)



Electricity Carbon Intensity the Biggest Change

By far, the largest source of change in emissions in the BAU comes from the decarbonization of the electricity grid that serves Bloomington. As carbon-intensive sources of power, like coal, have been decommissioned the average GHG emissions associated with a kilowatt-hour (kWh) of electricity used in Bloomington has fallen in recent years. This is expected to continue if the major electricity supplier for the area, Duke Energy, meets its goals of cutting GHG emissions 50% below 2005 levels by 2030 and to "net zero" emissions by 2050.[2] This projected change in the electricity supply also impacts Bloomington's Water & Wastewater emissions, which include emissions associated with electricity to operate the water and wastewater systems.

Waste Emissions Largest Projected BAU Increase

The largest increase in GHG emissions in the BAU is from solid waste. Bloomington is projected to have significant population growth through 2050, so if waste generation and management practices are not changed the emissions from solid waste will grow too.

[2] https://www.duke-energy.com/_/media/pdfs/our-company/climate-report-2020.pdf

Table 2. Bloomington BAU GHG Emissions ($MTCO_2e$)

	Year			Change	Change	Share of Total Change
Source	2025	2030	2050	2008-2050	2008-2050	
Electricity	772,099	674,354	168,363	(876,849)	-84%	103%
Natural Gas	106,524	112,645	130,816	38,571	42%	-5%
Other Industrial Energy	84,540	84,540	84,540	26,755	46%	-3%
Transportation	185,255	176,704	170,720	(13,310)	-7%	2%
Waste	83,478	87,651	106,541	36,642	52%	-4%
Water & Wastewater	16,264	14,403	5,408	(15,972)	-75%	2%
Other	33,322	29,743	10,776	(50,791)	-82%	6%
Business as Usual Total	**1,281,481**	**1,180,041**	**677,164**	**(854,953)**	**-56%**	**100%**

Data and Assumptions

The assumptions for each projection by emissions source are described below.

Population

Bloomington is projected to see a 52% population growth between 2008 and 2050 to over 118,000 residents in the BAU scenario. This will impact the level of activity throughout the city. The BAU uses Bloomington's 2018 population of 86,522 and applies a 1% annual increase to that value. This is in line with recent growth and the average growth in Monroe County from STATS Indiana from 2000-2050.[3]

Electricity

The Bloomington GHG Inventory uses the grid average emissions factor from the US EPA's eGRID database for the RFC West subregion. As mentioned, the BAU incorporates Duke Energy's 50% reduction below 2005 by 2030 and net zero by 2050 climate goals. Net zero typically means that there are still some fossil fuel emissions in the system that are being offset some other way. The BAU assumes 10% of GHG emissions per kWh remaining in 2050 based on Duke Energy's plan to maintain 6% natural gas and 30% other energy sources.[4]

[3] http://www.stats.indiana.edu/pop_proj/ An alternative method for projecting Bloomington's population would be a proportional value of the county projection. STATS Indiana projects a population of 180,159 residents for Monroe County in 2050, which if weighted proportionally to 2018 would mean 106,000 Bloomington residents in 2050. The BAU uses the higher number of 118,000 for the sake of capturing the full potential climate impact of population growth.

[4] https://www.axios.com/duke-energy-carbon-free-18a6b5b7-2829-4fe5-a445-e940edf26b76.html

Table 3. Electricity Carbon Intensity

Year	2005	2008	2018	2025	2030	2050
Electricity Emissions Factor ($MTCO_2e$/kWh)	0.000703	0.000702	0.000532	0.000427	0.000351	0.000070
Change from 2005	0%	0%	-24%	-39%	-50%	-90%

As climate change increases high heat days in Bloomington the demand for air conditioning is expected to increase electricity use. This is measured in "cooling degree days", which are projected to rise 42% by 2050.[5] The BAU applies this change to 20% of the electricity activity to approximate the share of electricity use that may be for space cooling.

The electricity BAU projection incorporates the projected population growth for Bloomington. Combining these factors, the electricity demand in Bloomington is projected to increase from 1.5 million kWh in 2018 to 1.9 million kWh in 2030 and 2.4 million kWh in 2050, but emissions associated with this activity decline as the electricity grid becomes less carbon intensive.

Natural Gas

Climate change is anticipated to reduce the need for space heating in Bloomington. "Heating degree days" are projected to decline 14% by 2050. The BAU applies this change to 75% of the natural gas use to approximate the share of natural gas used for heating.[6]

The natural gas BAU estimate incorporates the projected population growth for Bloomington and total usage grows to 25 million therms by 2050. The carbon-intensity of natural gas stays constant through the BAU projection.

Other Industrial Energy

In the Bloomington GHG inventory "Other Industrial Energy" is energy used at the IU Central Heating Plant. As described in the 2018 GHG Inventory, emissions at this facility have decreased with fuel switching from coal to natural gas in recent years. The 2018 emission level is projected to stay flat through 2050 under BAU.

[5] See weighted mean of RCP 8.5 projections https://crt-climate-explorer.nemac.org/local-climate-charts/?county=Monroe%2BCounty&city=Bloomington%2C%20IN&fips=18105&lat=39.165325&lon=-86.52638569999999&zoom=7&nav=local-climate-charts&id=cdd_65f

[6] See weighted mean of RCP 8.5 projections https://crt-climate-explorer.nemac.org/local-climate-charts/?county=Monroe%2BCounty&city=Bloomington%2C%20IN&fips=18105&lat=39.165325&lon=-86.52638569999999&zoom=7&nav=local-climate-charts&id=cdd_65f

Transportation

Transportation emissions in the Bloomington GHG Inventory are comprised of gasoline and diesel use by on-road vehicle travel, transit vehicle fuel use, aviation emissions at the Monroe County Airport, and off-road activities, such as construction equipment.

Emissions from non-transit gasoline and diesel vehicles were 70% of Bloomington's transportation emissions in 2018. On-road vehicle miles traveled (VMT) in Bloomington were 293 million miles in 2018 and the BAU scenario applies the average annual population increase to this going forward, resulting in 415 million miles in 2050.

Vehicle efficiency has been improving nationwide, and the Energy Information Agency's Annual Energy Outlook (EIA AEO) projects that trend will continue. The BAU projection uses a weighted average fuel economy for gasoline passenger vehicles and diesel heavy trucks to estimate that fossil fuel vehicles on the road in 2050 will average 31.5 miles per gallon (mpg).[7] The carbon-intensity of gasoline and diesel fuel stay constant through the BAU projection.

In addition, national projections expect an increased uptake of electric vehicles in coming years. The Edison Electric Institute has estimated that electric vehicle will be 7% of all vehicles on the road in the country by 2030.[8] Sales of electric vehicles in Indiana have been lower than national averages to-date, so the BAU projection assumes a lower share of EVs in Bloomington—2% of vehicle miles traveled by 2025, 3.5% by 2030, and 9% by 2050.[9] The efficiency of electric vehicles is held constant at 30 kWh per 100 miles.[10]

The emissions associated with other transportation sources are held constant at 2018 levels. Taken together these trends result in a decrease in transportation-related emissions even as VMT grows in the city.

[7] https://www.eia.gov/outlooks/aeo/pdf/appa.pdf
[8] http://www.ehcar.net/library/rapport/rapport233.pdf
[9] https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/
[10] https://www.fueleconomy.gov/feg/PowerSearch.do?action=noform&path=1&year1=2019&year2=2020&vtype=Electric&pageno=4&sortBy=Comb&tabView=0&rowLimit=10 Efficiency of EVs will improve over coming years but will also be counter-weighted by the introduction of additional larger vehicle types.

Table 4. Transportation Emissions Projections

Year	2008	2018	2025	2030	2050
VMT	272,403,655	293,007,400	325,320,930	341,586,976	415,201,105
Average On-Road MPG	19.1	19.5	23.5	26.2	31.5
Gallons of Fuel (Gasoline & Diesel)	14,237,620	15,040,733	13,550,057	12,576,835	11,975,859
On Road Gas/Diesel Emissions ($MTCO_2e$)	130,093	138,553	124,821	115,856	110,320
Electric Emissions ($MTCO_2e$)			846	1,260	812
Other Emissions ($MTCO_2e$)	53,937	59,588	59,588	59,588	59,588
Total Transportation Emissions	**184,030**	**198,141**	**185,255**	**176,704**	**170,720**
Change from 2008	0%	8%	1%	-4%	-7%

Waste

Emissions associated with solid waste disposal and treatment are scaled based on population growth projections.

Water and Wastewater

In 2018, 88% of the emissions associated with water and wastewater are due to electricity use in the system. As discussed in the electricity section above, the decarbonization of the electricity grid is projected to eliminate many of these emissions. The BAU links future water and wastewater electricity use and wastewater N2O emissions to population growth in Bloomington. The net result is a 63% reduction in emissions from these sources to 5,408 $MTCO_2e$ in 2050.

Other Emissions

The fugitive emissions associated with natural gas and the transmission and distribution emissions associated with electricity were 3.26% and 3.87% respectively in 2018. The BAU projection applies these same shares to natural gas and electricity going forward.

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Section A2

Glossary of Terms

A

Activity Data

Data on the magnitude of a human activity resulting in emissions or removals taking place during a given period of time. Data on energy use, metal production, land areas, management systems, lime and fertilizer use and waste arisings are examples of activity data. (IPCC)

Aerosols

A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 micrometer that reside in the atmosphere for at least several hours. Aerosols may be of either natural or anthropogenic origin. Aerosols may influence climate in several ways: directly through scattering and absorbing radiation, and indirectly by acting as cloud condensation nuclei or modifying the optical properties and lifetime of clouds. (IPCC2)

Afforestation

Planting of new forests on lands that historically have not contained forests. (IPCC2)

Air Pollutant

Any man-made and/or natural substance occurring in the atmosphere that may result in adverse effects to humans, animals, vegetation, and/or materials. (CARB)

Anthropogenic

The term "anthropogenic", in the context of greenhouse gas inventories, refers to greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities. (USEPA2)

Atmosphere

The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium and radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio) and ozone. In addition, the atmosphere contains the greenhouse gas water vapor, whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols. (IPCC2)

B

Baseline Emissions

A baseline is a measurement, calculation, or time used as a basis for comparison. Baseline emissions are the level of emissions that would occur without policy intervention or without implementation of a project. Baseline estimates are needed to determine the effectiveness of emission reduction programs (also called mitigation strategies).

Base Year

The starting year for the inventory. Targets for reducing GHG emissions are often defined in relation to the base year.

Biogenic

Produced by the biological processes of living organisms. Note that we use the term "biogenic" to refer only to recently produced (that is non-fossil) material of biological origin. IPCC guidelines recommend that peat be treated as a fossil carbon because it takes a long time to replace harvested peat.

Biogeochemical Cycle

Movements through the Earth system of key chemical constituents essential to life, such as carbon, nitrogen, oxygen, and phosphorus. (NASA)

Biomass
Either (1) the total mass of living organisms in a given area or of a given species usually expressed as dry weight; or (2) Organic matter consisting of or recently derived from living organisms (especially regarded as fuel) excluding peat. Includes products, by-products and waste derived from such material. (IPCC1)

Biomass Waste
Organic non-fossil material of biological origin that is a byproduct or a discarded product. "Biomass waste" includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and gases; but excludes wood and wood-derived fuels (including black liquor), biofuels feedstock, biodiesel, and fuel ethanol. Note: EIA "biomass waste" data also include energy crops grown specifically for energy production, which would not normally constitute waste. (EIA)

Black Carbon
Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal and/or possible light absorbing refractory organic matter (Charlson and Heintzenberg, 1995, p. 401). (IPCC2)

C

Carbon Cycle
All parts (reservoirs) and fluxes of carbon. The cycle is usually thought of as four main reservoirs of carbon interconnected by pathways of exchange. The reservoirs are the atmosphere, terrestrial biosphere (usually includes freshwater systems), oceans, and sediments (includes fossil fuels). The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes. The ocean contains the largest pool of carbon near the surface of the Earth, but most of that pool is not involved with rapid exchange with the atmosphere. (NASA)

Carbon Dioxide (CO_2)
A naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. (IPCC2)\

Carbon Dioxide Equivalent (CO_2e)
A metric used to compare emissions of various greenhouse gases. It is the mass of carbon dioxide that would produce the same estimated radiative forcing as a given mass of another greenhouse gas. Carbon dioxide equivalents are computed by multiplying the mass of the gas emitted by its global warming potential.

Carbon Disclosure Project (CDP)
An international organization that administers a platform for organizations and cities to publicly disclose their environmental impacts, such as climate risk. CDP is one of the approved disclosure platforms utilized by GCoM.

Carbon Emissions
The release of carbon dioxide into the atmosphere. Primary human sources of the release of carbon dioxide occur from burning oil, coal, and gas for energy use.

Carbon Equivalent (CE)
A metric measure used to compare the emissions of the different greenhouse gases based upon their global warming potential. Carbon equivalents can be calculated from to carbon dioxide equivalents by multiplying the carbon dioxide equivalents by 12/44 (the ratio of the molecular weight of carbon to that of carbon dioxide). The use of carbon equivalent is declining in GHG inventories.

Carbon Intensity
The amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is weight of carbon per British thermal unit (Btu) of energy. When there is only one fossil fuel under consideration, the carbon intensity and the emissions coefficient are identical. When there are several fuels, carbon intensity is based on their combined emissions coefficients weighted by their energy consumption levels. (EIA)

Carbon Neutrality
For the purposes of the Plan, Carbon Neutrality refers to the point at which the organization / organization's net greenhouse gas emissions reach 0. This will likely be achieved through a combination of reducing emission sources and offsetting and sequestering any remaining emissions.

Carbon Sinks
A forest, ocean, or other natural environment viewed in terms of its ability to absorb carbon dioxide from the atmosphere.

Carbon Sequestration
This refers to the capture of CO_2 from the atmosphere and its long term storage in oceans (oceanic carbon sequestration), in biomass and soils (terrestrial carbon sequestration) or in underground reservoirs (geologic carbon sequestration).

Chlorofluorocarbons (CFCs)
Greenhouse gases covered under the 1987 Montreal Protocol and used for refrigeration, air conditioning, packaging, insulation, solvents, or aerosol propellants. Because they are not destroyed in the lower atmosphere, CFCs drift into the upper atmosphere where, given suitable conditions, they break down ozone. These gases are being replaced by other compounds, including hydrochlorofluorocarbons and hydrofluorocarbons, which are greenhouse gases covered under the Kyoto Protocol. (IPCC3)

Circular Economy
An alternative to a traditional linear economy (make, use, dispose) in which an economy is a regenerative system where resource input and waste are minimized. This is achieved through long-lasting product design, repair, reuse, remanufacturing, and recycling. Circular economy strategies are often cited as systems level approaches to reducing waste generation through product and system design.

Climate
Climate in a narrow sense is usually defined as the "average weather" or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. (IPCC2)

Climate Adaptation or Resilience
The capacity of a natural environment to prevent, withstand, respond to, and recover from a disruption. The process of adjusting to new climate conditions in order to reduce risks to valued assets.

Climate Change
Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. (IPCC2)

Climate Hazard
An extreme climate event or condition that can harm human health, livelihoods, or natural resources. It can include abrupt changes to the climate system such as extreme precipitation, storms, droughts, and heat waves.

Climate Risk
The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability and hazard. (IPCC):

Climate Vulnerability
Is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its capacity to adapt. Vulnerability = potential impact (sensitivity x exposure) – adaptive capacity (IPCC):

Climate Vulnerability Assessment
A report used to identify and define the risks posed by climate change and inform adaptation measures needed to combat climate change. Reports can be about a wide range of fields including food security, poverty analysis, and extreme weather events.

Cogeneration
Cogeneration is an industrial structure, installation, plant, building, or self-generating facility that has sequential or simultaneous generation of multiple forms of useful energy (usually mechanical and thermal) in a single, integrated system. (CARB)

Combined Heat and Power (CHP)
Combined heat and power is the simultaneous production of both electricity and useful heat for application by the producer or to be sold to other users with the aim of better utilisation of the energy used. Public utilities may utilise part of the heat produced in power plants and sell it for public heating purposes. Industries as auto-producers may sell part of the excess electricity produced to other industries or to electric utilities. (IPCC)

Community Solar
Solar facilities shared by multiple community subscribers who receive credit on their electricity bills for their share of the power produced. Community solar allows members of a community to share the benefits of solar power on their property without installing it on their own property. Electricity generated by the community solar farm typically costs less than the price from utility companies.

Consistency
Consistency means that an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. (IPCC)

Continuous Emission Monitor (CEM)
A type of air emission monitoring system installed to operate continuously inside of a smokestack or other emission source. (CARB)

Criteria Air Pollutant
An air pollutant for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Examples include: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM10 and

PM2.5. The term "criteria air pollutants" derives from the requirement that the U.S. EPA must describe the characteristics and potential health and welfare effects of these pollutants. The U.S. EPA and CARB periodically review new scientific data and may propose revisions to the standards as a result. (CARB)

D

Deforestation

Those practices or processes that result in the change of forested lands to non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present and contributing to carbon storage. (UNFCC)

Distillate Fuel Oil

A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation. (EIA)

E

Emissions

The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere. (USEPA1)

Emission Factor

A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions. (IPCC)

Emission Inventory

An estimate of the amount of pollutants emitted into the atmosphere from major mobile, stationary, area-wide, and natural source categories over a specific period of time such as a day or a year. (CARB)

Emission Rate

The weight of a pollutant emitted per unit of time (e.g., tons / year). (CARB)

Environmental Justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies

Estimation

Estimation is the assessment of the value of an unmeasurable quantity using available data and knowledge within stated computational formulas or mathematical models.

F

Fluorocarbons

Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). (UNFCC)

Flux
Either (1) Raw materials, such as limestone, dolomite, lime, and silica sand, which are used to reduce the heat or other energy requirements of thermal processing of minerals (such as the smelting of metals). Fluxes also may serve a dual function as a slagging agent. (2) The rate of flow of any liquid or gas, across a given area; the amount of this crossing a given area in a given time. (e.g., "Flux of CO2 absorbed by forests"). (IPCC)

Fossil Fuel
Geologic deposits of hydrocarbons from ancient biological origin, such as coal, petroleum and natural gas.

Fuel Combustion
Fuel combustion is the intentional oxidation of materials within an apparatus that is designed to provide heat or mechanical work to a process, or for use away from the apparatus. (IPCC)

Fugitive Emissions
Emissions that are not emitted through an intentional release through stack or vent. This can include leaks from industrial plant and pipelines. (IPCC)

G
Geologic Carbon Sequestration
It is the process of injecting CO_2 from a source, such as coal-fired electric generating power plant, through a well into the deep subsurface. With proper site selection and management, geologic sequestration could play a major role in reducing emissions of CO_2. Research efforts to evaluate the technical aspects of CO_2 geologic sequestration are underway. (USEPA4)

Global Warming
Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities. Also see Climate Change (USEPA1)

Global Warming Potential (GWP)
An index, based upon radiative properties of well-mixed greenhouse gases, measuring the radiative forcing of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame. (IPCC2)

GCOM Global Covenant of Mayors:
GCoM is the largest global alliance for city climate leadership, built upon the commitment of over 10,000 cities and local governments. The alliance's mission is to mobilize and support climate and energy action in communities across the world.

Greenhouse Effect
Trapping and build-up of heat in the atmosphere (troposphere) near the earth's surface. Some of the heat flowing back toward space from the earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase. (UNFCC)

Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories:
A robust, transparent and globally-accepted framework that cities and local governments can use to consistently identify, calculate and report on city greenhouse gas emissions.

Greenhouse Gas
Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). (UNFCC)

Green Infrastructure
An approach to managing precipitation by reducing and treating stormwater at its source while delivering environmental, social, and economic benefits. Stormwater runoff can carry trash, bacteria, and other pollutants and is a major cause of water pollution in urban areas.

Gross Domestic Product (GDP)
The sum of gross value added, at purchasers' prices, by all resident and non-resident producers in the economy, plus any taxes and minus any subsidies not included in the value of the products in a country or a geographic region for a given period, normally one year. It is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural resources. (IPCC3)

H

Halocarbons
A collective term for the group of partially halogenated organic species, including the chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), halons, methyl chloride, methyl bromide, etc. Many of the halocarbons have large Global Warming Potentials. The chlorine and bromine-containing halocarbons are also involved in the depletion of the ozone layer. (IPCC2)

Hydrocarbons
Strictly defined as molecules containing only hydrogen and carbon. The term is often used more broadly to include any molecules in petroleum which also contains molecules with S, N, or O An unsaturated hydrocarbon is any hydrocarbon containing olefinic or aromatic structures. (IPCC)

Hydrofluorocarbons (HFCs)
Compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful greenhouse gases with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23). (USEPA1)

I

ICLEI Local Governments for Sustainability:
A membership organization for local governments to pursue reductions in carbon pollution and improvements in advancing sustainable urban development. ICLEI's members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

Intergovernmental Panel on Climate Change
The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its

capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories. (USEPA1)

K

Kilowatt Hour (kWh):
A measure of electrical energy equivalent to a power consumption of 1,000 watts for one hour.

Kyoto Protocol
The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organisation for Economic Cooperation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on 16 February 2005. (IPCC2)

L

Land Use and Land Use Change
Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have a radiative forcing and/or other impacts on climate, locally or globally. (IPCC2)

LULUCF
Acronym for "Land Use, Land Use Change and Forestry", a category of activities in GHG inventories.

M

Megawatt Hour (MWH):
A measure of electrical energy equivalent to a power consumption of 1,000,000 watts for one hour.

Methane (CH_4)
A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 25 times that of carbon dioxide (CO_2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, flooded rice fields, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The GWP is from the IPCC's Fourth Assessment Report (AR4).

Metric Ton
The tonne (t) or metric ton, sometimes referred to as a metric tonne, is an international unit of mass. A metric ton is equal to a Megagram (Mg), 1000 kilograms, 2204.6 pounds, or 1.1023 short tons.

Million Metric Tons (MMT)
Common measurement used in GHG inventories. It is equal to a Teragram (Tg).

Mitigation:
Actions taken to limit the magnitude or rate of long-term global warming and its related effects. Climate change mitigation generally involves reductions in human emissions of greenhouse gases.

Mobile Sources
Sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats, and airplanes. (CARB)

Mode Share
The percentage of travelers using a particular type of transportation. Modal share is an important component in developing sustainable transport within a city or region because it reveals the level of utilization of various transportation methods. The percentage reflects how well infrastructure, policies, investments, and land-use patterns support different types of travel.

Model
A model is a quantitatively-based abstraction of a real-world situation which may simplify or neglect certain features to better focus on its more important elements. (IPCC)

Municipal Solid Waste (MSW)
Residential solid waste and some non-hazardous commercial, institutional, and industrial wastes. This material is generally sent to municipal landfills for disposal. (USEPA1)

N
Natural Sources
Non-manmade emission sources, including biological and geological sources, wildfires, and windblown dust. (CARB)

Net-zero Emissions (NZE)
Building A building or property that generates or offsets all energy consumed. If the City develops a NZE building code, this definition will have to be refined to provide additional guidance on calculating emissions and offsets to achieve net-zero emissions.

Nitrogen Fixation
Conversion of atmospheric nitrogen gas into forms useful to plants and other organisms by lightning, bacteria, and blue-green algae; it is part of the nitrogen cycle. (UNFCC)

Nitrogen Oxides (NO_x)
Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced in the emissions of vehicle exhausts and from power stations. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), can impair visibility, and have health consequences; they are thus considered pollutants. (NASA)

Nitrous Oxide (N_2O)
A powerful greenhouse gas with a global warming potential of 298 times that of carbon dioxide (CO_2). Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, manure management, fossil fuel combustion, nitric acid production, and biomass burning. The GWP is from the IPCC's Fourth Assessment Report (AR4).

O
Ozone (O_3)
Ozone, the triatomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog).

Tropospheric ozone acts as a greenhouse gas. In the stratosphere, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the ozone layer. (IPCC2)

Ozone Depleting Substances (ODS)
A compound that contributes to stratospheric ozone depletion. Ozone-depleting substances (ODS) include CFCs, HCFCs, halons, methyl bromide, carbon tetrachloride, and methyl chloroform. ODS are generally very stable in the troposphere and only degrade under intense ultraviolet light in the stratosphere. When they break down, they release chlorine or bromine atoms, which then deplete ozone. (IPCC)

P
Perfluorocarbons (PFCs)
A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF_4 and C_2F_6) were introduced as alternatives, along with hydrofluorocarbons, to the ozone depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases: CF_4 has a global warming potential (GWP) of 7,390 and C_2F_6 has a GWP of 12,200. The GWP is from the IPCC's Fourth Assessment Report (AR4).

Photosynthesis
The process by which plants take carbon dioxide from the air (or bicarbonate in water) to build carbohydrates, releasing oxygen in the process. There are several pathways of photosynthesis with different responses to atmospheric carbon dioxide concentrations. (IPCC2)

Point Sources
Specific points of origin where pollutants are emitted into the atmosphere such as factory smokestacks. (CARB)

Power Purchase Agreement (PPA)
A power purchase agreement (PPA), or electricity power agreement, is a contract between two parties; one party generates electricity (the seller) and the other party looks to purchase electricity (the buyer). Individual customers and organizations may enter into PPAs with individual developers or may join together to seek better prices as a group. PPAs can allow longer term commitments to renewable energy as well as a form of “direct” investing in new renewable energy generation.

Property-Assessed Clean Energy (PACE)
A program created for financing energy efficiency and renewable improvements on private property. Private property can include residential, commercial or industrial properties. Improvements can include energy efficiency, renewable energy and water conservation upgrades to a building.

Process Emissions
Emissions from industrial processes involving chemical transformations other than combustion. (IPCC)

R
Radiative Forcing
A change in the balance between incoming solar radiation and outgoing infrared (i.e., thermal) radiation. Without any radiative forcing, solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth. The addition of greenhouse gases to the atmosphere traps an increased fraction of the infrared radiation, reradiating it back toward the surface of the Earth and thereby creates a warming influence. (UNFCC)

Reforestation
Planting of forests on lands that have previously contained forests but that have been converted to some other use. (IPCC2)

Regeneration
The act of renewing tree cover by establishing young trees, naturally or artificially - note regeneration usually maintains the same forest type and is done promptly after the previous stand or forest was removed. (CSU)

Renewable Energy
Energy resources that are naturally replenishing such as solar, wind, hydro and geothermal energy.

Renewable Energy Credits (RECs)
A market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource. The single largest category of reductions in Evanston's emissions has been through the purchase of RECs.

Residence Time
Average time spent in a reservoir by an individual atom or molecule. Also, this term is used to define the age of a molecule when it leaves the reservoir. With respect to greenhouse gases, residence time usually refers to how long a particular molecule remains in the atmosphere. (UNFCC)

Reservoir
Either (1) a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored; or (2) Water bodies regulated for human activities (energy production, irrigation, navigation, recreation etc.) where substantial changes in water area due to water level regulation may occur. (IPCC)

Respiration
The process whereby living organisms convert organic matter to carbon dioxide, releasing energy and consuming molecular oxygen. (IPCC2)

Retro-commissioning
The systematic process to improve an existing building's performance ensuring the building controls are running efficiently and balancing the designed use and the actual use of the building.

Ride-share
The practice of sharing transportation in the form of carpooling or vanpooling. It is typically an arrangement made through a ride-matching service that connects drivers with riders.

S
Scope 1:
Scope 1 includes emissions being released within the city limits resulting from combustion of fossil fuels and from waste decomposition in the landfill and wastewater treatment plant.

Scope 2:
Scope 2 includes emissions produced outside the city that are induced by consumption of electrical energy within the city limits.

Scope 3:
Scope 3 includes emissions of potential policy relevance to local government operations that can be measured and

reported but do not qualify as Scope 1 or 2. This includes, but is not limited to, outsourced operations and employee commute.

Short Ton
Common measurement for a ton in the United States. A short ton is equal to 2,000 lbs or 0.907 metric tons. (USEPA1)

Sink
Any process, activity or mechanism that removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol from the atmosphere. (IPCC2)

Social Cost of Carbon
The social cost of carbon is a measure of the economic harm from climate change impacts, expressed as the dollar value of the total damages from emitting one ton of carbon dioxide into the atmosphere.

Solar Radiation
Electromagnetic radiation emitted by the Sun. It is also referred to as shortwave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun, peaking in visible wavelengths. (IPCC2)

Source
Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol into the atmosphere. (IPCC2)

Stationary Sources
Non-mobile sources such as power plants, refineries, and manufacturing facilities which emit air pollutants. (CARB)

Sulfur Dioxide (SO_2)
A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain). (UNFCC)

Sulfur Hexafluoride (SF_6)
A colorless gas soluble in alcohol and ether, slightly soluble in water. A very powerful greenhouse gas with a global warming potential most recently estimated at 22,800 times that of carbon dioxide (CO_2). SF_6 is used primarily in electrical transmission and distribution systems and as a dielectric in electronics. This GWP is from the IPCC's Fourth Assessment Report (AR4).

T

Terrestrial Carbon Sequestration
It is the process through which carbon dioxide (CO_2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils. The term "sinks" is also used to refer to forests, croplands, and grazing lands, and their ability to sequester carbon. Agriculture and forestry activities can also release CO_2 to the atmosphere. Therefore, a carbon sink occurs when carbon sequestration is greater than carbon releases over some time period. (USEPA3)

Therm:
A unit of measure for energy that is equivalent to 100,000 British Thermal units, or roughly the energy in 100 cubic feet of natural gas. Often used for measuring natural gas usage for billing purposes.

Total Organic Gases (TOG)
Gaseous organic compounds, including reactive organic gases and the relatively unreactive organic gases such as methane. (CARB)

Transparency
Transparency means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information. (IPCC)

Trend
The trend of a quantity measures its change over a time period, with a positive trend value indicating growth in the quantity, and a negative value indicating a decrease. It is defined as the ratio of the change in the quantity over the time period, divided by the initial value of the quantity, and is usually expressed either as a percentage or a fraction. (IPCC)

U
Urban Tree Canopy
Describes the makeup and characteristics of trees within the urban environment.

V
VMT Vehicle Miles Traveled:
A unit used to measure vehicle travel made by private vehicles, including passenger vehicles, truck, vans and motorcycles. Each mile traveled is counted as one vehicle mile regardless of the number of persons in the vehicle.

W
Water Vapor
The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapor feedback. In addition to its role as a natural greenhouse gas, water vapor plays an important role in regulating the temperature of the planet because clouds form when excess water vapor in the atmosphere condenses to form ice and water droplets and precipitation. (UNFCC)

Weather
Atmospheric condition at any given time or place. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard). (USEPA1)

Z
Zero Emission Vehicles (ZEV)
A vehicle that does not emit harmful emissions during operation. Harmful emissions can have a negative impact on human health and the environment. Electric (battery-powered) cars, electric trains, hydrogen-fueled vehicles, bicycles, and carriages are considered to produce zero emissions.

Zero Waste
A cyclical system in which products are designed for reuse, which creates no waste. A zero waste system eliminates the volume and toxicity of waste and materials and conserves current resources through reuse.

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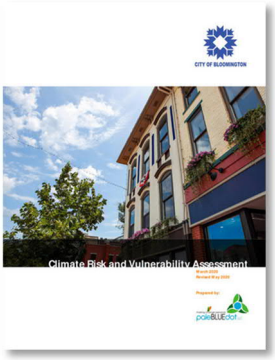
Section A3

Supporting Research

Supporting Research

Climate Risk and Vulnerability Assessment



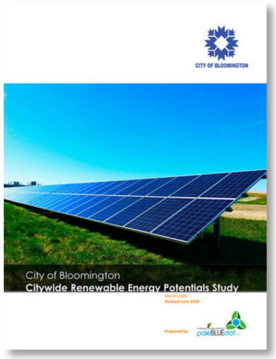
At the beginning of the Climate Action Planning effort, The paleBLUEdot team developed a Climate Risk and Vulnerability Assessment for the City of Bloomington. The assessment included the identification of vulnerable populations within the community and possible impacts and risks associated with projected climate change for the region. paleBLUEdot mapped the vulnerable populations within the City as well as existing City infrastructure and resources which may be capable of supporting climate adaptation strategies. These assessments provided a basis for understanding vulnerabilities and resources which supported the decision making process needed for identifying and prioritizing climate adaptation measures to be included in the final Climate Action Plan. The Assessment focused on City-Wide vulnerabilities with a particular focus on climate vulnerable populations to ensure all populations benefit from proposed implementation measures.

Broad Climate Change Impacts and Risk Factors

The paleBLUEdot identified and summarized the broad climate change metrics already experienced, projected climate change impacts, and risk factors at a regional level. Data on Midwest was collected from the US National Climate Assessment as well as Indiana University, Purdue University, and the University of Michigan Climate Center. State of Indiana specific data was collected and summarized from State and National agencies, and regional university data sources. In addition, detailed climate projections, based on National Center for Atmospheric Research, was developed for the City of Bloomington.

Click on the link below or scan the QR code to access the vulnerability assessment:
https://view.publitas.com/palebluedot/bloomington-climate-risk-and-vulnerability-assessment/

Renewable Energy Potentials Study



At the beginning of the Climate Action Planning effort, In support of development of effective renewable energy goalsetting and to establish strategies addressing renewable energy development, paleBLUEdot conducted a Community-Wide solar pv potentials study including economic and environmental benefits. Through study of community-wide potential, the City of Bloomington was provided data enabling the creation of near and long-term renewable energy targets and implementation strategies based on community specific opportunity. This effort included:

1) Collect city-wide satellite data (NREL, NOAA, and NASA data).
2) Determine building roof stock characteristics and solar suitable buildings, calculate total suitable areas by roof configuration/orientation.
3) Calculate total rooftop solar capacity and annual energy generation by roof configuration/orientation
4) Identify cost efficient annual energy generation potential.
5) Research solar market at national, State and regional levels. Identify low, medium, and high solar market absorption rates and city-wide solar pv goals.
6) Identify environmental and economic benefit of solar including economic development and job creation potential (NREL JEDI model)
7) Develop City-Wide Renewable Solar Energy Potentials report.

Click on the link below or scan the QR code to access the renewable energy study:
https://view.publitas.com/palebluedot/city-of-bloomington-renewable-energy-potentials-study/

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Section A4

Bloomington Climate Infographics

Bloomington Climate Infographics

Below are infographics developed during the Climate Action Plan planning effort in support of the City's communications. Click on or scan the QR code to access the infographics.

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Section A5

Cumulative Potential Cost Savings

Bloomington CAP Cost Savings

Population	85071	County	147,230	0.577810229
Households	30897			
Jobs	50700			

Transportation

																	Cumulative
1	**Goal TL 1**						year 10	9	8	7	6	5	4	3	2	1	0	
	VMT saved	23,564,853	gas saved	586,503	Cost per car	0.7 total savin	$16,495,397	$14,845,857	$13,196,318	$11,546,778	$9,897,238	$8,247,699	$6,598,159	$4,948,619	$3,299,079	$1,649,540	$0	$90,724,684
	monthly Pub Transit cost	30	ave miles c	400	cost per mil	0.075 Total costs	$1,674,979	$1,507,481	$1,339,983	$1,172,485	$1,004,987	$837,489	$669,992	$502,494	$334,996	$167,498	$0	$9,212,384
																		$81,512,300
2	**Goal TL2**						year 10	9	8	7	6	5	4	3	2	1	0	
	VMT converted	34,978,506	gas saved	1,080,699	EV sav/mile	0.106166667 total savin	$3,713,551	$3,342,196	$2,970,841	$2,599,486	$2,228,131	$1,856,776	$1,485,421	$1,114,065	$742,710	$371,355	$0	$20,424,533
	monthly Pub Transit cost																	**$20,424,533**
																		$101,936,832

Energy

																	Cumulative
	Goal EB 1					year 10	9	8	7	6	5	4	3	2	1	0	
3	Residential savings - electrical to solar	73,869,663	0.0515	Savings per kwh	total savin	$3,804,288	$3,423,859	$3,043,430	$2,663,001	$2,282,573	$1,902,144	$1,521,715	$1,141,286	$760,858	$380,429	$0	$20,923,582
4	Residential savings - electrical EE	90,798,235	0.1	Savings per kwh		$9,079,824	$8,171,841	$7,263,859	$6,355,876	$5,447,894	$4,539,912	$3,631,929	$2,723,947	$1,815,965	$907,982	$0	$49,939,029
5	Residential savings - NG EE	1,913,831	0.3055	Savings per therm		$584,675	$526,208	$467,740	$409,273	$350,805	$292,338	$233,870	$175,403	$116,935	$58,468	$0	$3,215,714
	Residential total			**total**		**$13,468,786**	**$12,121,908**	**$10,775,029**	**$9,428,151**	**$8,081,272**	**$6,734,393**	**$5,387,515**	**$4,040,636**	**$2,693,757**	**$1,346,879**		**$74,078,326**
3	Comm/Ind savings - electrical to solar	118,964,534	0.02265	Savings per kwh		$2,694,547	$2,425,092	$2,155,637	$1,886,183	$1,616,728	$1,347,273	$1,077,819	$808,364	$538,909	$269,455	$0	$14,820,007
4	Comm/Ind savings - electrical EE	135,550,042	0.0755	Savings per kwh		$10,234,028	$9,210,625	$8,187,223	$7,163,820	$6,140,417	$5,117,014	$4,093,611	$3,070,208	$2,046,806	$1,023,403	$0	$56,287,155
5	Comm/Ind savings - NG EE	908,763	0.2696	Savings per therm		$245,002	$220,502	$196,002	$171,502	$147,001	$122,501	$98,001	$73,501	$49,000	$24,500	$0	$1,347,514
	Comm/Ind - Total			**total**		**$13,173,577**	**$11,856,220**	**$10,538,862**	**$9,221,504**	**$7,904,146**	**$6,586,789**	**$5,269,431**	**$3,952,073**	**$2,634,715**	**$1,317,358**		**$72,454,675**
																	$146,533,001

Solid waste

															Cumulative
	Residential food waste diversion				year 10	9	8	7	6	5	4	3	2	1	0	
	Calculation based on per capita food savings budget of 30% diversion															
6	Estimated food tons thrown (from Monroe Co report)	19050.34		Organics thrown	13335.2352	13,907	14,478	15,050	15,621	16,193	16,764	17,336	17,907	18,479	19050.34	
				Organics saved	5715.1008	5143.59072	4572.08064	4000.57056	3429.06048	2857.5504	2286.04032	1714.53024	1143.02016	571.51008	0	31,433
7	Value per ton			**Value/Saved** **2469**	**$14,110,584**	**$12,699,525**	**$11,288,467**	**$9,877,409**	**$8,466,350**	**$7,055,292**	**$5,644,234**	**$4,233,175**	**$2,822,117**	**$1,411,058**	**$0**	**$77,608,211**
8	Commercial waste diversion - businesses per year				600	540	480	420	360	300	240	180	120	60	0	
8	Cost based on MN WasteWise reported average business savings ($431) escallated to 5 year			Value 475	**$285,000**	**$256,500**	**$228,000**	**$199,500**	**$171,000**	**$142,500**	**$114,000**	**$85,500**	**$57,000**	**$28,500**	**$0**	**$1,567,500**
				Businesses included by 2030 30.00%												$79,175,711

														Cumulative
		year 10	9	8	7	6	5	4	3	2	1	0		
SubTotal		**$59,571,917**	**$53,614,725**	**$47,657,534**	**$41,700,342**	**$35,743,150**	**$29,785,959**	**$23,828,767**	**$17,871,575**	**$11,914,383**	**$5,957,192**	**$0**	**$327,645,544**	
													$0	

Social Cost of Carbon

		year 10	9	8	7	6	5	4	3	2	1	0	
	Avoided GHG				208471.9147	187,625	166,778	145,930	125,083	104,236	83,389	62,542	41,694	20,847	0	1,146,596
10	**Cost per ton**	150,581,910	2100 annu	1290494	GHG mTons	$116.69 cost per to	**$24,325,645**	**$21,893,081**	**$19,460,516**	**$17,027,952**	**$14,595,387**	**$12,162,823**	**$9,730,258**	**$7,297,694**	**$4,865,129**	**$2,432,565**	**$0**	**$133,791,048**

GrandTotal	**$83,897,562**	**$75,507,806**	**$67,118,050**	**$58,728,294**	**$50,338,537**	**$41,948,781**	**$33,559,025**	**$25,169,269**	**$16,779,512**	**$8,389,756**	**$0**	**$461,436,592**

Notes and Sources

1. Savings per VMT based on AAA estimates https://www.slashgear.com/aaa-says-it-costs-about-74-cents-per-mile-to-drive-23496316/ https://www.thesimpledollar.com/save-money/is-it-really-cheaper-to-ride-the-bus/
2. Savings per VMT converted from ICE to EV https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs
3. The average cost savings per kWh consumed through on-site solar is calculated at 50% of the retail solar rate for residential and 30% for commercial. This assumes an average solar array payback period of 15 years (note, average residential payback period is estimated at 8 to 12 years and average commercial at 8 to 10 years see: https://www.solarreviews.com/blog/how-to-calculate-your-solar-payback-period and: https://www.paradisesolarenergy.com/blog/payback-and-roi-of-solar-energy-for-farms-businesses). The average solar array effective life span is typically anticipated as 30 years (see: https://www.solarpowerworldonline.com/2017/01/life-expectancy-solar-array/)
4. Energy efficiency savings per kWh saved basded on average electricity cost per kWh: https://www.electricitylocal.com/states/indiana/bloomington/
5. Energy efficiency savings for natural gas is based on Vectren therm rates: https://www.vectren.com/assets/downloads/rates/IGCHistoricaltrackingfactors.pdf#search=indiana%20therm%20rate
6. Food waste tonnage saved is calculated on achieving a 30% diversion by 2030 and includes waste annual waste reduction calculaions in line with overall waste reduction goals. Food waste share of organics based on "MONROE COUNTY SOLID WASTE MANAGEMENT DISTRICT MIXED WASTE PROCESSING FEASIBILITY STUDY JANUARY 2018" see:http://gogreendistrict.com/public-info_33_463535807.pdf
7. Value per ton based on average for Prevent and Recover strategies by ReFED "A ROADMAP TO REDUCE U.S. FOOD WASTE " See https://www.refed.com/downloads/ReFED_Report_2016.pdf
8. Savings per business engaged in waste reduction programs are based on MN WasteWise reported average business savings ($431) escallated to 5 year (mid point) Cumulative savings assume businesses remain. See https://www.mnchamber.com/your-opportunity/waste-wise operating within savings regime
9. Social Cost of Carbon is based on pro rata Bloomington share of projected Monroe County annual economic impacts by 2100 divided by the City's 2018 GHG emissions. Projected annual economic impacts are from Estimating economic damage from climate change in the United States By Solomon Hsiang, Robert Kopp, Amir Jina, James Rising, Michael Delgado, Shashank Mohan, D. J. Rasmussen, Robert Muir-Wood, Paul Wilson, Michael Oppenheimer, Kate Larsen, Trevor Houser Science30 Jun 2017 : 1362-1369 See: https://science.sciencemag.org/content/356/6345/1362

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