ILLINOIS DEPARTMENT OF TRANSPORTATION CARBON REDUCTION STRATEGY

GUIDING ILLINOIS TO A GREENER FUTURE

Illinois Department of Transportation

2023

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Executive Summary

Illinois Department of Transportation (IDOT) prepared this Carbon Reduction Strategy as directed by the Carbon Reduction Program (CRP) that was established under the Bipartisan Infrastructure Law (BIL).

This document serves as a framework for IDOT to reduce carbon emission and work with partner agencies and stakeholders. This document is an initial step in identifying transportation projects that will achieve reductions in carbon emissions from the transportation sector. IDOT's Carbon Reduction Strategy will be updated every four years, per the federal legislation.

Strategy to Reduce Carbon Emissions

The Carbon Reduction Strategy is focused on reduction of carbon dioxide (CO_2) emissions from the transportation sector, which accounts for 33% of Illinois' total CO_2 emissions. Climate change caused by carbon emissions and other greenhouse gases impact human health, the environment, and the economy. The strategy was developed by reviewing existing plans within Illinois and from peer states, and by evaluating the potential emissions reductions from projects that are eligible to receive funding under the CRP. IDOT collected input from key stakeholders to provide feedback on the strategic approach.

The Carbon Reduction Strategy includes five categories of transportation project types that can be implemented by IDOT and partner agencies and have the potential to achieve reductions in CO_2 emissions:

- Transit and active transportation
- Efficient roadway operations
- Lower carbon fuels and alternative fuels and energy
- Construction and maintenance
- Use of IDOT land

Strategy Implementation

Implementation recommendations highlight opportunities to incorporate consideration of carbon reduction into IDOT's many existing processes. IDOT will consult and coordinate with Transportation Management Agencies (TMAs), Metropolitan Planning Organizations (MPOs), and other agencies and jurisdictions to utilize CRP funds to maximize reduction of CO_2 emissions from the transportation sector.

Introduction

Purpose

On November 15, 2021, the Infrastructure Investment and Jobs Act was signed into law. This bill, also known as the Bipartisan Infrastructure Law (BIL), established a Carbon Reduction Program (CRP) with the purpose of providing funds for projects designed to reduce carbon dioxide (CO_2) emissions from transportation sources.

As stated in the CRP Implementation guidance:

> The United States is committed to a whole-of-government approach to reducing economy-wide net greenhouse gas pollution by 2030. The BIL provides considerable resources—including new programs and funding—to help States and other funding recipients advance this goal in the transportation sector. In addition, the BIL makes historic investments to improve the resilience of transportation infrastructure, helping States and communities prepare for hazards such as wildfires, floods, storms, and droughts exacerbated by climate change.[1]

As part of the CRP, each state is required to develop a Carbon Reduction Strategy. The guidance regarding the Carbon Reduction Strategy is flexible, allowing each state to develop a strategy that is tailored to its own unique priorities and emission sources. Each state must complete and submit its Carbon Reduction Strategy to the Federal Highway Administration (FHWA) by November 15, 2023.

[1] Gloria M. Shepherd, Memorandum, Information: Carbon Reduction Program (CRP) Implementation Guidance (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, April 24, 2022, https://www.fhwa.dot.gov/environment/sustainability/energy/policy/crp_guidance.pdf), 7.

The purpose of the Illinois Department of Transportation (IDOT) Carbon Reduction Strategy is to provide a framework for evaluating projects that will maximize the emission reductions achievable with the funding available under the CRP. The strategies and projects included in this document are expected to reduce CO_2 emissions from transportation sources by providing alternatives to driving alone, providing efficient roadway networks, supporting the transition to lower carbon fuels and electric vehicles, supporting greener construction methods and maintenance, and encouraging increased usage of low-carbon materials and carbon sequestration.

Development of the Carbon Reduction Strategy focused on the following goals:

- Assess potential carbon reduction benefits of eligible projects
- Identify other factors that are important for prioritizing eligible projects
- Identify best practices from other states to incorporate into IDOT's Strategy
- Provide guidance to Metropolitan Planning Organizations (MPOs)
- Identify future steps for IDOT and partners on reducing transportation emissions
- Collect input from key stakeholders that informs Strategy development

Climate Change: Causes and Impacts in Illinois

Gases that trap heat in the atmosphere are referred to as greenhouse gases (GHGs). Several gases are GHGs, including CO_2, methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. GHGs are necessary to help keep the Earth warm, but too many GHGs cause more heat to be trapped in the atmosphere, resulting in an increase in the overall temperature of the planet. As GHG emissions from human activities increase, they build up in the atmosphere and warm the climate, leading to many other changes around the world—in the atmosphere, on land, and in the oceans.

Impacts of Climate Change

Illinois' climate is typically temperate with cold winters, warm summers, and frequent fluctuations in temperature, humidity, cloudiness, and wind direction. The climate varies across the state, with average growing seasons nearly a month shorter in the northern portion of the state compared to the southern third of the state. In the winter, the northern portion of the state experiences significantly lower temperatures and significantly higher snowfall totals than the southern portion of the state. Northern Illinois can see up to 3 feet of snow annually, with the highest totals in the Chicago area, which experiences lake-effect snows from Lake Michigan.

According to the State Climatologist and the Prairie Research Institute, Illinois' climate has gotten warmer and wetter since the start of the 20th Century. According to high quality climate monitoring data from the NOAA Centers for Environmental Information, over the past 120 years, average daily temperature has increased by 1 to 2 degrees Fahrenheit. Illinois is expected to continue to see increasing air temperatures and increasing precipitation throughout the 21st century. By the end of the 21st century, average daily temperatures are projected to increase between 4- and 9-degrees Fahrenheit under a lower emissions scenario and between 8 and 14 degrees under a higher emissions scenario. These increases are expected to coincide with increased risk of extreme high temperatures in Illinois, and reduced risk of extreme cold temperatures. Illinois is expected to see an overall increase in precipitation, but in the form of more concentrated heavy rain followed by longer dry spells.

Flooding is the single most damaging weather hazard in Illinois, and flooding frequency is being exacerbated by climate change. Ever-increasing heavy precipitation since the 1940s has led to increased flood peaks on Illinois rivers. Flood losses in Illinois, totaling $257 million annually since 1983, are the third highest in the nation. Within Illinois and the Midwest, flood losses have been increasing at a greater rate than elsewhere in the nation. Over a 45-year period (1955-1999), Illinois had $5.195 billion in flood losses; 74% of these losses have occurred since 1985.

In addition to the increase in heavy rain events, projected increases in summer temperatures are expected to increase the severity frequency of droughts in Illinois[2]. These changes will affect the state's agriculture industry, as crop yields are dependent upon climate conditions. Illinois also serves as the nation's center for air and surface transportation. With the nation's busiest airport (O'Hare), the rail hub of the nation at Chicago, and the state's robust trucking industry, goods movement is a major economic driver for the state that can be significantly disrupted by severe weather and climate extremes. Resulting delays in shipments are also a major problem for manufacturers in Illinois. In July 2023, the Chicago area saw a heavy rain event with daily rainfall totals ranging from three to seven inches with a few localized areas seeing greater than eight inches of rain.[2] This rainfall event led the closure of I-290 for several hours – the major east/west interstate into Chicago – leading to traffic impacts throughout the region. In Chicago, Metra rail lines experience delays when temperatures reach below 0 degrees Fahrenheit or 90 degrees Fahrenheit and above.[3] The extreme temperatures lead to the shrinking or expanding of the metal rail. Additionally, extreme weather can lead to a greater chance of equipment breaking down leading to delay in service. Likewise, roadways are also impacted by excessive high temperatures. High temperatures for extended periods of time can lead to pavement failure or blowouts. [4] This impacts traffic along the roadway leading to delays until the roadway can be fixed.

Extreme weather events are currently having effects on human health and safety, and these threats will continue to mount with climate change. Annually, 74 deaths are attributed to heat, 18 deaths are attributed to cold, and 20 to 30 deaths in Illinois are attributed to floods, winter storms, tornadoes, and lightning. Prolonged heat waves are particularly deadly. Illinois experienced two of its most deadly heat waves during the 1990s. The 1995 heat wave, the deadliest on record, led to 753 Illinois deaths and major power outages in the Chicago metropolitan area.

Air pollution combines with increased heat to affect health. Ground-level ozone, which inflames and damages people's airways and aggravates lung conditions such as asthma, emphysema, and chronic bronchitis, forms with the combination of nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of heat and sunlight. As a result, elevated concentrations of ozone are more common in the summer months and especially on days of extreme high temperatures. Long-term exposure to ozone may lead to increased school absences, medication use, visits to doctors and emergency visits, and hospital admissions. Ozone nonattainment areas are most common in areas of higher population density due to greater

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https://stateclimatologist.web.illinois.edu/climate-change-in-illinois/[2]

[2] July 2, 2023: Significant Flash Flooding in Chicago and Nearby Suburbs

[3] https://metra.com/how-metra-handles-service-disruptions

[4] https://www.illinois.gov/news/press-release.26804.html

emissions of ozone precursor pollutants in those areas from more concentrated commercial activity, industry, and vehicle traffic. These urban areas also commonly overlap with areas of environmental justice concern, as is the case in Illinois.

CO_2 Emissions in Illinois

CO_2 accounts for 79 percent of all U.S. GHG emissions from human activities in 2021 and is the primary GHG emitted by these activities. The combustion of fossil fuels such as gasoline and diesel to transport people and goods was the largest source of CO_2 emissions in 2021. Therefore, the strategies presented in this document focus on the reduction of CO_2 emissions by the transportation sector, as directed by the CRP.

The largest source of CO_2 emissions in Illinois is the transportation sector, as highlighted in Figure 1. The transportation sector has also been the largest source of CO_2 emissions in Illinois since the mid 1970's, as shown in Figure 2. Although vehicle fuel economy continues to improve over time, these improvements have been outweighed by increases in vehicle miles traveled, resulting in rising CO_2 emissions from transportation while emissions in other sectors decline. Emissions from petroleum consumption for transportation increased from 2020 to 2021 due to the gradual recovery from the COVID-19 pandemic, which limited travel in 2020.

Figure 1 – Illinois 2021 CO_2 Emission Contribution by Sector[3]

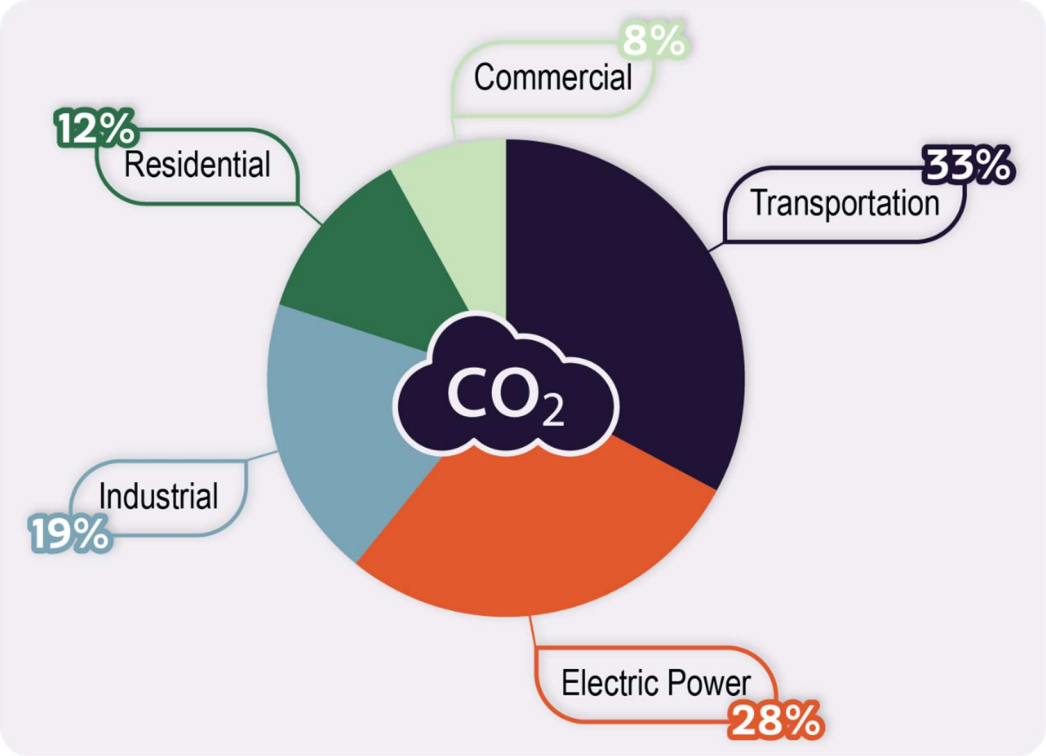
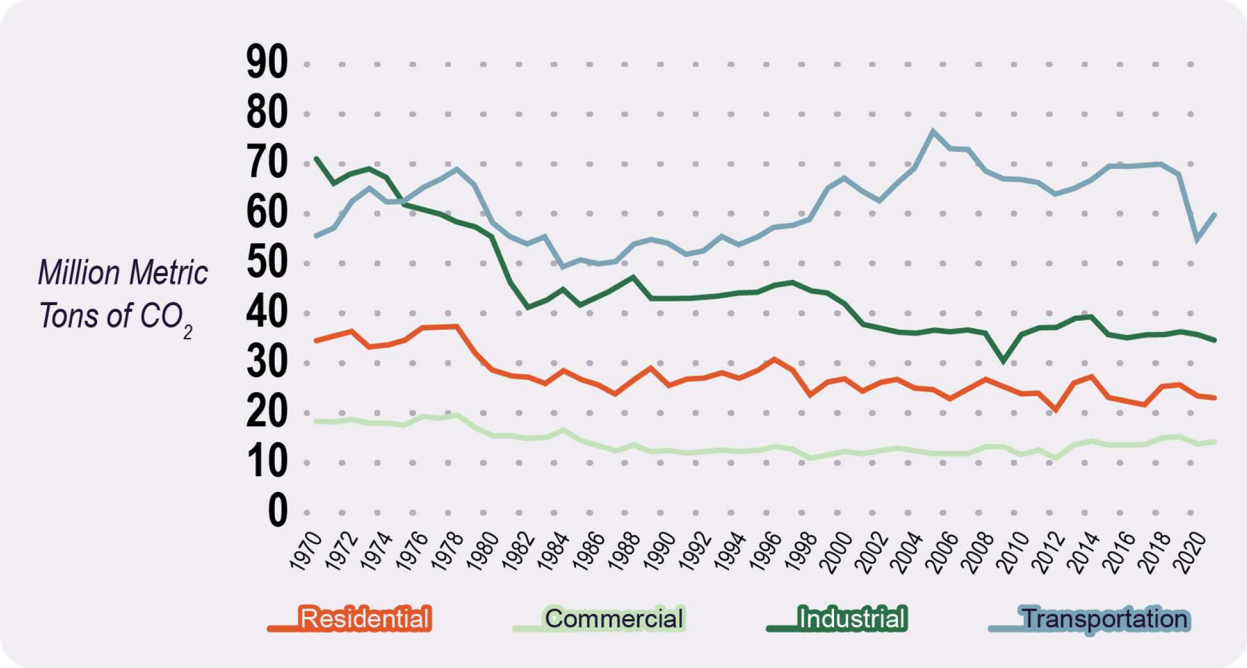
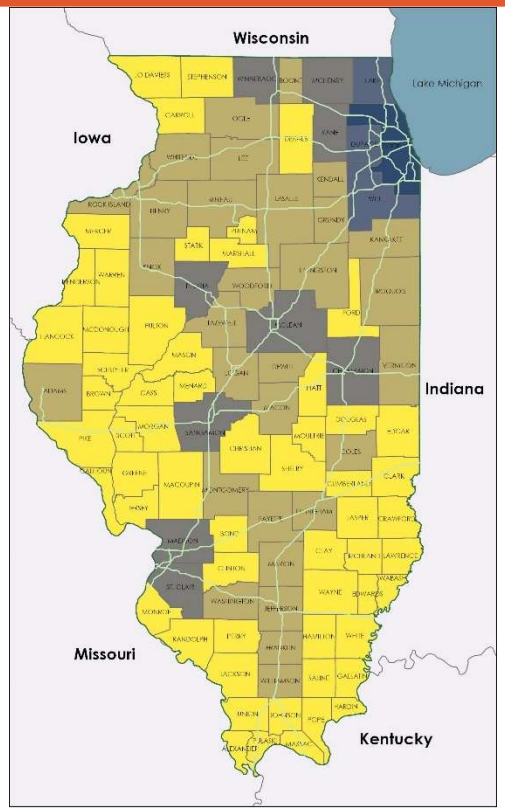


Figure 2 – Illinois CO_2 Trends by Sector (1970-2021)[4]



Transportation sector GHG emissions include emissions from on-road and offroad vehicles as well as emissions from aircraft, watercraft, and rail. Figure 3 presents the distribution of on-road GHG emissions by county, which are the subject of this Carbon Reduction Strategy. On-road GHG emissions are closely tied to vehicle miles traveled (VMT); therefore, counties that experience higher traffic volumes emit more GHG. Figure 4 presents the annual GHG emissions per capita by each county. Comparing these two figures helps to demonstrate solutions to reduce emissions are not the same everywhere and depend on characteristics of individual communities. GHG from on-road vehicles are primarily in the form of CO_2.

[4] EIA, *Sectorial Summaries*, *2021*.



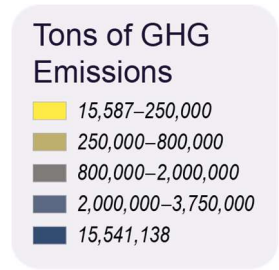
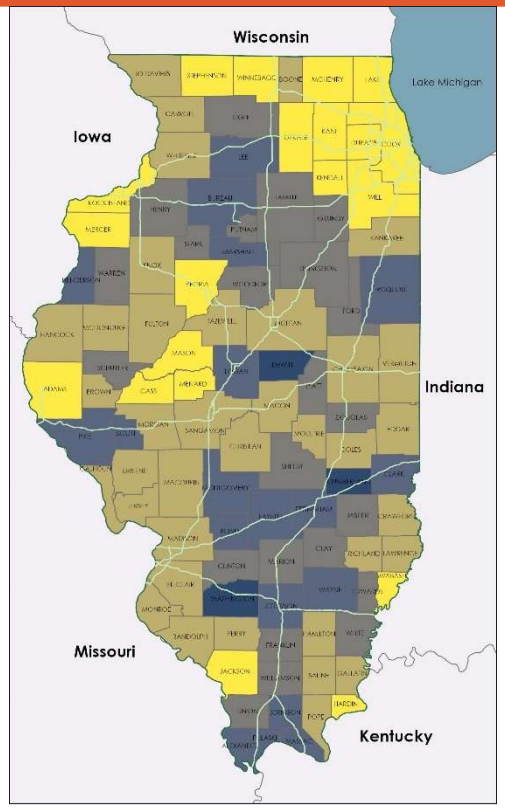


Figure 3 – On-road GHG Emissions by County



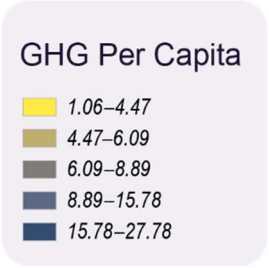


Figure 4 – On-road GHG Emissions per Capita by County

Illinois Transportation Sector CO_2 Emissions

The figures to the left demonstrate two different ways of looking at CO_2 emissions from the transportation sector in Illinois.

Figure 3 presents the total CO_2 emissions from on-road sources in 2020 by county. Counties with the greatest emissions are those with the greatest vehicle traffic due to areas of dense population (such as the Chicago metropolitan area) and locations with major interstate connections.

Figure 4 demonstrates a different point of view. Densely populated regions show a lower emission per capita due to shorter trip lengths and greater transportation options. The highest emissions per capita occur in areas with high percentages of interstate truck traffic, such as the I-80, I-70, and I-64 corridors.

A comparison of these two figures demonstrates that solutions to reduce carbon emissions from the transportation sector will vary by location and community. Strategies to reduce emissions should consider development patterns, freight movement, and the different travel needs of the communities that live and work in each part of the state.

Regulations and Actions

Many regulations exist that help to reduce GHG emissions from transportation. These actions can be grouped into a few overarching strategies. Each of these strategies are briefly described below, with select examples of regulations and actions at federal, state, and local levels highlighted.

Overall Target Setting

As a member of the US Climate Alliance, Illinois commits to implement policies that advance the goals of the Paris Agreement, aiming to reduce greenhouse gas emission by at least 26 to 28 percent below 2005 levels by 2025.

IDOT and the state's metropolitan planning organizations (MPOs) publish long-range plans that address the transportation system. These plans include a series of goals and priorities to maintain a thriving community and transportation system. Reducing pollutant emissions and preparing for the effects of climate change are discussed in the long-range plan published by each MPO in Illinois. For example, in ON TO 2050, the comprehensive plan for Northeastern Illinois, the Chicago Metropolitan Agency for Planning (CMAP) calls for the region to reduce greenhouse gas emissions by 80 percent relative to 2005 levels by 2050. The City of Chicago developed a Climate Action Plan (CAP) to outline a strategic framework for measuring and mitigating GHG emissions and related climate impacts with goals and strategies to reduce the city's carbon footprint.

A pending Federal Highway Administration rulemaking proposes new requirements for state departments of transportation and MPOs to set declining targets for greenhouse gas emissions from transportation. In addition, the 2022 Inflation Reduction Act established the Carbon Pollution Reduction Grant program, which provides funding for states and regions to develop Priority Climate Action Plans as well as additional funding to implement actions identified in those plans. The Illinois Environmental Protection Agency was awarded planning funding through this program in June 2023.

Improving Fuel Efficiency

Fuel economy standards increase fuel efficiency and reduce fuel use, which saves consumers money as well as reduces emissions caused by the burning of fossil fuels. Corporate Average Fuel Economy (CAFE) standards were first enacted by Congress in 1974 and are periodically updated. CAFE standards require set industry-wide fleet average fuel economy values for cars and light trucks within specific model year ranges. EPA has adopted GHG emissions standards for heavy-duty vehicles that are also periodically updated to regulate heavy-duty vehicles within specific ranges of model years.

Lower Carbon Fuels

The Renewable Fuel Standard (RFS) program is a national policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil, or jet fuel. Among other requirements, fuels must achieve a reduction in GHG emissions as compared to a 2005 petroleum baseline. Renewable fuels are produced from plants, crops, and other biomass, and can reduce greenhouse gas emissions when compared to burning the fossil fuels they replace.

Lower Carbon Vehicles

Multiple programs are in place in Illinois to promote the transition to electric vehicles. Directs Illinois EPA to establish rebate and grant programs for electric vehicles and charging stations. The statewide PACE (Property Assessed Clean Energy) program was launched to spur investment in electric vehicle charging stations and other energy efficiency projects.

Efficient Travel Options

The EPA's SmartWay program helps the freight transportation sector improve supply chain efficiency, reducing greenhouse gases and saving fuel costs for companies who participate. Through SmartWay, the EPA and its partners are making significant gains in the efficiency of how our nation moves goods, helping address air quality challenges, improving public health, and reducing freight's contribution to climate change.

IDOT, the state's Metropolitan Planning Organizations (MPOs) and local municipalities play key roles in investing in and supporting travel options other than passenger vehicles. IDOT administers the Illinois Transportation Enhancement Program (ITEP), which allocates resources to well-planned projects that provide and support alternate modes of transportation, enhance the transportation system through preservation of visual and cultural resources and improve the quality of life for members of the communities. ITEP requires communities to coordinate efforts to develop and build safe, valuable and functional projects in a timely manner. Under ITEP, the Illinois Department of Transportation (IDOT) works jointly with other state agencies, local governments, interest groups and citizens in enhancing the transportation system and building more livable communities. IDOT also administers the Safe Routes to School program, which works to increase rates of safe bicycling and walking to school.

Developing IDOT's Strategy to Reduce CO_2 Emissions

The CRP requires states to develop a Carbon Reduction Strategy that is unique to each state's priorities. Although reducing carbon emissions has always been a goal of IDOT through individual elements of IDOT's modal profiles through the Long-Range Transportation Plan's suite of plans, there has never been an exclusive document outlining IDOT's strategy. This Carbon Reduction Strategy document will be the first of its kind for IDOT as it works toward reducing emissions statewide.

Strategy Development

There are many different projects and strategies designed to reduce carbon emissions from transportation sources. There are also several ways to approach reducing carbon emissions, but there is no "one-size-fits-all" solution, especially in a state as geographically diverse as Illinois.

Review Existing Plans in Peer States and MPOs

One of the first steps taken during the development of the Carbon Reduction Strategy was a review of applicable plans and summaries published by peer states and other agencies within Illinois. Although the CRP requires each state to develop a Carbon Reduction Strategy, some states had already developed similar strategies and plans in prior years.

The document review was designed to pull the best practices from other states and units of government. Table 1 lists the documents that were reviewed. Appendix A provides a detailed outline of information gathered via the review.

Many of these plans included quantitative assessments of the relative benefits of different types of projects for reducing emissions from transportation. For example, Colorado's quantification of emissions reductions from representative projects was consistent with the manner IDOT plans to identify projects with the greatest potential to reduce emissions, and Florida's plan laid out

potential strategies into logical categories to address how emissions are reduced within transportation sector.

Table 1 – Peer Reviewed Documents

DOCUMENT	STATE/ENTITY
Draft Carbon Reduction Strategy	Indiana
GHG Pollution Reduction Planning Standard Colorado Greenhouse Gas Pollution Reduction Roadmap	Colorado
Carbon Reduction Quick Guide	Florida
Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity	California
Vehicle Miles Traveled Reduction Study	North Carolina
Climate Action Plan 2021-2026	Oregon
Illinois Long-Range Transportation Plan	IDOT
Chicago Metropolitan Agency for Planning (CMAP) On To 2050	CMAP
2050 Metropolitan Transportation Plan for the Rockford Region	R1 (Illinois)
2022 Chicago Climate Action Plan	City of Chicago
Louisville Greenhouse Gas Emissions Reduction Plan	City of Louisville

Consultation

Feedback from multiple sources was part of the Carbon Reduction Strategy development. IDOT has 16 MPOs in the state and four MPO liaisons to ensure that there is effective communication between the IDOT the MPOs. IDOT staff held virtual meetings with MPOs at the beginning of strategy development to understand how each organization was currently addressing carbon reduction and GHG emissions, types of projects each area was most interested in pursuing with CRP funding, and what assistance from IDOT would be most useful. A separate meeting was held with the TMAs to focus on how these areas were progressing in implementing selection processes for suballocated CRP funding. Additional meetings were held with the MPOs at key points in the development of the Carbon Reduction Strategy to present IDOT's approach and solicit feedback. In particular, MPO and TMA feedback was essential in confirming the emissions evaluation methodology and the list of projects considered from more detailed analysis.

In addition to MPO/TMA consultation and coordination, IDOT conducted additional engagement with a range of stakeholders, including across IDOT offices, state government agencies, environmental advocates, and members of the general public attending the Illinois State Fair.

Identifying Primary Goals

Based on both the review of carbon reduction documents from peer transportation agencies, consultation with the state's MPOs and TMAs, and feedback from other stakeholders, IDOT focused the first Carbon Reduction Strategy on evaluating the relative emissions benefits,

associated co-benefits, and important implementation considerations of projects eligible for Carbon Reduction Program funding. This approach allows the Carbon Reduction Strategy to inform IDOT programming of CRP funding, serve as a resource for TMAs working to implement their own CRP programs, and provide a solid foundation for future initiatives focused on reducing greenhouse gas emissions from transportation.

Evaluating Potentials to Reduce Emissions

To achieve meaningful emission reductions from the transportation sector, a series of incremental actions must be implemented to contribute to larger reduction goals. IDOT identified five categories of transportation projects based on the ways these projects reduce emissions. The categories are based on actions IDOT can influence by funding individual projects and programs or by integrating into agency operations. Within each category, individual projects were evaluated to determine their potential to reduce emissions of CO_2.

The five project categories constituting the Carbon Reduction Strategy are the following.

- Transit and active transportation
- Efficient roadway operations
- Lower carbon fuels and alternative fuels and energy
- Construction and maintenance
- Use of IDOT land

Each category is summarized below, including projects within each category and potential reductions of CO_2 emissions from individual project examples. All reductions quantified in this analysis are based on an implementation year of 2025. Projects that are implemented further into the future may achieve smaller reductions as the on-road fleet transitions to electric vehicles.

These five categories are the foundation of how Illinois will achieve carbon reductions from the transportation system. IDOT and partner agencies can use this information to identify new projects and strategies appropriate to each geographic area and the unique needs of travelers in each area of the state. Appendix B includes additional details about the assumptions used to estimate the potential carbon emission reduction benefits.

Transit and Active Transportation

Category Description

Passenger vehicles are the primary contributor to carbon emissions in Illinois. Providing alternatives to driving alone encourages decreased vehicle activity. Mass transit and active transportation facilities provide alternative options to driving alone, which reduces the number of vehicles on roadways.

Projects Eligible for CRP Funding

Projects within this category include increased bus service, increased rail service, ridesharing, and active modes. Note that CRP funds can be used to purchase new transit vehicles, but they cannot be used for operational expenses.

Emission Reduction Potential

Emission reductions were estimated based on the number of passenger vehicles that would be displaced by users switching to a new mode of travel and summarized in Table 2.

Table 2 – Category Example Projects, Transit and Active Transportation Modes

EXAMPLE PROJECTS	*Potential Reduction (MT CO_2/year)*
Expand transit service (non CTA) by 1 additional service mile	30
Bike-ped facility parallel to roadway <12,000 ADT	30
Bike-ped facility parallel to roadway 12,000-24,000 ADT	50
Purchase of 10 new vanpool vehicles	60
Bike-ped facility parallel to roadway >24,000 ADT	70
Expand CTA transit service by 1 additional service mile	615

MT CO2 = Metric tons of carbon dioxide. See Appendix B for more detailed emissions estimates.
ADT = average daily traffic.

The potential reductions shown for bicycle and pedestrian projects represent the average of a single new facility in a city or town with population greater than 250,000. The expected benefits are similar from a university town with a population less than 250,000, but the benefits from a smaller town or city would be less than the values shown. The emissions reductions would also vary based on the project length and number of activity centers near the route. The potential emissions reductions do not account for the additive benefits of providing connections to other existing facilities that build out a robust active transportation network.

Transit expansions include capital investments that increase service, such as additional vehicles and infrastructure needed to implement Bus Rapid Transit service. A separate emissions

reduction estimate is presented for transit service from the Chicago Transit Authority (CTA) and non-CTA transit service. CTA service is concentrated in the state's most densely populated communities and average much higher trips per mile than other locations outside of the CTA service area. Although an additional mile of CTA service would achieve significant emission reductions, it should be noted that transit projects, particularly fixed guideway projects, are significantly more complex to implement and tend to be both more expensive and involve longer timelines than other projects evaluated in this category.

Additional types of projects that can encourage a shift to modes other than driving alone were not quantified. Projects that upgrade transit station amenities, improve wayfinding, install secure bike parking, and improve lighting can attract new users to public transit and active transportation modes.

Implementation Considerations

The decision to purchase transit vehicles should consider whether an expanded fleet will also require additional maintenance, storage, and refueling needs. Emissions reductions from individual bicycle and pedestrian projects should consider the benefits potential for creating a connected network.

Emission reductions from these projects are more pronounced in the near term. The emissions benefits of reducing VMT decline as roadway users begin to transition to electric vehicles.

Co-Benefits

Projects in this category provide equity co-benefits by providing options to individuals that cannot afford a vehicle or are not able to operation a vehicle. Projects that reduce vehicles on the roadway reduce congestion as well as emissions of harmful air pollutants. Infrastructure to support active modes can be cost-effective as compared to projects that require major roadway construction.

Current IDOT Implementation

Projects within this strategy are consistent with the goals in the Statewide Public Transportation Plan and Active Transportation Plan. IDOT and partner agencies use funding from programs such as CMAQ, TAP, ITEP, and Safe Routes to School to support these types of projects. There are also projects that fit in both this category and the lower-carbon fuels category described in more detail below. For example, IDOT received $12.3 million from the FTA's Low or No Emission Vehicle Program to deploy 50 battery-electric paratransit vehicles, including associated charging infrastructure, to five large urban, four small urban and 15 rural public transit agencies.

Efficient Roadway Operations

Category Description

Vehicles emit less CO_2 when their engines are running efficiently and do not make frequent stops and starts. Projects that relieve congestion and reduce vehicle idling time reduce emissions by allowing vehicles to flow more freely. Roadway projects that relieve congestion allow vehicles to travel more efficiently, not only reaching their destinations faster but also spending less time emitting pollutants on the roadway.

Projects Eligible for CRP Funding

Projects within this category include technology-based projects designed to improve traffic infrastructure-based projects designed to improve traffic flow by providing signal upgrades and coordination, freeway ramp metering, electronic tolling, and variable message signs. This category also includes infrastructure-based projects that do not add capacity, such as roundabouts or the conversion of general purpose lanes to high occupancy vehicle lanes. A project that expands a roadway to add high-occupancy lanes would not be eligible to receive CRP funding.

Emission Reduction Potential

Emission reductions were calculated assuming that the flow of traffic improves as compared to congested conditions as a result of the implementation of each project type in Table 3.

Table 3 – Example Projects, Efficient Roadway Operations

EXAMPLE PROJECTS	*Potential Reduction (MT CO_2/year)*
Variable message signs	**80**
Transit signal priority	**170**
Traffic control center	**170**
Upgraded signal timing — individual intersection	**180**
Upgraded signal timing — corridor signal synchronization	**600**

MT CO2 = Metric tons of carbon dioxide. See Appendix B for more detailed emissions estimates

There are a variety of projects designed to use technology to improve the flow of traffic by providing drivers with information to avoid congested areas. The benefits of these projects increase as the volume of vehicles using the roadway increases. Improving vehicle speed by 5 to 10 miles per hour can reduce emissions by allowing vehicles to travel at speeds for which engines are designed to run most efficiently.

Vehicle engines are the least efficient when idling, which has historically been a large source of emissions. Projects that upgrade the timing of individual signals or corridors with many signals

reduce the time that cars and trucks spend idling at red lights. Optimizing corridors with multiple coordinated traffic signals would have a greater emissions reduction than an individual intersection, and in both cases the benefits depend on the volume of vehicles that use the roadway.

Implementation Considerations

Many of these projects are technology-based and would not require heavy construction, which can lead to quicker implementation. In addition, benefits from these projects will have the greatest impact in the near-term, before widespread implementation of newer vehicle technologies.

Emissions benefits from traffic flow improvement projects will be less pronounced in the future as emerging vehicle technologies improve emissions during operations and idling. Improved traffic flow would not contribute to any emissions reductions in electric vehicles because there are no existing tailpipe emissions. Start-stop technology is available for hybrid vehicles as well as gasoline powered vehicles to turn off the engine while idling, including at traffic signals and traffic jams. As older vehicles without this technology retire, signal optimization projects that reduce idling will not result in as great of an emissions reduction benefit.

Co-Benefits

Projects in this category are often designed to reduce congestion and delay. Projects that improve traffic flow also reduce the emissions of harmful air pollutants, particularly in locations adjacent to the congested roadway that may correspond with environmental justice communities. Improved traffic flow often includes a benefit to safety by reducing crashes. Congestion during traffic incidents contribute to increased idling emissions. Projects that incorporate intelligent transportation systems and other technologies can be cost-effective as compared to projects that require major roadway construction.

Current IDOT Implementation

Projects within this category are consistent with the Intelligent Transportation Systems (ITS) Architecture Strategic Plan and the 2023 State Freight Plan. IDOT signal coordination and timing funds have been used to study and reprogram signalized corridors to reduce overall stops and delays thus reducing emissions.

Lower Carbon Fuels and Alternative Fuels and Energy

Category Description

Burning fossil fuels such as gasoline and diesel is the greatest contributor to carbon dioxide emissions in Illinois. The transition to electric vehicles and other zero emission fuels is required to meet the state's GHG reduction targets.

Although IDOT does not set policies on electric vehicle sales, the agency can implement projects that support this transition by encouraging owners of gasoline- and diesel-powered vehicles to switch to zero emission options.

Projects Eligible for CRP Funding

Projects in this category include replacing vehicles that are fueled by gasoline or diesel with zero emission options such as electric or hydrogen fuel cell. This category also includes charging and refueling infrastructure for these alternative fuels. Truck stop electrification is also included because these projects would allow trucks to use electricity to power vehicles and auxiliary equipment during long-term parking instead of diesel.

Emission Reduction Potential

Emission reduction estimates presented in Table 4 account for the reduction in tailpipe emissions and for upstream emissions caused by electricity generation. Emission reductions from charging station installation assume that the availability of new charging infrastructure will encourage passenger vehicle users to make the transition to electric vehicles.

Table 4 – Example Projects, Transition to Electric and Zero Emission Vehicles

EXAMPLE PROJECTS	*Potential Reduction (MT CO_2/year)*
Installation of 1 public L2 charging station	10
Replace 10 heavy duty diesel vehicles with CNG vehicles	20
Installation of 1 public DCFC charging station	60
Replace 10 delivery and vocational trucks with electric trucks	60
Replace 10 heavy duty diesel trucks with zero-emissions trucks	170
Install truck stop electrification systems for 10 truck parking spaces	219
Replace 10 diesel buses with electric buses	500

MT CO2 = Metric tons of carbon dioxide. See Appendix B for more detailed emissions estimates.
CNG = compressed natural gas. DCFC = direct current fast charging.

Availability of public charging stations encourages car owners to transition from a gasoline vehicle to an electric vehicle. Charging stations can be installed in private or public parking lots. Fast chargers contribute greater emissions reductions because they can serve more vehicles.

Replacing diesel trucks and buses with vehicles powered by compressed natural gas (CNG) reduces CO_2 emissions; however, replacing them with trucks powered by electricity or hydrogen fuel cells reduces emissions even more by eliminating exhaust emissions. Agency-owned trucks could be replaced as part of the procurement process. Privately owned trucks could be replaced as part of a voucher program.

Emissions from truck stops can be reduced by providing truck drivers an alternative to idling their diesel engine. By connecting to an electrification system, truck drivers can operate in-cab heating and air conditioning systems and communications and entertainment equipment without idling their truck during rest periods.

Other types of projects that can encourage a shift to modes other than using zero emission fuels were not quantified. Projects that incentivize electric vehicle use—priority parking at park and rides or businesses, access to high-occupancy vehicle lanes—can make electric options more attractive to vehicle owners.

Implementation Considerations

Emissions benefits from these projects will have a lasting effect by supporting the transition to low and zero emission engines. Availability of electric passenger vehicles continues to increase in volume and affordability. There is currently limited availability of zero emission replacements for medium- and heavy- duty vehicles. Regional CO_2 emission reduction targets typically rely on the assumption that this technology will become more widespread over the next 25 years and beyond.

Widespread transition to cleaner vehicles depends on coordinated investments in charging infrastructure, the electric grid, and vehicles, as well as overcoming supply chain issues and technological hurdles. There are a number of Illinois and federal programs aimed at addressing these issues, described in more detail in the Regulations and Actions section above. Bus replacement may be limited by procurement schedules based on service life. Fleet owners must make a long-term commitment to anticipate the maintenance and infrastructure needs for alternative fuels.

Truck stop electrification has the potential for large emissions reductions, but this strategy relies on lot owners to invest money and square footage in the electrification systems. Trucks must also have compatible equipment to use the electrification system and pay an hourly rate for the electricity use, which can be comparable to staying in a hotel.

Co-Benefits

Reducing tailpipe emissions of CO_2 also reduce the emissions of emissions of harmful air pollutants, particularly in locations adjacent to the congested roadway that may correspond with environmental justice communities. Electrically powered vehicles are often quieter than their gasoline and diesel counterparts, thereby reducing noise pollution.

Current IDOT Implementation

Projects within this category are consistent with the Electric Vehicle Deployment Plan, as well as other statewide efforts to transition to cleaner fuels described in more detail above.

Construction and Maintenance

Category Description

In addition to projects that IDOT can implement in the transportation system, IDOT can take actions to reduce carbon emissions from agency activities. IDOT owns vehicles ranging from passenger vehicles to heavy-duty construction equipment. In addition to vehicle replacement, IDOT can regulate equipment use and idling. IDOT can also reduce emissions during project construction and roadway maintenance by using innovative materials and methods.

Projects Eligible for CRP Funding

Projects in this category include fleet vehicle replacement (passenger vehicles, trucks, construction equipment), energy efficient lighting, idle reduction policies, and alternative resurfacing materials and methods.

Emission Reduction Potential

The potential reductions presented in Table 5 include potential reductions from a variety of example actions that can be investigated by IDOT either as standalone projects, part of a project construction, or as part of ongoing operations and maintenance activities.

Table 5 – Example Projects, Construction and Maintenance

EXAMPLE PROJECTS	*Potential Reduction (MT CO_2/year)*
Replace 10 gasoline-powered landscaping equipment with electric options	18
Limit idling at project sites to 3 minutes	30
Replace 1,000 high-pressure sodium vapor (HPSV) light bulbs in streetlights, parking lots, or garages with light-emitting diode (LED) bulbs	30
Substitute hot-mix asphalt with warm-mix asphalt	134
Substitute hot-mix asphalt with reclaimed asphalt pavement (RAP)	216
Cold-in-place roadway recycling	1,080
Full-depth reclamation	1,080

MT CO2 = Metric tons of carbon dioxide. See Appendix B for more detailed emissions estimates.
ZEV = zero emission vehicle.

Landscaping and other equipment powered by electric motors do not produce emissions that would be produced by those fueled by gasoline or diesel. Other options to reduce emissions from these activities include reviewing maintenance schedules for opportunities to mow or trim vegetation less frequently.

Idling diesel engines are a significant source of CO_2 emissions. Limiting idling of work trucks at project sites can reduce emissions and save fuel. Idle reduction can be implemented by providing driver education and implementing idle reduction policies. Some vehicle systems include audio or visual alerts to remind drivers to turn on their engine if possible.

Paving and resurfacing activities require heavy duty equipment as well as heavy duty hauling trucks. Cold-in-place recycling and full-depth reclamation are methods that removing and reusing the existing asphalt surface. Reuse of materials reduces the need for haul truck trips to deliver materials to a worksite and waste away from the worksite.

During paving and resurfacing, emissions can be reduced by using materials that result in fewer emissions during the manufacturing process. Recycled materials such as reclaimed asphalt require less processing than raw materials. Warm-mix asphalt is the generic term for a variety of technologies that enable traditional hot mix asphalt pavement material to be produced, placed, and compacted at lower temperatures. In both examples, less energy is required to produce the materials as compared to standard paving practices, resulting in fewer emissions of CO_2.

Implementation Considerations

Emissions benefits from activities in this category have the potential to be achieved more quickly than projects that must go through IDOT's project pipeline.

Idle reduction policies are not appropriate for all types of work trucks. Some utility trucks, such as bucket trucks, idle to provide power for the truck's primary work function. Worker health and safety policies may allow for vehicle idling during certain types of weather for the comfort and safety of the work crew.

Use of alternative paving and resurfacing techniques requires IDOT staff and contractors to have the skills to manage and perform the desired work. These methods also rely on the availability and life cycle of recycled or innovative materials.

Emissions reductions from vehicle replacement could also be considered in this category, and they are addressed in more detail in the previous section.

Co-Benefits

Energy efficient lighting can also result in cost savings by using less energy and extending the useful life of individual bulbs that must be replaced. The use of recycled materials or in-place recycling methods during roadway resurfacing can result in cost savings if the process reduces the amount of material hauled to or away from a project site. Methods that reduce haul truck trips also have the benefit of reducing emissions of harmful air pollutants from truck exhaust and dust.

Current IDOT Implementation

Projects within this category are consistent with the Transportation Asset Management Plan. IDOT conducts an annual analysis detailing the Department's use of a variety of reclaimed and recycled materials in highway construction. In 2022, 1,329,932 tons of reclaimed and recycled materials were used in Illinois Highways, saving an estimated 59,764 tons of CO_2 equivalent.

Use of IDOT Land

Category Description

The other categories in the Carbon Reduction Strategy describe ways to reduce emission sources. This category includes actions that have the potential to remove carbon from the atmosphere. The actions in this category are best suited for right-of-way or other land parcels that are owned by IDOT.

Projects Eligible for CRP Funding

Projects including alternative uses of highway right-of-way (ROW) that reduce transportation emissions are eligible, including renewable energy generation facilities and biologic carbon sequestration practices.

Emission Reduction Potential

Carbon sequestration is the process of capturing and storing atmospheric CO_2. Carbon can be sequestered by trees, grasses, and soils. Preservation of these natural elements is critical, as is creating more opportunities to add them to developed and urbanized areas. Some examples of actions IDOT can take to increase natural settings are described below.

Trees planted on IDOT-owned lands can have a significant impact. Trees not only remove CO_2 from the atmosphere, but they also can help reduce the urban heat island effect and building cooling demand by providing shade. Native trees have the greatest opportunity to thrive with the fewest additional resources. Tools such as iTree (itreetools.org) can be used to predict the CO_2 removal from specific tree planting projects.

Vegetated open spaces can remove carbon by storing CO_2 in plants, grasses, and soils that would otherwise be paved. Although these natural elements usually produce lower levels of carbon reduction than tree planting, grasses can be more resistant to drought conditions and fires.

In addition to projects that add natural settings, IDOT can take care to dispose of waste materials in a manner that maximizes recycling and reuse. For example, trimmings from landscaping activities can be used for compost or sent to composting facilities. Composting improves carbon sequestration in soil, and it also prevents emissions of methane, another GHG.

IDOT can maximize land use by installing renewable energy technology, such as wind turbines and solar panels. Highway right-of-way, including land alongside highways, in the medians, within interchanges, and beyond the clear zones are well-suited for these types of electricity generation equipment. Rest areas and carports flanking highways are also potential locations for solar arrays and wind turbine installations.

Implementation Considerations

Emissions benefits from carbon sequestration projects may not be realized for years as trees and bushes mature to a size with maximum carbon sequestration potential. Installation of renewable energy technology will take time to see a return on investment.

Installation of equipment in the right-of-way must be consistent with the continued use, operations, maintenance, and safety of the highway facility, and will not impair the highway or interfere with the free and safe flow of traffic. Projects must also be consistent with state and local regulations for utility use within the right-of-way.

There may be competing demands that will need to be weighed for the use of highway right-of-way, including land alongside highways, in the medians, and within interchanges.

Co-Benefits

Planting trees and vegetation lower surface and air temperatures to reduce impacts of urban heat islands, which are urban areas with concentrated buildings, roads, and structures that become "islands" of higher temperatures relative to outlying areas. Allowing vegetated areas to grow with minimal maintenance supports pollinators by providing areas to nest and feed.

In addition to the environmental benefits of using clean, renewable sources of electricity, IDOT can benefit by lowering energy costs and creating new revenue streams. In some cases, a developer or utility installs the technology and then pays rent to the state for use of the land. IDOT could also form agreements with utilities to purchase the electricity generated by the technology at favorable rates over long periods.

Current IDOT Implementation

In 2021, IDOT conducted an assessment of technical and financial feasibility for solar panels at IDOT-owned facilities. In addition, IDOT is enrolled in the Monarch Candidate Conservation Agreement with Assurances (CCAA) that encourages landowners and land managers to adopt measures to create net conservation benefits for the monarch butterfly. In 2017, IDOT collaborated with other state agencies change its mowing policy for the benefit of the monarch and other pollinators. This change resulted in an approximate 34% reduction in direct mowing costs. IDOT also runs an annual $500,000 Pollinator Preservation and Restoration program, which distributes funding to the IDOT districts for specific projects.

Category Summary

IDOT identified five categories of projects that the agency can implement to reduce carbon emissions from the transportation sector. Each category has a range of benefits and challenges that should be considered as IDOT seeks to fund projects that have the effect of reducing carbon emissions. Projects may have more pronounced benefits in different parts of the state, depending on each area's land use and travel trends. Table 6 – presents a summary of the benefits and considerations for each carbon reduction project category.

Table 6 – Carbon Reduction Project Categories

Carbon Reduction Strategy Category	*How do these types of projects reduce carbon emissions?*	*What is the metric that drives emission reduction?*	*What are other co-benefits associated with this category?*
Transit and Active Transportation	Encourages shift away from single-occupancy vehicles	VMT	Air quality, equity, reduced congestion
Efficient roadway operations	Vehicles spend less time idling and increase speeds	Free-flow vehicle speed	Air quality, equity, cost-effectiveness, reduced congestion
Lower carbon fuels and alternative fuels and energy	Support transition from fossil fuels to electricity and other alternative fuels	Number of registered electric vehicles	Air quality
Construction and maintenance	Use of recycled materials and efficient equipment operations	Miles of roadway resurfaced	Cost-effectiveness
Use of IDOT land	Less manufactured materials, carbon sequestration, clean energy production	Acres of new vegetation and soil, energy produced	Air quality, cost-effectiveness

Strategy Implementation

Implementation measures of the Illinois Carbon Reduction Strategy are essential to incorporating carbon reduction into new and established planning, policy, and funding activities. IDOT and its partner agencies have well-established processes for multi-phase projects implemented throughout the state. These complex projects require the cooperation, coordination, and expertise of subject matter experts throughout IDOT. The implementation and incorporation of the Carbon Reduction Strategy will benefit by taking advantage of these processes and systems.

Use of Carbon Reduction Program Funds

CRP funds are allocated to each state, with suballocations identified for MPOs. Illinois's largest MPOs, referred to Transportation Management Areas, will determine a process to use their respective suballocations. TMAs have project selection and project delivery processes in place that can be modified to include the CRP funding source. The tables in the preceding sections provide planning-level emissions reduction estimates that can be used in the decision-making process.

IDOT will coordinate with the remaining MPOs to identify projects identified in this Carbon Reduction Strategy that will benefit each community. IDOT will oversee investment decisions and project delivery.

Integrate Carbon Reduction into the Transportation Planning Process

Considerations and understanding of carbon reduction should be incorporated into other IDOT studies and guides. This includes the Long-Range Transportation Plan, which is informed by a suite of other transportation efforts and studies, such as the Illinois State Freight Plan, Active Transportation Plan, and Intelligent Transportation System Architecture Strategic Plan. The Carbon Reduction Strategy will be one of many efforts used by the Long-Range Transportation Plan to form a blueprint for transportation across the entire state.

Consider Carbon Reduction as a Criterion for Funding Decisions

Funding decisions take many factors into account to determine the best use of available funds. These criteria often include the project need, cost, and timeline as well as additional benefits to underserved communities, air quality, and other environmental benefits. Carbon reduction should be included as part of this evaluation using criteria such as absolute carbon reduction using data from the tables in the previous sections, emissions reduced per dollar, and how quickly emission reductions can be achieved. IDOT is currently working to incorporate an emissions measure into the Department's Data Driven Decisions tool for evaluating capacity projects and may consider other ways to incorporate emissions reduction into planning and programming decisions.

Seek Innovative Ways to Promote Carbon Reduction Beyond CRP Funding

IDOT participates in the Illinois Carbon Working Group, a multi-agency group that meets regularly to share information about each agency's carbon reduction efforts and opportunities to work together. Group members have expressed interest in using DOT right-of-way for projects that promote native vegetation and pollinators.

IDOT should review the availability of new technologies during project design that could encourage carbon reduction. New technologies continue to become available for materials used for pavement and construction fill. For example, the Tri-County Regional Planning Commission has been working with community partners to develop a method to use dredged sediment from lakes to produce an engineered drainage soil that could be used for highway construction projects. Activities that reuse waste materials help to reduce carbon emissions by keeping materials out of landfills and avoiding manufacturing of new materials.

Provide Resources for MPOs, Counties, and Municipalities

This Carbon Reduction Strategy serves as a resource for MPOs, counties, and municipalities throughout Illinois as they incorporate carbon reduction into their transportation planning processes and funding decisions. IDOT will make available the calculations and methodologies that have been used to estimate project benefits.

Evaluation of Success

This Carbon Reduction Strategy should guide the development of transportation sector carbon reduction throughout the state. The document should be referenced for IDOT planning. In addition, the status and relative success of implementation should be measured for the next Carbon Reduction Strategy update.

Monitor Carbon Emission Trends

Because the combustion of fossil fuel is the largest source of GHG emissions nationwide, changes in emissions from fossil fuel combustion have historically been the dominant factor affecting total U.S. emission trends. Changes in CO_2 emissions from fossil fuel combustion are influenced by many long-term and short-term factors, including population growth, economic growth, changing energy prices, new technologies, changing behavior, and seasonal temperatures. Between 1990 and 2020, the increase in CO_2 emissions corresponded with increased energy use by an expanding economy and population, including overall growth in emissions from increased demand for travel. Many of the projects evaluated in this Carbon Reduction Strategy rely on changes in travel behavior, which is a challenge to predict.

The EPA and EIA resources that were used to create Figure 1 and Figure 2 are routinely updated by those agencies. For future updates to this Carbon Reduction Strategy, the most recent values should be reported and compared to the 2021 values to determine if CO_2 emissions from the transportation sector are trending downward. If trends are not showing the desired downward trajectory, additional data sources should be investigated to explain why reductions were not achieved.

Develop Performance Indicators

IDOT will develop performance measures to track the progress and establish targets for the reduction of CO_2 emissions from transportation. IDOT anticipates the finalization of new federal performance measures that will require the department to set these targets and is working proactively to prepare for this process. In addition, IDOT is working with partner agencies within Illinois on other planning efforts, such as the Climate Pollution Reduction Program Plan being led by the Illinois Environmental Protection Agency.

In addition to measures of CO_2 emissions, trends in VMT are published by IDOT each year. VMT per capita can be used to determine if transportation system users are choosing to use reduce vehicle trips or using alternate modes.

Considerations for Future Updates

The CRP requires each state to update its Carbon Reduction Strategy at least every four years. The updates should present the latest trends in Illinois's overall CO_2 emissions as well as those specific to the transportation sector. The indicators listed above and those included elsewhere in this document provide a strong foundation for measuring the effectiveness of the Carbon Reduction Strategy, and they can be used to identify effective projects and those that may be underused.

Future updates should review and update the estimated emission reductions from specific projects as methodologies evolve and more vehicles transition to alternative fuel sources. New projects may be introduced as Illinois and the country as a whole continue to integrate carbon reduction strategies within the transportation sector.

This Carbon Reduction Strategy is the first developed by IDOT. Future updates may include information about areas of ongoing research such as connected vehicle infrastructure, driverless freight, and mobility as a service.

INTRODUCTION

The Bipartisan Infrastructure Bill, signed into law in November 2021, establishes a Carbon Reduction Program (CRP), which provides funds for projects designed to reduce transportation emissions, defined as carbon dioxide emissions from on-road highway sources. CRP funds may be obligated for projects supporting various means of reducing transportation emissions. At the State's discretion, the CRP can also quantify the total carbon emissions from the production, transport, and use of materials used to construct transportation facilities in the State.

This memo summarizes the initial step of reviewing previous studies to identify progress made thus far and compile best practices. Documents from agencies within Illinois were reviewed to compile applicable resources, goals, and strategies that will be reflected in the statewide Carbon Reduction Strategy (CRS). Efforts from other states were also reviewed to provide examples of carbon dioxide (CO2) or greenhouse gas (GHG) reduction strategies and methodologies for estimating potential emissions reductions.

SUMMARY OF FINDINGS

Though federal legislation concerning mandated state carbon reduction strategies was only recently passed, states and metropolitan planning organizations have long identified the dire situation carbon emissions presents to the environmental, health, social, and economic well-being of communities. Numerous documents, studies, plans, and reports have been developed inventorying existing GHG conditions, and identifying measures, metrics, and benchmarks for reducing emissions. GHG emissions in the transportation sector are particularly important as the sector represents the largest segment of emissions statewide. Documents from Illinois, regional metropolitan planning organizations, and other States were reviewed to provide insights into Illinois developing CRS. This CRS will incorporate the best of each of these sources to provide a practical plan to reduce CO2 emissions from on-road highway sources. Documents from other states are valuable to provide examples of relevant strategies and the presentation of their potential benefits.

ILLINOIS CLIMATE AND EQUITABLE JOBS ACT (CEJA)

he Climate and Equitable Jobs Act (CEJA), Public Act 102-0662, was passed by the General Assembly and signed into law by Governor Pritzker on September 15, 2021. CEJA includes provisions to phase out carbon emissions from the energy and transportation sectors.

Transportation Highlights

- Provides that it is the policy of the State of Illinois to move toward 100% clean energy by 2050.
- Establishes a goal of adopting 1,000,000 electric vehicles in Illinois by 2030.
- Requires electric utilities to file beneficial electrification plans with the ICC to support the rapid deployment of electric vehicles and make-ready infrastructure statewide.
- Requires IEPA to award rebates to help fund up to 80% of the cost of the installation of charging stations and requires recipients to pay prevailing wage on installation projects.
- Creates an Electric Vehicle Coordinator within IEPA.
- Requires the Department of Transportation to conduct a study to consider how the adoption of EVs will adversely affect resources needed for transportation infrastructure.
- Creates an up to $4,000 rebate for consumers who purchase an electric vehicle, regardless of where they reside in Illinois.

CEJA SPECIFIC PROGRAMS

ELECTRIC VEHICLE REBATE

Beginning July 1, 2022, and continuing as long as funds are available, an Illinois resident that purchases an all-electric passenger vehicle from a dealer licensed in Illinois will be able to apply for a rebate, in the amounts set forth below. A rebate amount cannot exceed the purchase price of the vehicle. The purchaser must retain ownership of the vehicle for a minimum of 12 consecutive months immediately after the vehicle purchase date. Only one rebate will be issued to a purchaser in any 10-year period. See the Electric Vehicle Rebate Program page for more information.

- Beginning July 1, 2022, a $4,000 rebate for the purchase of an electric vehicle.
- Beginning July 1, 2026, a $2,000 rebate for the purchase of an electric vehicle.
- Beginning July 1, 2028, a $1,500 rebate for the purchase of an electric vehicle.
- Beginning July 1, 2022, a $1,500 rebate for the purchase of an electric motorcycle.

CHARGING INCENTIVE PROGRAM

The Agency is directed to provide funding, consistent with Illinois Commerce Commission-approved Beneficial Electrification Plans, to public and private organizations and companies to install and maintain Level 2 or Level 3 charging stations.

Up to 80% of the cost of the installation of charging stations may be funded. Additional awards may incentivize charging infrastructure in eligible communities. More information is available on the Driving a Cleaner Illinois website[1].

REVIEW OF NEW ILLINOIS DOCUMENTS

Several state and regional documents were obtained and reviewed for their relevance to the CRS. Of particular concern in these documents were any identified carbon reduction strategies, reduction targets, priority project types, GHG inventories, and overall approaches toward addressing and discussing greenhouse gases. Each document provides unique insight into the work conducted thus far to reduce carbon emissions and expectations and tactics for continuing to reduce carbon emissions. The following points briefly characterize the current state of carbon emissions, transportation emissions, and carbon reduction strategies in Illinois.

Main takeaways from each reviewed document helpful for developing this CRS are provided in the below sections. A table listing the reviewed documents is provided in Table 1.

[1] Driving a Cleaner Illinois. Driving a Cleaner Illinois - Driving a Cleaner Illinois

Table 1: Reviewed Documents

TITLE	AGENCY	YEAR
Illinois Long-Range Transportation Plan	IDOT	2019
Chicago Metropolitan Agency for Planning On To 2050	CMAP	2022
2050 Metropolitan Transportation Plan for the Rockford Region	R1	2020
2022 Chicago Climate Action Plan	City of Chicago	2022
Louisville Greenhouse Gas Emissions Reduction Plan	City of Louisville	2020

Table 2: Plan Check List

PLAN	GOALS	STRATEGIES	TARGETS	PERFORMANCE MEASURES	PROJECTS
Illinois Long-Range Transportation Plan	✓	✓		✓	
Chicago Metropolitan Agency for Planning On To 2050	✓	✓	✓	✓	✓
2050 Metropolitan Transportation Plan for the Rockford Region				✓	
2022 Chicago Climate Action Plan	✓	✓	✓	✓	
Louisville Greenhouse Gas Emissions Reduction Plan		✓	✓		

Table 3: Reviewed State Documents

STATE	DOCUMENT
Indiana	Draft Carbon Reduction Strategy
Colorado	GHG Pollution Reduction Planning Standard
	Colorado Greenhouse Gas Pollution Reduction Roadmap
Florida	Carbon Reduction Quick Guide
California	Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity
North Carolina	Vehicle Miles Traveled Reduction Study
Oregon	Climate Action Plan 2021-2026

ILLINOIS LONG-RANGE TRANSPORTATION PLAN

- Many of the goals and strategies in the plan encourage the use and expansion of other modes of transportation aside from cars and trucks.
- The following strategies to encourage alternative modes of transportation and reduce emissions are listed in the plan:
    - Work collaboratively with ports and waterways stakeholders to identify and address issues related to transporting commerce via navigable waterways. (Economy Chapter)
    - Advocate for the success of Illinois' passenger rail program. (Economy Chapter)
    - Improve transit ridership levels and riders' experiences through the use of rider-oriented technology. (Livability Chapter)
    - Increase the use of recycled materials in construction projects. (Livability Chapter)
    - Reduce emissions by implementing performance-based project selection. (Livability Chapter)
    - Support reduction in the use of single occupancy vehicles (SOVs). (Livability Chapter)
    - Realize positive air quality gains and reduced energy consumption with efficient passenger and freight operations. (Livability Chapter)
- The following performance measures are listed in the plan to track emissions:
    - Number of sustainability audits of IDOT facilities. (Livability Chapter)
    - Percentage of recycled materials used on construction projects. (Livability Chapter)

- Percent of non-SOV travel. (Livability Chapter)
- Total emissions reductions of Congestion Mitigation and Air Quality (CMAQ) funded projects. (Livability Chapter)
- Percent of per capita emissions of greenhouse gases reduced. (Livability Chapter)
- Number of energy/fuel-efficient vehicles added annually to IDOT and other fleets statewide. (Livability Chapter)
- Number of TDM efforts implemented and coordinated in Illinois. (Livability Chapter)

CMAP ON TO 2050

- The ON To 2050 Plan has a series of goals and strategies which work toward addressing climate change and reducing GHG. They are as follows:
  - Goal: Comprehensively address energy and climate change at the federal and state levels
    - Uphold commitment to the Paris Agreement and continue federal involvement in strategies to achieve these goals, including the expansion of renewable energy and efficiency programs and exploration of market mechanisms for reducing GHG (Greenhouse Gas) emissions.
    - Continue to implement the Future Energy Jobs Act and other emission reduction policies and programs that promote energy conservation and transition the region to renewable sources.
    - Regularly update the GHG (Greenhouse Gas) inventory to provide critical information to stakeholders on the implementation of emission reduction strategies.
    - Create a regional climate action plan to identify further strategies to move toward ON TO 2050's emissions reductions target and consider setting sector-specific targets for energy and transportation.
  - Goal: Transform transportation systems to reduce emissions
    - Continue to fund fleet replacement, such as electric buses and charging stations, through CMAQ.
    - Adopt electric vehicles and other innovative emission reduction technologies and plan for integration of solar and charging stations into new projects.
    - Review development ordinances to identify ways to promote electric vehicle infrastructure in the transportation system.
  - Goal: Increase low- and zero-emissions energy generation
    - Continue to diversify their energy portfolio to include a greater share of renewable sources.
    - Continue to advance renewable portfolio standards and keep pace with technological changes.
    - Allow and promote renewable energy systems in zoning, building, design guidelines, and energy codes and explore bulk purchasing options.
    - Develop template renewable energy ordinance language and design guidelines for use by local governments.
- The On To 2050 has revised its target indicators from the previous Go To 2040 Plan, the new target indicators are **2025**: 91.2 MMTCO2e or less, and **2050**: 25.7 MMTCO2e or less.
- Action Items
  - Regularly update the GHG inventory to provide critical information to stakeholders on the implementation of emission reduction strategies.

- Continue to fund fleet replacement, such as electric buses and charging stations, through CMAQ.
- Adopt electric vehicles and other innovative emission reduction technologies and plan for integration of solar and charging stations into new projects.
- Review development ordinances to identify ways to promote electric vehicle infrastructure in the transportation system.
- Help communities identify the potential benefits and pitfalls of new technologies with regard to economic competitiveness, affordable mobility, accessibility, and local quality of life.
- Increase transit funding and ensure new revenues provide substantive benefit for public transit.
- Prioritize capital projects that enhance pedestrian and bicycle access to rail and bus service.

2050 METROPOLITAIN TRANSPORTATION PLAN FOR THE ROCKFORD REGION

- The plan highlights a series of performance measures
  - System Performance
    - Percent of person miles traveled on the Interstate System that are reliable;
    - Percent of person miles traveled on the Non-Interstate NHS that are reliable;
  - Freight Movement
    - Truck Travel Time Reliability Index (TTRI)
  - CMAQ/Air Quality
    - Annual Hours of Peak Hour Excessive Delay Per Capita;
    - Percent of Non-Single Occupant Vehicle Travel; and
    - Total Emission Reductions.

2022 CHICAGO CLIMATE ACTION PLAN (CAP)

- The Chicago Climate Action Plan includes a series of pillars and strategies to reduce emissions.
  - Pillar 3: Deliver a robust zero-emission mobility network that connects communities and improves air quality
    - Strategy – Make walking, biking, or transit viable options for all trips
      - Expand high-quality and low-stress on-street bikeways and off-street trails
      - Increase Divvy bikes and shared micro mobility trips 30% by 2030
      - Enable Chicagoans to walk, bike, take transit, or use shared micro mobility for 45% of all trips by 2040
    - Strategy – Increase transit performance and encourage equitable transit-oriented development
      - Update land use policies to encourage sustainable development, accessibility, and street safety by 2023
      - Expand use of commuter benefits by 2024
      - Require transportation demand management plans for new development by 2025

- Update citywide car and bike parking requirements by 2025
- Increase CTA ridership 20% by 2030

▪ Strategy – Enable zero-emission transit and fleets

- Enable electric freight loading docks at commercial and industrial buildings, addressing new buildings by 2025 and existing buildings by 2030
- Support equitable electrification of ride-hail and taxi fleets by 2030
- Enable 100% electrification of delivery fleets by 2035
- Electrify 100% of the City's fleet by 2035
- Achieve zero-emission transit fleets across Chicagoland by 2040

o Pillar 4: Drive equitable development of Chicago's clean-energy future

▪ Strategy – Enable building and personal vehicle electrification

- Enable 2,500 new public passenger electric vehicle charging stations by 2035

▪ Strategy – Align building codes and standards with climate best practices

- Enable net-zero-carbon construction by 2040

- The plan also has a couple GHG reduction targets they are as follows:
  - Create jobs, develop circular economies, and improve air quality by pioneering clean last-mile logistics: three percent reduction.
  - Enable personal mobility and well-being by providing access to clean transport options and first-class walking and biking network: six percent reduction.
- The plan also had several performance measures which are as follows:
  - Daily Divvy bike trips of 1.5 per 1,000 residents in five economic hardship areas from May to October
  - Miles of protected bike lanes
  - Miles of total bike lanes
  - Miles of off-street trails
  - Transportation mode distribution
  - Sidewalk quality indicators

LOUISVILLE GREENHOUSE GAS EMISSIONS REDUCTION PLAN

- The Louisville plan set several strategies to reduce emissions for transportation these included the following:
  - Increase active transportation and ridesharing
  - Improved Transportation Systems
  - Fuel switch (e.g., electric, hydrogen fuel cell, etc)
- The plan developed a target to reduce the Louisville Metro's GHG emissions by 80 percent by 2050.

REVIEW OF OTHER STATE DOCUMENTS AND PROGRAMS

The Carbon Reduction Program requires each state to develop a Carbon Reduction Strategy by November 2023. While many states are still developing the Carbon Reduction Strategy, as required by the Carbon Reduction Program, there are states that have published other similar documents that address reducing greenhouse gas emissions from the transportation sector. This section summarizes information from other states to provide IDOT with examples of ongoing work in this area.

INDIANA – DRAFT CARBON REDUCTION STRATEGY

The Indiana Department of Transportation has developed a Draft Carbon Reduction Strategy that is posted on their website for public review and comment[2]. The document identifies five categories of transportation projects and strategies that can support carbon reduction in Indiana, as shown in Figure 1. Project types and strategies the support each category are summarized in tables. The document does not identify specific projects or estimate the potential reductions from the strategies.

Figure 1. Indiana DOT Carbon Reduction Categories

COLORADO

Colorado Greenhouse Gas Pollution Reduction Roadmap

In the 2019 legislative session Colorado passed House Bill 19-1261, the Climate Action Plan to Reduce Pollution ("Climate Action Plan"), which includes science-based targets of reducing statewide greenhouse gas pollution 26% by 2025, 50% by 2030, and 90% by 2050 from 2005 levels. To ensure that Colorado continues to make progress toward these targets, Governor Polis directed state agencies to develop this comprehensive Greenhouse Gas Pollution Reduction Roadmap ("Roadmap").

Colorado's goal has a near-complete electrification of vehicles by 2050, with an interim target of nearly 1 million light-duty EVs in service by 2030. Some of the strategies Colorado is undertaking includes the following:

- EV Incentives for Consumers
- Electric Bikes and Micromobility
- EV Charging Infrastructure Incentives
- Local Government EV Planning
- Public Investment in Clean Vehicle and Infrastructure
- Clean Truck Fleet Rules
- Transportation Demand Management
- Land Use Planning and Land Use Incentives
- Integrate GHG Pollution Standards and Analysis in Regional, and Statewide Plans
- Enhanced Multimodal Options

[2] Indiana DOT Carbon Reduction Strategy. https://www.in.gov/indot/public-involvement/public-involvement/carbon-reduction-strategy/

GHG Pollution Reduction Planning Standard

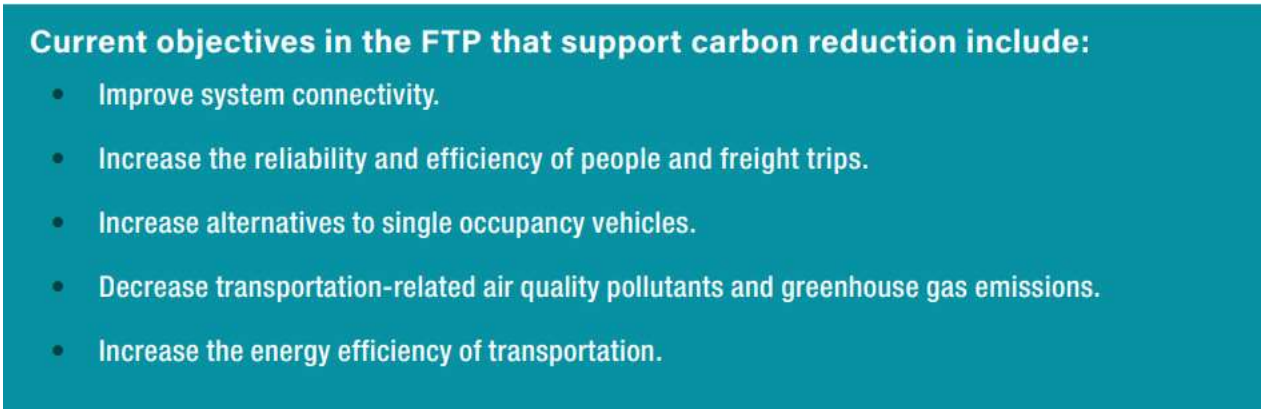
On December 16, 2021, the Transportation Commission voted to approve a groundbreaking new rule, the GHG Pollution Reduction Planning Standard[3], to reduce GHG emissions from the transportation sector. Under the Standard, CDOT and the state's five MPOs are required to achieve individually set GHG reduction levels at four different time periods - 2025, 2030, 2040, and 2050, which must be demonstrated in transportation planning documents using travel modeling. Overall, the standard encourages CDOT and the MPOs to develop long range transportation plans that support travel choices that reduce GHG emissions.

On May 19, 2022, the Transportation Commission voted to adopt Policy Directive 1610[4] on GHG Mitigation Measures, which establishes an ongoing administrative process and guidelines for selecting, measuring, confirming, verifying, and reporting on GHG Mitigation Measures. The Policy Directive includes a list of GHG mitigation measures that have been scored to reflect the ability of these project types to reduce GHG emissions in Colorado.

FLORIDA – CARBON REDUCTION QUICK GUIDE

Florida DOT developed a Carbon Reduction Quick Guide[5], designed to assist MPOs in developing goals and objectives to support the reduction of transportation emissions and to identify projects that align with those goals and objectives. The Quick Guide also contains a list of resources so MPOs can easily access answers to questions regarding the implementation of the IIJA program. The guide encourages MPOs to consider goals that align with objectives within the Florida Transportation Plan that support carbon reduction, as shown in Figure 3, and provides examples of noteworthy practices around the state.

Figure 3. Florida Transportation Plan Objectives that Support Carbon Reduction



CALIFORNIA - HANDBOOK FOR ANALYZING GREENHOUSE GAS EMISSION REDUCTIONS, ASSESSING CLIMATE VULNERABILITIES, AND ADVANCING HEALTH AND EQUITY

The California Air Pollution Control Officers Association (CAPCOA) has published a Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity[6]. This document is widely used by local

[3] Colorado DOT Greenhouse Gas Program. https://www.codot.gov/programs/environmental/greenhousegas

[4] Colorado DOT Policy Directive 1610. https://www.codot.gov/programs/environmental/greenhousegas/assets/pd-1610-0-greenhouse-gas-mitigation-measures-june2022.pdf

[5] Florida DOT Carbon Reduction Quick Guide. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/policy/carbon-reduction/2022carbon-emission-reduction-guide-12-12_v5.pdf?sfvrsn=eff0c914_2

[6] CAPCOA GHG Handbook. https://www.airquality.org/ClimateChange/Documents/Final%20Handbook_AB434.pdf

governments across California to reduce GHG emissions from new land use development projects and to create climate action plans, master plans, and general plans. This document does not present a statewide emissions reduction strategy, but it is a useful resource that includes factsheets, formulas, and guidance to calculate GHG reductions from over 80 GHG mitigation strategies. Information about specific strategies include GHG emissions reduction potential, co-benefits, climate resilience effects, and health and equity considerations.

NORTH CAROLINA – VEHICLE MILES TRAVELED REDUCTION STUDY

In 2021, North Carolina Department of Transportation published a study examining how to reduce vehicle mile (VMT) traveled in the state. The study provided an outline of existing conditions of VMT within North Carolina and forecasts. The study identifies 24 transportation demand management (TMD) strategies and provides a matrix on which MPOs/RPOs are implementing the strategies. The study then provides a one-pager of 38 projects, programs, or processes which are aimed to help reduce VMT. These one-pagers provide items like description, pros, cons, potential VMT reduction impact, implementation considerations, potential applications (cities, suburban, rural), and provides examples and links for more information.

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Regional

NON-MOTORIZED MODE SUPPORT

REGION TYPE

URBAN SUBURBAN

DESCRIPTION

Non-motorized modes of transportation include walking and biking. These modes can be recreational or for conveyance. Non-motorized mode support focuses on strategies to support and encourage walking or biking. This can include installing and maintaining sidewalks and bike lanes, increasing connectivity, public education and promotion campaigns of non-motorized modes, bicycle parking, bicycle racks on buses, pedways, and Safe Routes to School or work programs. This strategy could be used to support other strategies like Complete Streets.

PROS

- Non-motorized mode support increases transportation options, which benefits both drivers who switch to other modes and non-drivers.
- Walking and cycling are often more affordable than other modes of transportation.
- Non-motorized mode support can be combined with other strategies to reduce VMT.

CONS

- Streets and bike lanes need to be maintained for continued use.
- Non-motorized modes have a relatively high injury and fatality rate per mile due to these modes providing less protection to their users than motor vehicle travel.
- Not suitable for rural areas, only suitable for areas with good connectivity.

POTENTIAL VMT REDUCTION IMPACT

The Center for Clean Air Policy Guidebook allots a 2.5% reduction in VMT for the combined impact of all bicycle related measures. (CAPCOA) Fewer bicycle-related measures results in a lower impact.

A study from University College London found that 5-10% of automobile trips could be shifted to non motorized modes in urban areas. When other strategies like parking pricing reduced vehicle travel, between 10% and 35% of the trips shifted to walking or biking. (Mackett)

The town of Cottonwood, Minnesota-funded Safe Routes to School program built a path around Cottonwood Lake in 2009 through the Minnesota DOT. Before the construction of the path, only about 5 percent of Lakeview students walked or biked to school. Today, 11 percent of students use the path at least once per week and an additional 13 percent use the path at least once per month to walk or bike to school and for other recreational purposes.

IMPLEMENTATION CONSIDERATIONS

Successful walking and biking facilities need to be implemented in routes where there is a demand; the facilities must have a "destination". Connectivity is important.

NORTH CAROLINA EXAMPLES

- Cape Fear Regional Bike Plan https://www.pendercountync.gov/pcd/wp-content/uploads/sites/15/2017/07/Cape_Fear_Bicycle_Plan_DRAFT_screenquality.pdf
- NCDOT Safe Routes to School https://www.ncdot.gov/divisions/bike-ped/Documents/NCDOT_SRTS_Description.pdf
- Bikes on Buses, Raleigh, NC https://raleighnc.gov/services/content/PWksTransit/Articles/BikesonBuses.html
- Walk Raleigh https://raleighnc.gov/walk-raleigh

OTHER EXAMPLES

- Bicycle Parking and Amenities – Arlington, MA; Cambridge, MA; Norwell, MA; Portland, OR https://www.mapc.org/wp-content/uploads/2017/10/TDM-FINAL-REPORT-7_15_0.pdf
- Safe Routes to School – various nationwide locations https://www.saferoutespartnership.org/local/local-success-stories#statesrts

SOURCES

"How to Reduce the Number of Short Trips by Car", Roger Mackett, European Transport Conference, Centre for Transport Studies, University College London, 2000. https://aetransport.org/public/downloads/xBVhC/2543-514ec4aa1b046.pdf

"Quantifying Greenhouse Gas Mitigation Measures", California Air Pollution Control Officers Association, 2010. http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

TYPE OF TRIPS TARGETED

All trips

POTENTIAL APPLICATION LOCATIONS

Dense urban areas, towns, commercial centers, residential neighborhoods, recreation areas

IMPLEMENTED BY

STATE GOV'T COUNTY/ LOCAL GOV'T MPO/RPO

OREGON – CLIMATE

The Climate Action Plan is ODOT's 5-year plan for work to address the impacts of climate change and extreme weather on the transportation system. The plan includes actions ODOT is taking between 2021-2026 to reduce greenhouse gas emissions from transportation, address climate justice and make the transportation system more resilient to extreme weather events. The Climate Action Plan is unique to ODOT's work, and only contains actions under the agency's authority and the partnerships the agency is engaged in. The actions included in the plan were identified based on agency goals and priorities, as well as stakeholder feedback on important emissions reduction actions for the agency. The plan outlines climate decisions which can be made by the following strategy areas.

- Policy and Investments
- Managing Demand
- Pricing
- Electrification
- Clean Vehicles and Fuels
- System Efficiency
- Adaptation
- Sustainability
- Agency Partnerships
- Monitoring and Data

Appendix B – Emissions Quantification Methodology

INTRODUCTION

As part of the Carbon Reduction Strategy, Illinois Department of Transportation (IDOT) selected representative projects based on the list of eligible project types to determine the relative emissions benefits of various projects.
Since this exercise did not calculate emissions for specific projects where project details were known, the emissions were estimated using publicly available tools and methodologies that can be repeated and refined for future versions of the Carbon Reduction Strategy and any potential reporting of expected emissions reductions from specific projects under evaluation.

RESOURCES USED

- EPA Motor Vehicle Emissions Model (MOVES) Version 3.1 was used to develop emission factors for the general vehicle fleet and passenger vehicles on the roads in Illinois. MOVES incorporates the registered vehicle fleet mix as well as all federal emissions and fuel economy regulations in place during the analysis year. The emission factors used for the analysis were based on Cook County default assumptions. If different counties were assumed, the emissions factors would vary based on the ages and types of vehicles registered in that county. Selecting one representative county for this analysis is appropriate, considering the broad assumptions used for each calculation. MOVES was also used to develop an emission factor for construction, maintenance, and landscaping equipment using the NONROAD module. https://www.epa.gov/moves
- AFLEET Version 2020 was used to develop emission factors for trucks and buses using an array of fuel options. AFLEET includes estimates for direct emissions from the vehicle tailpipe as well as upstream emissions associated with the production and transport of fuel and energy. While electric and hydrogen fuel cell vehicles do not produce tailpipe emissions, the increases in emissions from power production must be considered for a complete comparison. Emission factors were developed using AFLEET national defaults. https://greet.es.anl.gov/afleet
- AFLEET Charging and Fueling Infrastructure (CFI) Emissions Tool was used to develop emission estimates for a publicly available charging station. https://afleet.es.anl.gov/infrastructure-emissions/
- FHWA CMAQ Toolkit is a series of Excel-based modules commonly used for the Congestion Mitigation and Air Quality Program emissions reporting. Many project types that reduce emissions of CO_2 are included within these modules. The Traffic Flow Improvement Module was used to identify emission factors for vehicles traveling at specific speeds and idling. Annual bus miles of travel was retrieved from the Transit Bus Retrofit and Replacement Module. https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/
- The National Asphalt Pavement Association published GHG Emissions Inventory for Asphalt Mix Production in the United States in 2022. Information in this document was used to estimate the emissions reductions using different pavement techniques for a typical resurfacing project.
- https://www.asphaltpavement.org/expertise/sustainability
- The California Air Resources Board (CARB) Methods to Find the Cost-Effectiveness of Funding Air Quality Projects was used to develop assumptions for how many new users would use bicycle and pedestrian facilities with various characteristics. https://ww2.arb.ca.gov/sites/default/files/2020-06/Congestion_Mitigation_Air%20_Quality_Improvement_Program_cost-effectiveness_methods_may2005.pdf

TOOL DEVELOPMENT

A Microsoft Excel-based tool was developed to perform this emissions analysis. The tool includes a tab that performs all calculations and a tab that summarizes all the inputs used and the source of that data or assumption. The following sections provide additional details and context for the calculations and assumptions used by the tool by project type.

TRANSIT SERVICE

Emissions reductions from transit service expansion represent the reductions from increased transit use that shifts commuters away from driving alone. To estimate the passenger vehicle miles reduced, new trips per service mile were based on system-wide average data from the National Transit Database for 2021. Trips per service mile were determined for Chicago Transit Authority (CTA) and other providers (non-CTA). The average trip distance was based on national average data from the CMAQ toolkit. Emissions reductions were multiplied by the drive alone mode share to acknowledge that not every new user will have shifted travel from a single occupancy vehicle. The result values could be scaled by the number of service miles that would be expanded by the project.

ACTIVE TRANSPORTATION FACILITIES

Emissions reductions from bicycle and pedestrian facilities were developed based on the methodology described in the California Air Resources Board's Methods to Find the Cost-Effectiveness of Funding Air Quality Projects[1]. This methodology estimates the number of automobile trips replaced by bicycle trips for commute and other non-recreational purposes using average daily traffic of the parallel roadway, length of the project, city population, and the number of activity centers within half a mile of the project. The estimates used for this evaluation assumed the maximum number of activity centers and maximum population adjustment factors to calculate the emissions reduced from each combination of project length and roadway AADT. These calculations are detailed in the emissions workbook tab labeled "Bike Ped Assumptions." For the purposes of this analysis, the same assumptions were used for pedestrian facilities, although that is likely an overestimate. The emissions reductions were multiplied by the drive alone mode share to acknowledge that not every new user will have shifted travel from a single occupancy vehicle.

VANPOOL SERVICE

Emissions reductions from vanpool opportunities represent the reductions from commuters shifting modes from driving alone. To estimate the passenger vehicle miles reduced, the average trip distance was based on national average data from the CMAQ toolkit, and it was assumed that vans would have capacity for 10 users. The emissions reductions were multiplied by the drive alone mode share to acknowledge that not every new user will have shifted travel from a single occupancy vehicle. The result value could be scaled by the number of vans considered for purchase or the number of expected users per van.

ROADWAY OPERATIONS

Multiple project types (variable messaging signs, traffic control centers, transit signal priority, and signal synchronization) were evaluated to determine potential benefits from projects that improve efficiency on roadways by increasing vehicle speeds and decreasing travel time. Emissions benefits for these types of projects were assumed to only occur during peak hours when congestion is most likely to be relieved. Emissions of vehicles traveling average speeds of 20 to 50 miles per hour were obtained from the CMAQ toolkit. A 5 mph increase in speed was assumed to represent a 10% reduction in travel time. A 10 mph increase in speed was assumed to represent a 30% reduction in travel time.

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[1] https://ww2.arb.ca.gov/sites/default/files/2020-06/Congestion_Mitigation_Air%20_Quality_Improvement_Program_cost-effectiveness_methods_may2005.pdf

INDIVIDUAL SIGNAL

Emissions reductions from an individual signal were based on the elimination of 60 seconds of idling per vehicle. Emissions benefits for project type were assumed to only occur during peak hours when congestion is most likely to be relieved. The resulting value could be scaled based on the roadway volume and seconds of delay reduced.

PUBLICLY AVAILABLE CHARGING STATIONS

Emission reductions were based on one moderate utilization charging station, using AFLEET CFI defaults for the number of vehicles to access the station and fuel consumption. Emission reductions were calculated separately for level 2 (L2) charging stations and Direct Current Fast Charging (DCFC) stations. The result values could be scaled by the number of charging stations under consideration.

VEHICLE REPLACEMENT

Emissions reductions were estimated by subtracting the emissions of the electric or zero-emission vehicle from emissions for an identical diesel vehicle. For the purposes of this analysis, zero-emission trucks were assumed to be the average of heavy-duty vehicles powered by electricity or hydrogen fuel cells. Electric bus emissions were calculated by comparing a new electric bus to a new diesel bus, assuming a bus at the end of its service life would be replaced one of these options. The result values could be scaled by the number of vehicles under consideration for replacement. The alternative fuel factors from AFLEET are included in the spreadsheet tool in the tab labeled “Alt Fuel Emission Factors.”

TRUCK STOP ELECTRIFICATION

Emissions reductions were estimated for installation of offboard power equipment that can be used to support truck drivers’ rest needs such as temperature control and running appliances onboard the vehicle without idling the truck’s diesel engine or using a diesel auxiliary power system. The idling emission factor used in these calculations is an average of MOVES emission factors for extended idle and auxiliary power system factors. No upstream emissions from electricity production were included in this calculation. The result value could be scaled by the number of truck parking spots upgraded.

REPLACE GASOLINE POWERED LANDSCAPING EQUIPMENT

Annual emissions for average gasoline-powered landscaping equipment were estimated using the NONROAD module. The value used is an average of all commercial gasoline equipment within the landscaping category, which includes a range of equipment such as mowers, chainsaws, blowers, tractors, and chippers. If specific equipment is to be replaced, it is recommended that emission factors and activity specific to that equipment be identified. No upstream emissions from electricity production were included in this calculation.

REPLACE DIESEL POWERED LANDSCAPING EQUIPMENT

Annual emissions for average diesel-powered landscaping equipment were estimated using the NONROAD module. The value used is an average of all commercial diesel equipment within the landscaping category, which includes a range of equipment such as mowers, chainsaws, blowers, tractors, and chippers. If specific equipment is to be replaced, it is recommended that emission factors and activity specific to that equipment be identified. No upstream emissions from electricity production were included in this calculation.

REPLACE DIESEL POWERED CONSTRUCTION EQUIPMENT

Annual emissions for average diesel-powered construction equipment were estimated using the NONROAD module. The value used is an average of all diesel equipment within the construction category except off-road trucks. The construction category includes a range of equipment such as graders, loaders, dozers, cranes, pavers, and tractors. It was assumed that replacement of off-road trucks would have similar emissions reductions as estimated for on-road trucks. If specific equipment is to be replaced, it is recommended

that emission factors and activity specific to that equipment be identified. No upstream emissions from electricity production were included in this calculation.

IDLE REDUCTION

Emissions reductions can be achieved by implementing restrictions for how long construction equipment may idle at a worksite. Reductions were estimated assuming a 5-minute limit on idling for 2 idle events per day. The heavy-duty truck idling emission factor was obtained from the CMAQ toolkit. This value could be scaled based on the number of trucks affected by the idle restriction.

STREETLIGHT BULB REPLACEMENT

Emissions reductions were estimated for the upstream electricity reduction that could be achieved by replacing high pressure sodium (HPSV) lamps with light-emitting diode (LED) streetlamps. The energy saved per bulb was estimated by reviewing existing studies from recent municipal projects to replace lightbulbs in city streetlights[2]. This value was multiplied by the number of bulb replaced and the electricity emission factor provided by EPA's Emissions & Generation Resource Integrated Database (eGRID) for the RFCW subregion[3]. This value could be scaled based on the number of light bulbs replaced, and the emission factor should be updated if lightbulbs other than HPSV or LED are under consideration.

RESURFACING WITH WARM-MIX ASPHALT

Resurfacing with warm-mix asphalt as an alternative to hot-mix asphalt (HMA) reduces approximately 15% of CO_2 emissions associated with the energy needed for asphalt production[4]. The National Asphalt Paving Association's (NAPA) GHG Emissions Inventory for Asphalt Mix Production in the United States estimates that an average lifecycle emission intensity of asphalt mix in the United States ranges from 50.2 to 52.1 kg of CO_2 equivalent (CO_2e) per ton of mix produced, and mix production contributes to about 43% of the lifecycle emissions of HMA. The emissions reduction was determined by assuming a 15% reduction in the 43% contribution of material production, for a reduction of 3.4 kg CO_2e per ton of mix. Assuming a typical resurfacing project uses 40,000 tons of mix, these values were multiplied to determine the potential reduction of CO_2 per resurfacing project, assuming CO_2e is primarily CO_2.

RESURFACING WITH RECLAIMED ASPHALT PAVEMENT

Information from the National Asphalt Paving Association's (NAPA) GHG Emissions Inventory for Asphalt Mix Production in the United States was used to determine the reductions from scenarios that utilize reclaimed asphalt pavement (RAP). This document estimates that each ton of RAP used in asphalt mixtures in 2019 reduced GHG emissions by approximately 27 kg CO_2e in the United States. It was assumed a minimum of 20% RAP is used for resurfacing projects that require RAP use, and cold in-place recycling and full-depth reclamation methods use 100% RAP. Emission reductions and were calculated according to the following equation, assuming CO_2e was primarily CO_2:

Emissions reduction per project (kg/CO_2) = RAP emissions reduction (27 kg CO_2e/ton of mix)
* percentage RAP used (20% or 100%, depending on scenario)
* average HMA tonnage per project (40,000 ton of mix)

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[2] Resources used include: https://www.pge.com/en_US/large-business/save-energy-and-money/business-solutions-and-rebates/lighting/led-street-lighting-replacement-program.page, https://cob.org/wp-content/uploads/wsdot-led-lighting-eval-10-15-13.pdf

[3] https://www.epa.gov/egrid/power-profiler#/

[4] https://www.appg-betterroads.org/wp-content/uploads/2019/09/aia-warm-mix-document-Fl.pdf

Illinois DOT - Carbon Reduction Strategy Development
Quantification of expected emission reductions by project type

Travel Options	Strategies	Example Projects	How GHG is reduced	Data for Emission Calculations	Value	Units	GHG Reduction (MT CO2 / year)
	Public transportation	Expanded transit service - non-CTA providers	Promotes shift from SOV	New service miles	1	miles	
				Bus trips per mile of service - non CTA providers	91	trips/mile	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2e/mile	28.7
	Bike-ped facility parallel to roadway <12,000 ADT	New bike lanes or sidewalks	Promotes shift from SOV	New users	52	users	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2/mile	33.0
	Bike-ped facility parallel to roadway 12,000-24,000 ADT	New bike lanes or sidewalks	Promotes shift from SOV	New users	85	users	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2/mile	53.9
	TDM programs	New vanpool service	Promotes shift from SOV	New vanpool vehicles	10	vans	
				Passengers per van	10	passengers	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2/mile	63.4
	Bike-ped facility parallel to roadway >24,000 ADT	New bike lanes or sidewalks	Promotes shift from SOV	New users	117	users	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2/mile	74.2
	Public transportation	Expanded transit service - CTA	Promotes shift from SOV	New service miles	1	miles	
				Bus trips per mile of service - CTA	1941	trips/mile	
				One-way commute trip length	4	miles	
				Annual commute days	260	days/year	
				Drive alone mode share	67%	%	
				Passenger vehicle emission factor - gasoline	413	g CO2e/mile	615.8

Efficient Roadway Operations	Strategies	Example Projects	How GHG is reduced	Data for Emission Calculations	Value	Units	GHG Reduction (MT CO2 / year)
	Congestion management strategies (e.g. programs that support congestion pricing, shifting transportation demand to nonpeak hours or other modes, increase vehicle occupancy rates, electronic toll collection, other travel demand	Variable messaging signs on highway	Emissions are reduced when vehicles increase speeds	Corridor AADT	120,000	vehicles/day	
				Duration of peak period	6	hours	
				Annual commute days	260	days/year	
				Emission factor - highway congested speed	383	g CO2e/mile	
				Emission factor - highway improved speed by 5 mph	373	g CO2e/mile	81.1
	Congestion management strategies (e.g. programs that support congestion pricing, shifting transportation demand to nonpeak hours or other modes, increase vehicle occupancy rates, electronic toll	Transit signal priority	Emissions are reduced when vehicles increase speeds	Corridor AADT	50,000	vehicles/day	
				Duration of peak period	6	hours	
				Annual commute days	260	days/year	
				Emission factor - arterial congested speed	516	g CO2e/mile	
				Emission factor - arterial improved speed by 5 mph	464	g CO2e/mile	169.0
	Congestion management strategies (e.g. programs that support congestion pricing, shifting transportation demand to nonpeak hours or other modes, increase vehicle occupancy rates, electronic toll	Traffic control center	Emissions are reduced when vehicles increase speeds	Corridor AADT	50,000	vehicles/day	
				Duration of peak period	6	hours	
				Annual commute days	260	days/year	
				Emission factor - arterial congested speed	516	g CO2e/mile	
				Emission factor - arterial improved speed by 5 mph	464	g CO2e/mile	169.0
	Advanced transportation and congestion management technologies (e.g. intelligent transportation systesm, electronic toll collection)	Individual Signal upgrade (signal timing, roundabout)	Emissions are reduced when vehicles spend less time idling	AADT of affected roadways	50,000	vehicles/day	
				Delay reduced due to project	60	seconds/veh	
				Annual commute days	260	days/year	
				Duration of peak period	6	hours	
				Emission factor - average fleet idle	3	kg CO2/hr	179.8
	Advanced transportation and congestion management technologies (e.g. intelligent transportation systesm, electronic toll collection)	Signal sychronization along corridor	Emissions are reduced when vehicles experience fewer stop-and-go conditions	AADT of corridor	100,000	vehicles/day	
				Annual commute days	260	days/year	
				Duration of peak period	6	hours	
				Emission factor - arterial congested speed	516	g CO2/mile	
				Emission factor - arterial improved speed by 10 mph	424	g CO2/mile	597.4

Lower carbon fuels/ Alternative Fuels & Energy	Strategies	Example Projects	How GHG is reduced	Data for Emission Calculations	Average Value	Units	GHG Reduction (MT CO2 / year)
	Acquisition, installation, and operation of publicly accessible electric vehicle charging	Install publicly available fast charging	Promotes switch from fossil fuel to electric	Charging points per station	2.57	chargers/station	
				L2 charger emission factor	4.99	ton CO2/charger	12.8
	Acquisition, installation, and operation of publicly accessible hydrogen, natural gas, or propane vehicle fueling infrastructure	Replace heavy-duty diesel vehicles with CNG	Promotes switch from fossil fuels to fuels with lower emissions	# Alt fuel vehicles supported	10	vehicles/day	
				Annual delivery/fleet truck miles	16222	miles/day	
				Heavy-duty truck emission factor - diesel	1719	g CO2/mile	
				Heavy-duty truck emission factor - CNG	1593	g CO2/mile	20.5
	Acquisition, installation, and operation of publicly accessible electric vehicle charging	Install publicly available fast charging	Promotes switch from fossil fuel to electric	Charging points per station	2.57	chargers/station	
				DCFC charger emission factor	23.22	ton CO2/charger	59.7
	Replace light-duty and medium-duty trucks with electric options	Replace medium-duty diesel vehicles with electric	Promotes switch from fossil fuel to electric vehicles	# trucks replaced	10	trucks	
				Annual delivery/fleet truck miles	16222	miles/year	
				Light/Medium Duty truck emission factor - gas/diesel	756	g CO2/mile	
				Light/Medium Duty truck emission factor - electric	388	g CO2/mile	59.7
	Replace heavy-duty trucks with electric options	Replace heavy duty diesel vehicles with ZEV	Promotes switch from fossil fuel to electric vehicles	# trucks replaced	10	trucks	
				Annual delivery/fleet truck miles	16222	miles/year	
				Heavy-duty truck emission factor - diesel	1719	g CO2/mile	
				Heavy-duty truck emission factor - ZEV	666	g CO2/mile	170.8
	Truckstop electrification systems	Install off-board power at existing truck stops	Promotes switch from fossil fuels to fuels with lower emissions	# trucks served annual average day	20	HD Trucks	
				Time spent hotelling per truck	6	hours per day	
				Idling heavy truck emission factor	5000	g/hour	219.0
	Electric Bus Replacements	Replace diesel buses with electric buses	Promotes switch from fossil fuels to fuels with lower emissions	# buses replaced	10	buses	
				Annual transit bus miles	30000	miles/yr	
				Transit bus emission factor - diesel	2828	g CO2/mile	
				Transit bus emission factor - electric	1301	g CO2/mile	458.3

Construction and Maintenance	Strategies	Example Projects	How GHG is reduced	Data for Emission Calculations	Value	Units	GHG Reduction (MT CO2 / year) or (*MT CO2 / project*)
	Replacement of maintenance/landscaping equipment with electrically powered	Replace gasoline landscaping	Promotes switch from fossil fuels to fuels with	# equipment replaced	10	equipment	
				Emission factor - gasoline landscaping equipment	1	MT CO2/day	14.0
	Replacement of maintenance/landscaping equipment with electrically powered	Replace diesel landscaping	Promotes switch from fossil fuels to fuels with	# equipment replaced	10	equipment	
				Emission factor - diesel landscaping equipment	3	MT CO2/day	26.0
	Reduce heavy-duty vehicle idling at construction sites	limit all idling to 3 minute maximum	Reduces fuel consumption	Estimated idle time before limit	8	minutes	
				Estimated idle time after limit	3	minutes	
				# of trucks per day	100	trucks	
				# of idle times per truck per day	2	idle episodes	
				Idle Emission Factor	6602	Grams/hours	
				# of days per year	262	days per year	28.9
	Purchase or lease of zero-emission construction equipment and vehicles and supporting facilities	Replace diesel construction equipment with ZEV	Promotes switch from fossil fuels to fuels with lower emissions	# of equipment replaced	1	equipment	
				Emission factor - diesel construction equipment	32	MT CO2/year	31.6
	Replacement of street lighting and traffic control devices with energy-efficient alternatives	Replace HPSV street lights with LED	Efficient use of energy reduces GHG emissions from electricity use	streetlight replaced with LED - high	1,000	bulbs	
				kWh saved per bulb	100	kWh/bulb	
				Electricity emission factor	474.5	g CO2e/kWh	47.5
	Approaches to reduce emissions from the construction of transportation projects (e.g. pavement, materials, equipment,	Resurface with warm-mix asphalt in place of hot-mix asphalt	Reduces upstream emissions from material production	Warm-mix asphalt pavement reduction	3	kg CO2/ton of m	
				Average tons HMA per resurfacing project	40,000	tons/project	
				Percetage of reclaimed asphalt used	100%		*134*
	Approaches to reduce emissions from the construction of transportation projects (e.g. pavement, materials, equipment, recycling methods)	Resurface with reclaimed asphalt pavement in place of hot-mix asphalt	Reduces upstream emissions from material production and emissions from transporting materials to work site	Reclaimed asphalt pavement reduction	27	kg CO2/ton of m	
				Average tons HMA per resurfacing project	40,000	tons/project	
				Percetage of reclaimed asphalt used	20%	%	*216*
	Approaches to reduce emissions from the construction of transportation projects (e.g. pavement, materials, equipment, recycling methods)	Resurface using cold in-place recycling	Reduces upstream emissions from material production and emissions from transporting materials to work site	Reclaimed asphalt pavement reduction	27	kg CO2/ton of m	
				Average tons HMA per resurfacing project	40,000	tons/project	
				Percetage of reclaimed asphalt used	100%	%	*1080*
	Approaches to reduce emissions from the construction of transportation projects (e.g. pavement, materials, equipment, recycling methods)	Resurface using full-depth reclamation	Reduces upstream emissions from material production and emissions from transporting materials to work site	Reclaimed asphalt pavement reduction	27	kg CO2/ton of m	
				Average tons HMA per resurfacing project	40,000	tons/project	
				Percetage of reclaimed asphalt used	100%	%	*1080*

Natural Settings	Strategies	Example Projects	How GHG is reduced	Data for Emission Calculations	Value	Units	GHG Reduction (MT CO2 / year)
	Increasing tree coverage	Tree planting	Trees sequester CO2 and in urban environments can help to reduce the urban heat island effort and building cooling demand by providing shade	Example from US Forestry - i-tree - https://planting.itreetools.org/app/location/ Assuming 100 elm trees with 24" diameter planted near building over 40 year lifespan Reduction in MT/yr calculated by dividing iTree result by 40	100	Elm trees	Example: 11.8 (sequestered) 10.5 (avoided if planted near building)
	Promoting vegetated open spaces	New vegetated open space	Vegetation helps to sequester CO2	Carbon sequestration estimates require site-specific soil parameters such as biomass by land cover and annual soil carbon accumulations			