Table B.1 Transportation GHG Analysis Tools

GHG Tool	Developer/ Sponsor Agency	Year of Inception/ Update[1]	Availability	Brief Description	Relevance to GHG Emissions Estimation
Emission Factor Models/Tools					
MOVES	U.S. EPA	2015 (update)	Free/public	Estimates emissions and energy use from all on-road sources at the national, county, and project level. Nonroad emissions also can be added using an additional script. Current version is MOVES2014a released in 2015.	Accepted U.S. (49-State) source of emission factors, including GHG; widely used for air quality regulatory purposes, so many users are familiar. Emission factors are based on detailed local inputs of vehicle fleet, operating conditions, and other influencing factors.
EMFAC	CARB	2017 (update)	Free/public	California Air Resources Board developed emissions models used to assess emission from on-road vehicles, including cars, trucks, and buses in California. The most recent approved version is EMFAC2017.	Accepted emission factor model (including GHG) for use in California; comparable functionality to MOVES.
GREET	Argonne National Labs	2017 (update)	Free/public	Spreadsheet-based tool which calculates for a given vehicle and fuel system: total resource consumption (energy), fossil fuel use, natural gas, and water. Also provides all emissions of GHG (and their CO_2-equivalent) along with other pollutants.	Compared to MOVES or EMFAC, provides life-cycle emission factors, not just tailpipe, and can be tailored to over 100 different fuel paths, and almost any available vehicle technology type, to examine GHG emissions from alternative fuel vehicles.
VISION	Argonne National Labs	2017 (update)	Free/public	Model designed to provide estimates of the potential energy use, oil use, and carbon emission impacts of advanced light-duty and heavy-duty vehicle technologies and alternative fuels through the year 2050, and in some cases 2100.	Useful for future scenario analysis of alternative fuel and vehicle technologies, considering fleet turnover.
Mobile Combustion, Version 2.6	WRI	2015 (update)	Free/public	This tool calculates the CO_2, methane (CH4) and nitrous oxide (N_2O) emissions from various transportation sources using activity data input by the user. Uses default emissions factors calculated by UK Department for Environment, Food and Rural Affairs (DEFRA), U.S. EPA, and the United Nations Intergovernmental Panel on Climate Change (IPCC) (2006), but customized emissions factors can be added if known.	Useful rough calculation tool to give an idea of Scope 1 and Scope 3 emissions from transportation activities. The use of EPA or IPCC data does give some structure to results, but it will be highly dependent on quality of user inputs.
Emission Factors from Cross-Sector Tools spreadsheet	WRI	2017 (update)	Free/public	This Excel document provides standardized CO_2, CH_4, and N_2O emissions values for purchased energy and transportation sources per unit of fuel (e.g., kilograms (kg)/gallon) and per distance traveled (e.g., g/mile).	A quick way to look up emission factors by fuel type or per mile by vehicle type, age, etc., to apply to specific vehicle fleets with known characteristics. However, fuel economy values may not reflect the latest U.S. standards or local conditions.
Inventory and Forecast Accounting/Support Tools					
GreenDOT	ICF Intl.	2010	Free/public	A spreadsheet tool which estimates CO_2 emissions from State DOT construction, maintenance, and operations activities. The tool includes modules for emissions from electricity used in/along roadways, on-road vehicle fleets, off-road equipment, and materials used in roadway construction. Developed under National Cooperative Highway Research Program (NCHRP) 25-25 Task 58.	Spreadsheet function can give useful initial analysis for estimating GHG emissions for various DOT activities.
ClearPath	ICLEI	Ongoing	Limited to municipalities	Online software platform for completing greenhouse gas inventories, forecasts, climate action plans, and monitoring. Focused at the community-wide or Government-operations level.	A proprietary tool for inventorying. Basic level available to all signatories of Global Covenant of Mayors for Climate and Energy. More advanced versions (for planning and monitoring) available to ICLEI members.
Local Greenhouse Gas Inventory Tool	U.S. EPA	2018 (update)	Free/public	Interactive spreadsheet tool which can calculate GHG emissions for many sectors, including transportation. Two separate modules: one for community-wide inventories, the other for inventories of local Government operations only. The tool is scalable to larger-scale community focus or individual areas within a city.	Not designed for State agency use, but useful to local stakeholders who may provide local GHG emissions to regional or statewide GHG inventories.
PATHWAYS	E3	2008 + updates	Proprietary, customized applications	This model is a platform for evaluating economy-wide GHG emissions through 2050 and identifying and evaluating GHG reduction measures from transportation, buildings, industry, electricity, and other sectors. It is a "stock rollover" model that considers realistic timing of investments to replace appliances, vehicles, buildings, and other infrastructure.	Good for inventory and forecast scenario development. Will need "off-model" assessment of impacts such as VMT reduction and EV market penetration.
Simplified GHG Emissions Calculator	U.S. EPA	2018 (update)	Free/public	Simplified calculation tool to help small businesses and low-emitting organizations estimate and inventory annual GHG emissions. Users can calculate direct and indirect emissions from all sources through the input of activity data.	Not directed at DOTs or metropolitan planning organizations (MPO) or sophisticated enough for their level of analysis but may be helpful tool to make small contractors/subcontractors aware of and could make broader GHG analysis easier.
Tools to Evaluate Agency Construction, Maintenance, and Operations Activities					
Infrastructure Carbon Estimator	FHWA/MnDOT	2010/2019 (update)	Free/public	A spreadsheet tool that estimates life-cycle energy and greenhouse gas emissions from the construction and maintenance of transportation facilities. Based on a nationwide database of construction bid documents, data collected from State DOTs, and consultations with transportation engineers and life-cycle analysis experts.	Requires limited data inputs and is designed to inform planning and pre-engineering analysis for roadways, facilities, and bridges. Only gives an approximate emissions value as it does not ask for detailed inputs.
Pavement Life-cycle Assessment Tool (PaLATE)	UC Berkeley	2013	Free/public	Spreadsheet-based tool which calculates environmental and economic effects of pavement and road construction. Users input initial designs, initial construction material, maintenance material and processes, equipment, and cost for a project. Tool provides outputs of energy consumption, CO_2 emissions, and other pollutant emissions and resource consumption.	A tool for performing detailed calculations of GHG emissions from various pavement and road construction approaches.
Greenhouse-Gas Assessment Spreadsheet for Capital Projects (GASCAP)	Rutgers University for New Jersey DOT	2014	Free/public	Microsoft Excel based spreadsheet tool that provides estimates of life-cycle GHG emissions for many of the different components of a transportation construction project, as well as for maintenance activities.	The primary modules provide estimates of embodied emissions associated with a wide range of materials, construction equipment used on a project site, emissions associated with project mobilization, traffic disruption based on how the project is staged, and life-cycle maintenance over the lifetime of the project. Other module2014s include procedures for using recycled materials, induced travel effects, and rail capital projects.
Inventory of Carbon and Energy (ICE)	Circular Ecology	2005	Free from developer	Database tool providing full life-cycle energy consumption for materials used in construction or buildings.	Useful resource for understanding indirect energy (and emissions) from materials used by DOTs.

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Waste Reduction Model (WARM)	U.S. EPA	2016	Free/public	Spreadsheet-based tool which calculates individual/total GHG emissions and savings of various waste management scenarios from a current baseline level. The model calculates emissions and energy across a wide range of material types commonly found in municipal solid waste. Evaluates various practices, including source reduction, recycling, combustion, composting, anaerobic digestion and landfilling.	Could be used to evaluate State DOT waste and materials management activities (e.g., associated with construction activities). Materials in tool include concrete, asphalt concrete, lumber, metal products, plastic goods, and others. WARM considers energy and emissions consumed over the life-cycle of the material, not only disposal-related impacts.
U.S. Environmentally Extended Input-Output Model (USEEIO)	U.S. EPA	Ongoing	Free/public	An open-source modeling framework that can be used with the openLCA to identify opportunities to reduce negative environmental and social impacts of various goods and services. It is built using a technique from life-cycle assessment that combines industry economic data with data on environmental releases and resources used.	A State-specific version of the overall USEEIO model can be developed (EPA has been working with Georgia since 2014) which is used to assess life-cycle impacts of goods and services produced or consumed by a State. State DOTs can use the USEEIO model with project or organizational-level budget documentation to assess related supply chain impacts.
Smart Location Calculator	U.S. EPA	2017	Free/public	Simple spreadsheet tool estimating workplace location's effect on worker commuting patterns. Analyzes workplace location and scores on a series of indicators including worker commute mode-share, vehicle-miles traveled, and workplace accessibility via transit. Gives emissions associated with a worker's VMT for the site compared to the metro area average and comparable locations.	Could be used by a DOT to evaluate GHG implications of alternative facility locations, or to support local land use planning.
Construction Carbon Calculator G4C	Good Company		Proprietary	Tool to calculate carbon emissions for heavy construction and pavements.	Could be used by a DOT to evaluate carbon footprint of construction activities and materials.
General GHG, Energy, and VMT Reduction Strategy Analysis Tools					
VisionEval	Oregon DOT and FHWA	Ongoing	Free/public	VisionEval is a programming framework of disaggregate strategic planning model elements that include GHG emissions functionality. VisionEval includes code that is common to four other tools listed here—EERPAT, RPAT, and RSPM – and all are based on the GreenSTEP model originally developed by Oregon DOT in 2008.	FHWA has an effort underway to improve access and documentation for the VisionEval model which should make it a more widely usable framework for scenario modeling and policy analysis addressing GHG and other outcomes, incorporating functionality of the other VisionEval family tools listed here.
Energy and Emissions Reduction Policy Analysis Tool (EERPAT)	FHWA	2016	Free/public	Based on the GreenSTEP model (part of the VisionEval framework), but with a graphical user interface and designed to serve all 50 States and published by FHWA. EERPAT uses disaggregate household-level analysis to create an integrated, State-level modeling system. It is designed specifically to evaluate strategies for reducing transportation energy consumption and GHG emissions.	Quick runtimes allow users to evaluate the impact of proposed policies on GHG emissions, vehicle miles traveled, travel delays, etc. Allows for evaluation at individual policy level or to show interactions for multiple policies.
Rapid Policy Analysis Tool (RPAT)	Strategic Highway Research Program 2 (SHRP 2)	2015	Free/public	Based on the GreenSTEP model (part of the VisionEval framework). A strategic model that conducts scenario planning to evaluate land use and transportation policies; also captures the interactions or interrelations which various individual proposed land-use or policy actions would have as a whole. In the future this tool is likely to be subsumed within VisionEval.	Allows for more detailed evaluation of land use strategies and interactions than in the EERPAT or RSPM model.
Regional Strategic Planning Model (RSPM)	Oregon DOT		Free/public	This tool is an offshoot of the GreenSTEP statewide GHG model (VisionEval framework) to support the preparation of metropolitan area strategic assessments and scenario plans, including GHG and other measures such as vehicle activity and congestion. In the future this tool is likely to be subsumed within VisionEval.	Planning-level tool designed for metropolitan-level application; a State DOT would use the State-level EERPAT or RPAT tools but might recommend RSPM to metropolitan agencies.
Impacts 2050	NCHRP	2014	Free/public	Part of NCHRP Report 750 (Vol. 6), a spreadsheet tool focused on demographic scenario analysis to determine the impacts of sociodemographic factors in future travel demand. Impacts 2050 integrates two elements: 1) system dynamics model that represents regional links between population, land use, employment, transport supply, and travel behavior; and 2) scenarios representing visions of possible futures.	This is not a forecasting tool as it focuses on the breadth of scope and flexibility of assumptions, rather than on short-term accuracy and spatial detail. Not a GHG model but could be useful in giving potential travel demand which can then be used in other planning processes or GHG emission strategies. Useful for considering factors such as changes in vehicle occupancy from shared mobility that may not be considered in other tools.
Trip Reduction Impacts of Mobility Management Strategies (TRIMMS)	University of South Florida	2018 (update)	Free/public	A visual basic application spreadsheet model that estimates the impacts of many different transportation demand management initiatives and also provides program cost effectiveness assessments, such as net program benefit and benefit/cost ratio analysis.	Since decreasing VMT is one of the main GHG mitigation strategies, this tool could provide useful analysis of GHG and benefit/cost of a variety of demand management actions.
SB1 Grant Programs Emissions Calculator	Caltrans	2017 (update)	Free/public	Spreadsheet-based emissions calculator for evaluating project emissions using input data on VMT, service miles, ton miles, and speeds.	One of the only tools identified that focuses on transportation project-specific emissions evaluation for multiple project types. However, requires user inputs of data such as VMT changes, so not a true forecasting tool.
CMAQ Emissions Calculator Toolkit	FHWA	Ongoing	Free/public	Excel tools to assist in calculating emissions reductions from Congestion Mitigation and Air Quality (CMAQ) projects, including bicycle/pedestrian, transit service and technology, carpooling and vanpooling, alternative fuels and vehicles, and congestion reduction and traffic flow improvements.	While CMAQ projects are primarily focused on air quality and congestion mitigation, FHWA has added GHGs as outputs to these tools. They are one of the only prepackaged tools available for estimating project-level GHGs.
CCAP Transportation Emissions Guidebook Emissions Calculator	CCAP	2007	Free/public	A basic spreadsheet tool which provides approximate emissions benefits from proposed projects and policies. Calculator has two sections: 1) Land Use, Transit and transportation demand management (TDM); and 2) Vehicle Technology and Fuels. The associated Guidebook also presents various policy briefs and a technical support appendix.	Rudimentary tool which provides a rough approximation of emissions. Data are somewhat dated.
Climate Action for Urban Sustainability (CURB)	World Bank	2017	Free/public	A toolkit designed to help guide cities through the process of planning and implementing actions to reduce energy use, save money, and cut local GHG emissions. Spreadsheet tool supports inventory/forecast development and assessment of maximum potential impact of actions. Transportation inputs include total trips and distances, mode shift, fuels, and efficiency; tool also allows input from other transportation planning models.	Multisector, aimed at cities with an international audience, and simplistic relationships, but could be useful for U.S. municipalities with DOT technical support (e.g., for scenario evaluation).

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Limited Focus/Strategy-Specific Analysis Tools					
Envision Tomorrow	Fregonese Associates Inc.	2018 (update)	Free/public	An open-access spreadsheet and geographic information system (GIS)-based scenario planning package to evaluate community growth patterns and the impact of future policy decisions on aspects of public health, fiscal resiliency and environmental sustainability. Transportation impacts are based on land use-travel demand relationships described in seven "D" factors.	Useful to support land use scenario analysis—comparing travel demand and emissions impacts of different growth patterns or land use plans.
CommunityViz	City Explained, Inc.	2018 (update)	Purchase from developer	GIS-based decision support software for regional and local planners in land use planning. Allows for scenario analysis of different land use alternatives and impacts. Can be linked to 3D visualizations.	Useful to support land use scenario analysis—comparing travel demand and emissions impacts of different growth patterns or land use plans.
UrbanFootprint	Calthorpe Analytics	2018 (update)	Subscription via developer	Web-based land use/urban planning and scenario analysis software. Has an emissions module to estimate annual emissions associated with energy use, including transportation. Module uses baseline emissions rates for GHG and other pollutant emissions, but localized rates can be input if known. Transportation impacts are based on land use-travel demand relationships described in seven "D" factors.	Useful to support land use scenario analysis—comparing travel demand and emissions impacts of different growth patterns or land use plans.
Sketch7	Sacramento Area Council of Governments	2012	Free/public	A spreadsheet and web-based GIS tool which estimates VMT based on land use and transportation characteristics. The tool predicts VMT for several situations, including a given project, the surrounding area, using a before-and-after project scenario, and compares the project scenarios to the regional VMT averages.	May be a simpler, free alternative to privately owned land use scenario planning tools, but without user support or regular updates.
Conserve by Bicycling and Walking Benefits Calculator	Florida DOT	2009	Free/public	Spreadsheet-based calculation tool that estimates for a given corridor improvement (using data input by the user) the resulting travel mode split to bicycle or walking, and also the resulting daily reductions of fuel usage, healthcare costs, and CO_2 emissions.	Project-level GHG tool specifically for bike and walk investments.
Transit Greenhouse Gas Emissions Estimator	U.S. DOT (Federal Transit Administration)	2016	Free/public	Spreadsheet-based tool for GHG emissions from construction, operations, and maintenance phases of projects across selected transit modes.	Provides a rough estimate of GHG emissions based on limited data inputs but can be used for a broad range of transit projects.
Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET)	Argonne National Lab	2017 (update)	Free/public	Spreadsheet tool evaluates environmental and economic benefits/costs of alternative fuel and advanced vehicle technology. Uses data from GREET fuel-cycle model to provide "well-to-wheel" fuel usage and GHG emissions factors. Also uses EPA MOVES data to estimate tailpipe emissions.	Useful for evaluation of alternative vehicle/fuel technologies in DOT or contractor fleets, as well as broader (community or statewide) evaluation of advanced vehicle technology policies.
Heavy-Duty Vehicle Emissions Calculator (HDVEC)	Argonne National Lab	2017	Free/public	Based on the AFLEET tool, provides comparison analysis of NO_x, particulate matter (PM), and GHG emission reductions for different commercially available alternative fuel medium-duty and heavy-duty vehicle technologies. Provides calculations for various scenarios, including old vehicle repower, scrappage, or early retirement; and clean vehicle replacement levels.	Useful for evaluation of alternative vehicle/fuel technologies in DOT or contractor fleets, as well as broader (community or statewide) evaluation of advanced vehicle technology policies.
Diesel Emissions Quantifier (DEQ)	U.S. EPA	2018 (update)	Free/public	Evaluates clean diesel projects and upgrade options for medium-heavy and heavy-duty diesel engines. Estimates baseline emissions; reduced emissions; cost-effectiveness for NO_x, $PM_{2.5}$, hydrocarbons (HC), carbon monoxide (CO) and CO_2; and PM-related health benefits.	Simple web-based program for users with little or no modeling experience. Useful for evaluation of emissions control technologies in agency or contractor fleets, as well as broader evaluation of clean vehicle technology policies.
Market Acceptance of Advanced Automotive Technologies (MA3T)	Oak Ridge National Lab	2019 (update)	Free/public	Spreadsheet-based tool with Visual Basic programming to estimate electric vehicle market uptake and consumer response to a variety of EV pricing and policy incentives. Set up for national use, but State-specific inputs can be changed.	Publicly available model that can be used for light duty EV forecasting and incentive policy evaluation.
Other Tools					
Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)	FHWA	2018 (update)	Free/public	A web-based self-evaluation tool providing voluntary best practices to improve sustainability. Covers full life-cycle of transportation services, including system planning, project planning, design, and construction. Also provides best practices focused on operations and maintenance.	Not a GHG quantification tool, but can assist DOTs with identifying, implementing, and evaluating overall sustainability efforts (including reducing GHG emissions) across all aspects of their operations.
Greenhouse Gas Equivalencies Calculator	U.S. EPA	2017 (update)	Free/public	Simplified calculator tool which helps to translate abstract or technical emissions values into useful comparisons such as annual emissions from number of cars, households, or power plants.	Could support DOT communications around GHG inventory or reduction strategies, giving the ability to create value comparisons that stakeholders and the public may more easily understand.

[1] Some tools are updated annually or on other regular intervals; the date shown in this table is the most recent as of 2019.