CENTER FOR CLEAN AIR POLICY

Part One:
Land Use, Transit & Travel Demand Management

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CCAP'S MISSION

The Center for Clean Air Policy was established in 1985 by a group of state governors to develop and promote innovative policy solutions to energy and environmental problems. From our initial work as a key player in the development of a SO_2 trading system to help control acid rain to ongoing projects that focus on market-oriented approaches to ozone, climate change, and air toxics, we have promoted the idea that sound energy and environmental policy solutions serve both environmental and economic interests. The Center has over 20 years of experience addressing climate change, air emissions, and energy policy in ways that are both efficient and effective.

The Center has been actively engaged in analyzing and advancing policies in all sectors of the economy-electricity, transportation and land-use, buildings, commercial, industrial, agriculture, and forestry-as well as cross-cutting experience in emissions trading and emissions registries. The Center uses a number of tools in its efforts to support policy development, including stakeholder dialogues and economic and policy analysis. Through carefully directed stakeholder dialogues, the Center is able to integrate technical analyses with political realities to create recommendations for policy designs that have support from multiple groups and strong prospects for implementation. The Center is also highly experienced in many of the analyses needed to inform the policy development process, including cost-effectiveness analysis, power sector modeling, and economy-wide modeling.

GUIDEBOOK OVERVIEW

States and localities have influence over a number of decisions that affect transportation emissions such as land use regulation, transportation planning, and infrastructure spending. The purpose of this guidebook is to engage state and local officials in understanding the extent to which policy decisions impact air pollution, energy use, and greenhouse gas (GHG) emissions. The CCAP Transportation Emissions Guidebook consists of two parts:

- **Part One: Land Use, Transit & Travel Demand Management**
  This first section focuses on policies related to travel demand and examines the impacts of land use and investment decisions on transportation emissions. Policies analyzed in part one include: transit-oriented development, bicycle initiatives, pay-as-you-drive insurance, light rail, comprehensive smart growth policy, etc.

- **Part Two: Vehicle Technology and Fuels**
  This section will be released in late 2005 and will focus on measures such as, feebates, hybrids, biofuels, low-rolling resistance tires, etc.

The purpose of the CCAP Transportation Emissions Guidebook is to provide basic 'rules of thumb' to calculate emissions reductions from the implementation of specific transportation and land use policies. The guidebook is a unique tool that consists of a user-friendly spreadsheet tool, or Guidebook Emissions Calculator, which enables users to quantify the emissions benefits from a variety of projects and policies, a series of policy briefs, and a technical appendix. Each of these is discussed more below.

Guidebook Emissions Calculator

The Guidebook Emissions Calculator consists of individual worksheets for all of the quantified policy briefs, a summary matrix table across measures, and documentation of emission factors used.

For Part One, the Guidebook Emissions Calculator incorporates the rules of thumb into a VMT calculation. (For Part Two, the Guidebook Emissions Calculator is based more on fuel use and direct emissions). This calculation is not meant to give an exact estimate of the VMT reductions from the policy measures; rather it presents an order of magnitude sense of potential VMT reductions. The emissions impacts are calculated from the VMT reduction estimates using on emission rates for each affected mode.

The policies analyzed within the spreadsheet tool (identifiable with the same numbering as in the report) present impacts based on default or average data on the left (coded in blue), but allow the user to enter regional specific data in the right column (coded in orange). The shaded cells represent the areas typically adjusted by users, but all assumptions can be changed. The default tables from the spreadsheet tool are also incorporated into the policy briefs in the report to give the reader a general idea of the possible reductions from each of the policies quantified.

Policy Briefs

Each part of the guidebook contains a series of policy briefs subdivided into a few key subject areas. An important point to note is that the dividing line between these subject areas is not hard and fast, rather, its purpose is to allow for a more navigable report.

Each of the policy briefs includes:

- A qualitative description including case studies, implementation issues, and key references
- A quantitative analysis including an assessment of potential air quality benefits, energy savings, and GHG reductions (note: the default data tables from the spreadsheet tool are included in the policy briefs)
- Web-links to relevant models and resources

Background (incl. Technical Appendix)
The final component of the CCAP Transportation Emissions Guidebook is the supplementary information found in the background and in the technical appendix (located together on the website under the *Background* header on the toolbar). In the background section the reader will find relevant introductory text about transportation emissions and in the technical appendix, the user will find more information on relevant models and quantitative tools that go beyond the scope of the Guidebook Emissions Calculator.

A LIVING DOCUMENT
The CCAP Transportation Emissions Guidebook places an emphasis on the integration of land use and transportation decision making, and the development of strategies that help reduce the local and regional vehicle miles traveled. The guidebook highlights recent case studies and incorporates the latest data sources whenever possible. To keep the CCAP Transportation Emissions Guidebook relevant and as useful as possible to the users, we hope to update it at regular intervals with the latest information. To accomplish this however we would greatly appreciate any feedback you, the user, may offer. If you know of a case study or a better "number" for example, please send your feedback to guidebook@ccap.org.

CCAP would like to thank the **U.S. Environmental Protection Agency**, the **U.S. Department of Transportation** and the **Surdna Foundation** for their support in the development of this guidebook.

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CCAP Transportation Emissions Guidebook: Land Use, Transit & Travel Demand Management

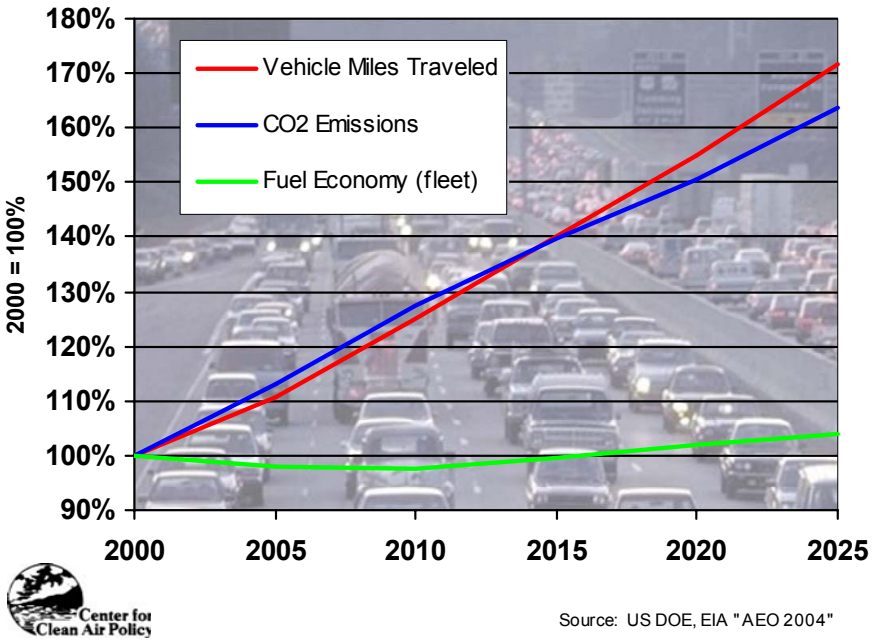
Part one of this two-part guidebook focuses on policies related to travel demand and examines the impacts of land use and investment decisions on transportation emissions. It consists of 19 policy briefs divided into four sections including:

1. Land Use
2. Transportation Alternatives
3. Fiscal Tool & Incentives
4. State and Local Programs

BACKGROUND

Transportation Emissions

Transportation emissions are the result of three main factors; vehicle technology, fuel characteristics and vehicle miles traveled (VMT). Dramatic progress in emissions control technology and fuel quality has reduced emissions over the past 30 years *per mile* for NOx, VOCs and CO (with the exception of CO_2); but rapid growth in the amount of driving is offsetting these reductions, especially in some fast-growing regions. In the case of CO_2 per vehicle, fleet-wide vehicle emission rates have been essentially stagnant since 1991 while VMT grew 25% over the same period. As seen in the figure below, long-term growth in driving is expected to outpace the CO_2 emissions benefits of vehicle technology improvements.



The new California CO_2 emission standards (if they survive legal challenge), will result in fleet-wide savings of 27% in 2030 – still not enough to keep up with VMT growth. Thus, while we must continue to make progress on vehicle technologies and fuels – and policies to implement them – we must also assess the extent to which we can mitigate growth in VMT.

Linking Land Use & VMT

Patterns of urban growth characteristic of post WWII North American development have created cities and regions that are centered upon and are dependent on the car to meet transportation needs. Located largely at the urban fringe, this pattern of suburban, or greenfield, development is typically dominated by housing-only enclaves consisting of single family homes with two-car garages and a hierarchical road system (with one way in and out). Here, land use functions are isolated (residential, commercial, employment), origins and destinations are farther apart, infrastructure design is oriented toward the automobile, and low population densities are not conducive to public transportation. With the automobile as the only realistic transportation mode for suburbanites in these sprawling communities, commuters are faced with increased driving distances and increased congestion. All told, this pattern of growth has resulted in deteriorating urban air quality and human health, increased emissions of greenhouse gases, limited transportation and housing choice, inefficient use of infrastructure, and communities that are less able to meet the needs of their residents.

Smart growth, new urbanism, community energy planning and sustainable city planning are movements that have emerged from within the fields of planning, urban design and architecture in response to concerns over the sustainability of the sprawl pattern of urban development. Smart growth initiatives at both the state and local levels have garnered increased attention due to the escalating environmental, socio-economic and human health impacts of the land use decisions that have typified North American development over the last half century.

Advocates for environmental, public health, economic and energy interests highlight the need to design communities that reduce inefficiencies in the transportation and land use planning system. The benefits range from reducing greenhouse gases that lead to global warming, improving air quality to addressing the public health concerns caused by physical inactivity and obesity. Other benefits include:

- reduced pedestrian-motor vehicle accidents, injuries, and fatalities
- decreased need for additional transportation infrastructure
- improved overall public health through more active lifestyles
- improved livability of a community
- greater mobility choices for all members of the community (i.e. seniors, children, and low-income households)
- increased property values in walkable neighborhoods
- more attractive destinations for tourists
- increased sales for local businesses

Smart growth provides a viable alternative growth strategy that can develop healthy and sustainable urban environments.

Reducing VMT Though Smarter Growth

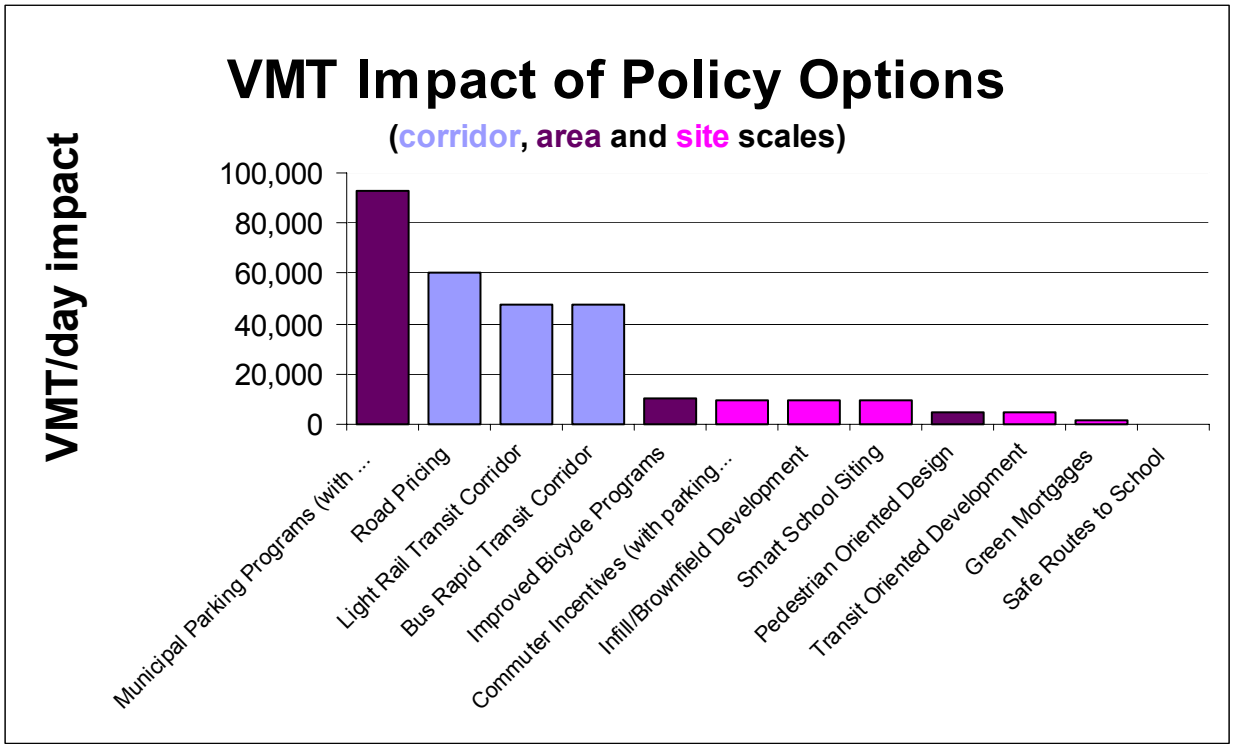
The central tenet of smart growth is the return to more compact built forms that are typically more walkable, more livable and less reliant on the automobile for daily transportation needs. Smart growth strategies place an emphasis on urban sustainability and include among others:

- concentrated activity centers
- mixed use development
- increased density near transit
- pedestrian oriented design

- interconnected travel networks
- parking management
- open space preservation

The creation of more walkable urban environments requires both a larger scale, regional approach that promotes higher densities, mixed uses and transit-oriented communities, as well as site-level urban design features that promote safety and access to local services on foot. The guidebook examines policies at both these scales.

The figure below illustrates the potential VMT/day impact of policies at the corridor, area and site scale -- 500, 000 trips/day, 100,000 trips/day, 5,000trips/day respectively-- based upon the default assumptions in the Guidebook Emissions Calculator. As evident from the graph, those policies that at the larger scale tend to have the largest impact on VMT. While this is perhaps intuitive, it points to the fact that if, for example, a municipality had a regional TOD policy rather than just working project by project, it could have a significant impact on city-wide VMT.

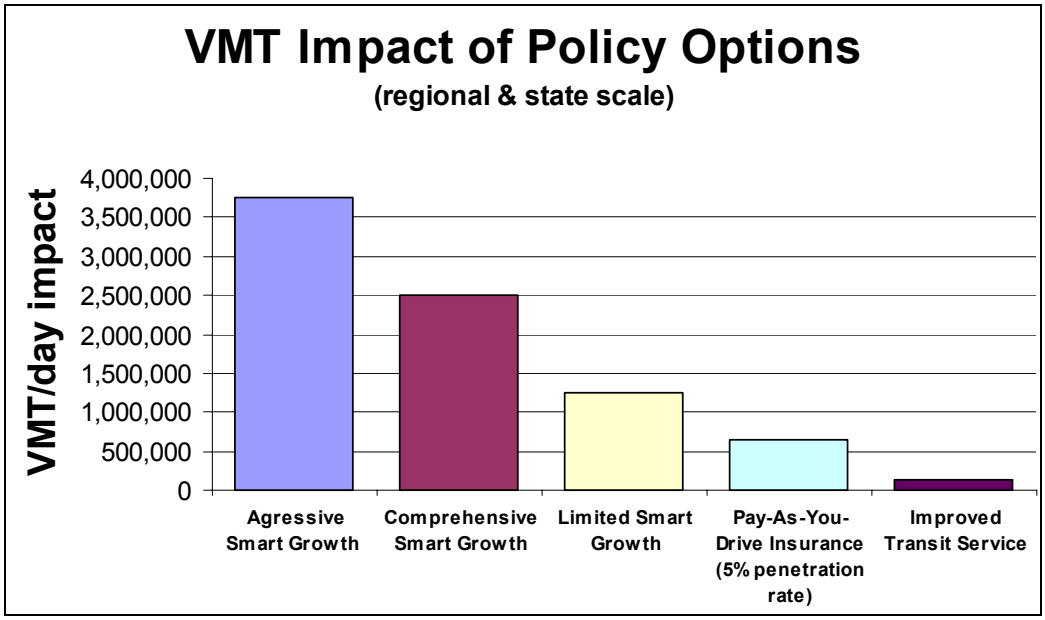


(Note: please see the "Default Matrix" in the Guidebook Emissions Calculator for more information regarding this graph)

In other words, the implementation of such smaller scale policies or strategies cannot occur in isolation. If only implemented at the site scale, smart growth approaches, such as TOD or infill/brownfield development, are not enough to curb growing rates of automobile use and subsequent transportation emissions. A balance must be achieved across urban regions enabling residents to meet employment, housing, transportation, recreational, education and commercial needs to minimize the need to drive.

Issues that affect the sustainability of growing city regions are not restricted by local boundaries. Planning at a regional scale can serve to efficiently focus development and transportation investments, preserve open spaces, and impose pollution controls in order to minimize the negative impacts of sprawling urban development. The coordination of growth across a wider geographical region avoids the simple redirection of sprawling land use patterns from one jurisdiction to the next.

Comprehensive regional smart growth planning strategies that include a implementation strategy of complementary land use, transit and travel demand management policies and programs are projected to reduce regional VMT from anywhere between 3 to 25 percent. Savings in VMT could potentially be higher when implemented with financial incentives and other complementary policies. The graph below highlights the potential VMT reduction impact of a few policy options at the larger regional and state scales.



(Note: please see the "Default Matrix" in the Guidebook Emissions Calculator for more information regarding this graph)

Implementing Smarter Growth

Implementing smart growth policies requires comprehensive approaches that can slow growth in vehicle use and associated emissions by providing numerous transportation choices with supportive land use patterns. A comprehensive regional plan developed with serious and inclusive public involvement is a fundamental first step. Without a strong implementation follow-through however, a good plan is little more than pretty maps and drawings. Strong political leadership and adequate funding are especially important to help ensure that good plans go from paper to reality. Further, the creation of regulatory bodies to insure the coordination and implementation of smart growth plans and policies can help ensure that initiatives by branches of the government do not contradict one another. Other key elements needed to successfully implement smart growth policies include:

- strong political leadership
- regional cooperation
- a comprehensive regional planning framework

- funding for efficient transportation alternatives
- targeted infrastructure spending
- incentives to redevelop the center city & first ring suburbs
- elimination of regulatory or financial policies that encourage sprawl

Implementing smart growth policies requires overcoming many barriers by using all available tools, be they fiscal, political, regulatory, technical, etc. This guidebook is meant to be one such tool. It highlights case studies, resources, implementation techniques, useful data and sample calculations figures. If communities and regions have the tools to embark on the path of smarter growth, it will allow cities to growth more efficiently, and sustainably in order to meet the challenges of and maximize the opportunities of future growth.

1.0 LAND USE

1.1 Transit-Oriented Development (TOD)

OVERVIEW

Transit Oriented Development (TOD) is becoming recognized as a viable form of growth management that addresses the needs of rapidly growing communities both large and small. As defined by the California Department of Transportation, TOD typically integrates "moderate to higher density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment and shopping opportunities designed for pedestrians without excluding the auto. TOD can be new construction or redevelopment of one or more buildings whose design and orientation facilitate transit use."[1]

TODs facilitate reduction in household automobile usage through the provision of both accessible transit alternatives and local employment and retail locations. The development of systematic TOD networks can change transportation behaviors at both local and regional scales. Analyses of the travel characteristics of California TODs conducted by Lund et al. indicate a 5.0 times greater rate of transit use for residents of TODs than those of comparable or adjacent locations. Similarly, transit use for office workers was 3.5 times greater for TODs.[2]

Local reductions in VMT of 20-30% result from increased transit use, walking and bicycling as modes of transportation. Achieving regional reductions - estimated at 5% for widespread TODs - would likely require locating new growth around multiple transit-accessible corridors.[3] Consequently, air pollution emissions and energy consumption decrease for households within TODs. Rates of greenhouse gas emissions have been shown to be 2.5 to 3.7 tons per year per household lower within TOD locations.[4,5]

The CMHC study cited early found that the most significant emissions reductions occur by changing regional location, which reduces CO_2 emissions 21 - 58%, while changing the 3-Ds along (without the context of regional access) can reduce CO_2 emissions by 15 - 50%.[6] Such savings from regional location are also seen in the well-cited Atlantic Station project (14-52%). Changing site design alone can also result in VMT savings of up to 6% (without changing mix of use, density or location).[7] (Please also see the Infill/Brownfield Brief, 1.2)

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[1] Cal Trans (2002) "Statewide Transit-Oriented Development Study Final Report": http://transitorienteddevelopment.dot.ca.gov/PDFs/Statewide%20TOD%20Study%20Final%20Report%20Sept.%2002.pdf

[2] Lund et al. (2004) "Travel Characteristics of Transit-Oriented Development in California": http://www.csupomona.edu/%7Erwwillson/tod/Pictures/TOD2.pdf

[3] A recent study by the Canadian Mortgage Housing Corporation (CMHC) quantifies how density, diversity and design elements interact across suburban, medium density and neo-traditional (urban) forms. The CMHC study provides clarity on the impact of the so-called three Ds (diversity, design and density) with and without regional emisslocation (access). The study concludes that while building in the style of an urban town center (neo-traditional) is helpful, smart growth style planning is most successful when done on a regional basis. For more information, see http://www.cmhc.ca/en/index.cfm

[4] Based on expected TOD household savings of 5,000-7,500 VMT per year. This anticipated reduction estimate is based on the Deborah Dagang and Terry Parker, "Transportation Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study", for the California Environmental Protection Agency, Air Resources Board, 1995.

[5] Cal Trans (2002) "Statewide Transit-Oriented Development Study Technical Appendices": http://transitorienteddevelopment.dot.ca.gov/PDFs/Statewide%20TOD%20Study%20APPENDIX%20Final%20Sept.%2002.pdf

[6] CMHC, *op cit.*

[7] Walters, G. et al., "Adjusting Computer Modeling Tools to Capture Effects of Smart Growth: Or

1.1 Transit-Oriented Development (TOD)

POLICY QUANTIFICATION
Transit oriented development policy effects reductions through the impact on mode split as more transportation choices become viable.

TOD: Rule of Thumb
Site-level VMT Reduction: 20-30%[8]

Quantification Methodology
The steps involved in quantifying benefits from transit-oriented development are:

1. Identify/define where development would have gone
2. Specify travel characteristics of the project area and the avoided area
   a. Data needed for each site
      - Average trip length
      - Number of trips taken
      - Mode split
   b. Sources for data and analysis
      - Travel Demand Models
      - Case Studies (see below)
      - Rules of Thumb (see box above)

3. Calculate difference in VMT, energy, emissions

   VMT Savings = $VMT_0 - VMT_p = (T_0 \times TL_0 \times M_0) - (T_p \times TL_p \times M_p)$

   Where: T = number of trips, TL = average trip length, M = Percent of trips utilizing automobiles. Subscripts denote base (0) and policy (p) cases.

   Emissions Savings = VMT Savings x Emission Factors

Note that this approach assumes zero marginal emissions impact due to increased transit utilization (i.e., no new transit vehicle trips are assumed to be needed at this scale of ridership increase).

Sample Calculation
The changes in mode split are based on typical changes between transit oriented and standard development from Dagang and Parker's 1995 study.[9] The emission savings - based on 5,000 trips to and from the development site - are illustrated in the emissions summary table.

The calculations were derived using the equation above and the following assumptions:

'Poking at the Project Like a Lab Rat',"*Transportation Research Record 1722* (2000), pp. 17-26.
[8] Based on Deborah Dagang and Terry Parker (1995), "Transportation Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study," for the California Environmental Protection Agency, Air Resources Board.
[9] Ibid.

1.1 Transit-Oriented Development (TOD)

Assumptions	Standard Development	Transit Oriented Development
Total Trips per Day	5,000	5,000
Mode Split		
Automobile	95%	**75%**
Transit/Walking/Biking	5%	**25%**
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for TOD quantification based on Dagang and Parker study referenced above

The VMT savings calculation for the TOD case is detailed below:
VMT Savings = (5,000 × 5.0 × 0.95) – (5,000 × 5.0 × 0.75) = 5,000 miles per day

Daily VMT Savings	
VMT BAU	23,750
VMT Transit-Oriented Development	18,750
Difference	5,000
Percent Savings	**21%**

Emissions and Fuel Savings

Transit Oriented Development	VMT Reduction (%)	CO2 (annual metric tons)	N2O (annual metric tons)	CH4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**21%**	717	0.051	0.153	$146,000	73,000

Transit Oriented Development	NOx	PM-10	PM-2.5	SO2	CO	VOC
Annual Emission Reductions (Tons)	2.818	0.131	0.095	0.155	42.694	5.585
Tons Per Day	0.008	0.000	0.000	0.000	0.117	0.015

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Transit oriented development can result in local and regional benefits in addition to reductions in VMT and associated air pollutant emissions. There are many economic, social and transportation benefits including:

- increased mobility options for heavily congested regions
- improved mobility for segments of the population, such as youth and the elderly, without access to cars
- enhanced public safety through the development of more pedestrian oriented communities
- increased cost effectiveness of transit investment through improved ridership
- potential reductions household transportation costs of up to $3-4,000 per household annually[10]

[10] Cal Trans (2002), *op cit.*

- preservation of agricultural and open space areas by redirecting greenfield development to urban areas
- increased local retail development and economic revitalization
- reduced public infrastructure costs through more efficient use of existing resources
- increased affordability of housing with increased densities and lower transportation costs
- rising property values and local tax revenues
- increased accessibility to housing options
- enhanced livability of communities through improvements in air quality, public health, accessibility to public spaces, commute times etc[11]

KEY ISSUES/IMPLEMENTATION

Market demand for TODs is no longer considered a barrier to implementation with the success of numerous TOD projects nationwide. TOD projects, however, continue to face many implementation challenges.[12] They include:

- lack optimal development standards and systems to coordinate development processes
- no cohesive regulatory and policy framework
- difficulty obtaining financing for mixed use developments due to concerns of private lenders, lengthy approvals processes and limited public funding in many regions
- local tax structure often promote large scale retail development over residential land uses
- poor transit design often isolates the station area from the community (i.e. limited pedestrian access and large parking facilities)
- obtaining development approvals is often slow as local zoning may be unsupportive of transit
- local community opposition based on density, traffic and parking concerns
- parking challenges impact costs, financing and public support[13]
- land aggregation is difficult, particularly, for urban and infill sites
- limited use of financial tools to (i.e., tax increment financing)
- information and expertise on implementation is limited

A variety of broad implementation strategies have been used to promote Transit Oriented Developments. They include:

- supporting TOD Planning through the transfer of federal transportation funds to local governments for TOD planning and implementation
- abatement of taxes for TODs to aid market development for higher density, mixed use communities
- transit joint development which allows transit agencies to use, sell or lease land that will help generate ridership
- direct participation of local governments in financing and building TODs

[11] Reconnecting America (2002) "Transit Oriented Development: Moving from Rhetoric to Reality": http://www.reconnectingamerica.org/pdfs/DBelzerTOD.pdf

[12] The Great American Station Foundation (2002) "Challenges to Implementing Transit-Oriented Development": http://www.reconnectingamerica.org/pdfs/BELZERPR.PDF

[13] Cal Trans (2002) "Statewide Transit-Oriented Development Study Final Report": http://transitorienteddevelopment.dot.ca.gov/PDFs/Statewide%20TOD%20Study%20Final%20Report%20Sept.%2002.pdf

1.1 Transit-Oriented Development (TOD)

CASE STUDIES

California- Recent changes to California's *Transit Village Development Planning Act* in May 2004 aimed to promote development in areas surrounding transit modes such as light rail, bus and ferry terminals. This alternation to the act allows a greater range of transit oriented developments eligibility for state transportation funding and specialized permit approval processes.
(http://www.smartgrowth.org/news/article.asp?art=4084)

Dallas, TX- Opened in 1996, the Dallas Area Rapid Transit (DART) light rail service has been a catalyst for development near transit stations. Despite limited local and regional support for TODs, mixed use developments such as Mockingbird Station, are underway at several station sites. The result has been escalating economic activity and a driving force for redevelopment in many Dallas area communities. Studies have indicated that property values near DART stations have risen 25% faster between 1996 and 2000 that those that are not transit accessible.
(http://www.apta.com/research/info/briefings/documents/dart2002.pdf)

Edmonton, Canada- The City of Edmonton is the primary developer of the Fort Road - Old Town project. The master plan governing the area aims to integrate transportation and land use initiatives to create a transit and pedestrian-oriented urban village. High quality pedestrian infrastructure around an existing LRT station is a key component of the transportation plan including creation of a landscaped median, and improved streetscape features. Commercial and retail uses will be developed at street level and medium to high density residential housing will be integrated into the neighborhood.)
(http://www.edmonton.ca/portal/server.pt/gateway/PTARGS_0_2_265_210_0_43/http%3B/CMSServer/COEWeb/infrastructure+planning+and+building/current+and+future+projects/Old+Town+Fort+Road+Redevelopment.htm)

Mountain View, CA- The city of Mountain View's commuter rail station is the focal point of "the Crossings", an 18-acre transit oriented development designed by Peter Calthorpe and developed in partnership with Caltrain. The site, formerly a shopping plaza, was transformed into a mixed use community that included 500 residential units, as well as single family, condominium and rental units in close proximity to the new Caltrain station.
(http://transitorienteddevelopment.dot.ca.gov/station/stateViewStationOverview.jsp?stationId=1)

Portland, OR- The city's growth management strategy prioritized transit supportive developments and fostered TOD development along the Metropolitan Area Express (MAX) light rail lines. The Orenco Station TOD on the Westside MAX line is a 190- acre development which, at full build out, will have 1,834 homes and a mixed use town center. Orenco station was the recipient of the National Association of Homebuilders Association Award for 1999 for the best master planned community in the United States.
(http://www.trimet.org/inside/publications/sourcebook.htm)

San Francisco, CA- The Bay Area's Metropolitan Transportation Commission is actively engaged in smart growth planning through programs that link transportation and land use decisions. The *Transportation for Livable Communities Program* was launched in 1998 and has expanded to include the *Housing Incentive Program* in 2000. These programs provide planning and capital grants to promote the development transit oriented communities.
(http://www.mtc.ca.gov/planning/smart_growth/)

Other States- TOD programs are being integrated into the planning of major transit systems across the United States, including systems in: Colorado, Florida, Georgia, Illinois, Maryland, Massachusetts, New Jersey, Ohio, Oregon, Pennsylvania, and Virginia. (http://transitorienteddevelopment.dot.ca.gov/PDFs/Statewide%20TOD%20Study%20APPENDIX%20Final%20Sept.%2002.pdf)

KEY RESOURCES & REFERENCES

California Department of Transportation- searchable database for 21 statewide TOD projects include information on stations, projects, processes photos and links to Caltrans TOD studies:
http://transitorienteddevelopment.dot.ca.gov/

Caltrans- "Statewide Transit Oriented Development Study- Factors for Success in California" includes links to the executive summary, final report, technical appendices and supplementary report on parking and TODs:
http://transitorienteddevelopment.dot.ca.gov/miscellaneous/StatewideTOD.htm

Envision Utah- provides information on Envision Utah's Transit-Oriented Development initiatives:
http://www.envisionutah.org/trans_land.html

Orenco Station Development- contains access to information on housing options within the transit oriented community and access to virtual tours:
http://www.orencostation.com/home.htm

Reconnecting America- Center for Transit Oriented Development provides access to resources that promote the further market development of TODs:
http://www.reconnectingamerica.org/html/TOD/index.htm

Rutgers University- Evaluation of the New Jersey Transit Village Initiative, includes access to evaluation reports and link to New Jersey Department of Transportation Transit Village webpage:
http://policy.rutgers.edu:16080/vtc/tod/

San Francisco Bay Area Rapid Transit District- "BART Transit-Oriented Development Guidelines" includes information on building and planning successful TOD projects:
http://www.bart.gov/docs/planning/TOD_Guidlines.pdf

US Environmental Protection Agency- "Our Built and Natural Environment, a Technical Review of the Interactions between Land Use, Transportation and Environmental Quality":
http://www.epa.gov/livability/pdf/built.pdf

1.2 Infill and Brownfield Development

OVERVIEW

Infill and brownfield policies attempt to guide development away from greenfield sites and city edges towards underutilized/abandoned properties within the urban core. These forms of compact urban development make use of existing infrastructure and relieve growth pressure placed on outlying areas.

Infill and brownfield development projects address local air quality and greenhouse gas concerns by reducing the number of vehicle miles traveled and allowing for easier access to transit and pedestrian facilities. US Environmental Protection Agency assessments of selected infill developments indicate significant reductions in vehicle miles traveled, VOC and NOx emissions.[14]

Conservative estimates from a survey of regional planning directors at the University of California at Berkeley's Institute of Urban and Regional Development, indicate that through infill development existing urban areas have substantial capacity for new residential development.[15] Similarly, brownfield sites have the potential to allow for significant growth within existing urban regions. It is estimated that the United States currently has between 13,000 and 450,000 of such abandoned and under utilized industrial or commercial sites.[16]

Similar to the quantification presented in the TOD brief (1.1), VMT reductions from Infill/Brownfield development greatly depends on factors such as design, density, and location relative to destinations and transit.

POLICY QUANTIFICATION

Infill and brownfield development policy effects VMT reductions by impacting mode split and trip length. Mode split shifts trips away from automobile use as more transportation choices become viable. Average trip length is reduced as housing development occurs closer to trip destinations.

Infill/Brownfield: Rule of Thumb
Site-level VMT Reduction: 15-50%[17]

Quantification Methodology

EPA provides general guidance on how to quantify benefits from land use. The steps involved in quantifying benefits from infill/brownfield development are:[18]

1. Identify/define where development would have gone without the project. Options include:
   - Assign growth to a single "greenfield" site
   - Assign growth to fastest growing parts of the region
   - Use land use model to distribute growth
   - Distribute growth based on average regional trends
2. Specify travel characteristics of the project site and the avoided site

[14] US EPA (2001a), "Comparing Methodologies to Assess Transportation and Air Quality Impacts of Brownfields and Infill Development": http://www.epa.gov/livability/pdf/comparing_methodologies.pdf
[15] US EPA (2001b), "Our Built and Natural Environments": http://www.epa.gov/smartgrowth/pdf/built.pdf
[16] Ibid.
[17] US EPA (2001c), "The Transportation and Environmental Impact of Infill versus Greenfield Development: A Comparative Case Study Analysis": http://www.epa.gov/livability/pdf/infill_greenfield.pdf
[18] US EPA (2001a), *op cit.*

- Data needed for each site
  - Average trip length
  - Number of trips taken
  - Mode split
- Sources for data and analysis
- Travel Demand Models
- Case Studies (see below)
- Rules of Thumb (see box above)

3. Calculate difference in VMT, energy, emissions

VMT Savings = $VMT_0 - VMT_p = (T_0 \times TL_0 \times M_0) - (T_p \times TL_p \times M_p)$

Where: T = number of trips, TL = average trip length, M = Percent of trips utilizing automobiles. Subscripts denote base (0) and policy (p) cases.

Emissions Savings = VMT Savings x Emission Factors

Note that this approach assumes zero marginal emissions impact due to increased transit utilization (i.e., no new transit vehicle trips are assumed to be needed at this scale of ridership increase).

Sample Calculation

The changes in mode split and trip length are based on representative changes between infill and greenfield sites as demonstrated in the quantification of the Atlantic Station project.[19] The emission savings based on 5,000 trips to and from the infill/brownfield site are illustrated in the emissions summary table. (Note this is assumed to be a smaller scale project than Atlantic Station.)

The calculations were derived using the equation above and the following assumptions:

Assumptions	Greenfield Development	Infill/Brownfield Development
Total Trips per Day	5,000	5,000
Mode Split		
Automobile	98%	**76%**
Transit/Walking/Biking	2%	**24%**
Average Automobile Trip Length	5.0	**3.9**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split and trip length for infill quantification based on Atlantic Steel case study referenced above

The VMT savings calculation for the infill/brownfield case is detailed below:
VMT Savings = (5,000 × 5.0 × 0.98) – (5,000 × 3.9 × 0.76) = 9,594 miles per day

[19] Schroeer, W. and G. Anderson (January 2000), "Transportation and Environmental Impacts of the Atlanta Steel Project," presented at the 79th Annual Meeting of the Transportation Research Board.

1.2 Infill and Brownfield Development

Daily VMT Savings	
VMT BAU	24,500
VMT Infill/Brownfield Development	14,906
Difference	9,594
Percent Savings	**39%**

Emissions and Fuel Savings

Infill/Brownfield Development	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	39%	1375	0.098	0.294	$280,151	140,075

Infill/Brownfield Development	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	5.407	0.251	0.183	0.297	81.922	10.717
Tons Per Day	0.015	0.001	0.001	0.001	0.224	0.029

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Infill development and brownfield redevelopment projects can reduce air pollutant emissions while enhancing the environmental, economic and social components of urban communities. Co-benefits attributable to such projects include:

- increased transportation choices
- improved local human and ecosystem health through brownfield redevelopment
- reduction in impacts of sprawl development through more efficient use of urban land resources
- decreased public expenditures through the use of existing infrastructure and service provisions
- lowered personal transportation costs resulting from reduced automobile reliance
- decreased exposure to traffic congestion
- enhanced walkability of communities provides for a safer urban environment
- promoting economic development and an enhanced tax base
- revitalizing downtowns and neighborhood centers[20]

KEY ISSUES/IMPLEMENTATION

Infill and brownfield projects face a variety of hurdles which often result in developers opting to undertake greenfield developments. Prior to any successful implementation, issues that are considered may include:

- physical constraints such as site contamination and poor drainage may result in increased project costs
- land is typically divided among numerous owners
- sites may be situated in less than optimal locations
- small projects must integrate well into the characteristics of the existing neighborhood
- social opposition may arise against increased densities, parking provisions, local traffic or resistance to change

20 Maryland Department of Planning (2001) "Models and Guidelines for Infill Development"

- local land use regulations may provide constraints to infill projects through building codes, parking requirements, road design and slow approval processes
- economic uncertainty is created by unclear timeframes risk associated with cleanup costs
- lack of funding for infrastructure maintenance and improvement through Capital Improvement Programs in many rural jurisdictions to support infill development

CASE STUDIES

Atlanta, GA- Atlantic Station Project: The $2 billion conversion of the former Atlantic Steel mill site in midtown Atlanta to Atlantic Station, a 138-acre mixed use community incorporating both residential and commercial uses. The project is focused on green construction and smart growth principles and has had a variety of regional transportation benefits.
(http://www.epa.gov/livability/topics/atlantic_steel.htm)
For more information on smart growth and air quality in the Atlanta region, see:
http://www.ccap.org/publications_trans.htm

Denver, CO- The site of Denver's old Stapleton Airport, located 10 minutes from the city's downtown is targeted to become "America's biggest urban infill development". The development will incorporate the compact mixed-use principles espoused by New Urbanist Developers, and will ultimately include 12,000 in coming years. The project has also made provisions for open space areas within the community, the restoration of the previously covered Westerly Creek, wildlife habitat, hiking and bicycling trails, and a linkage to the newly-created Rocky Mountain Arsenal Wildlife Refuge.
(http://www.stapletondenver.com/history/planningtoaction.asp)

Pennsauken, NJ- The Pennsauken waterfront redevelopment plan includes $1 billion in investment to create office, retail and commercial space alongside 2,650 residential units. The brownfield sites for development were identified as part of the Environmental Protection Agency Brownfields Assessment Pilot program in 2000. Future development will adhere to smart growth planning principles and will be integrated into regional light rail transit systems.
(http://www.smartgrowth.org/news/article.asp?art=4111&State=31&res=1024)

Portland, OR- The city's Belmont Dairy site is an example of a mixed use urban infill project that has fostered reinvestment in the local community. The contaminated industrial site was abandoned in the early 1990s and has since been transformed into a mixed use community that includes market rate and affordable housing options, as well as street level retail access. The site provides easy access to transit as well as design features to promote walking and cycling alternatives.
(http://www.epa.gov/livability/pdf/density.pdf)

Montreal, Canada- Canadian Pacific Railway's Angus Shops location in Montreal underwent a transformation from a heavily contaminated industrial complex, to a mixed used residential, commercial and industrial community. The redevelopment project resulted in nearly $400 million in private investment locally, the reintegration of the site with the surrounding communities, and increased municipal tax revenues by over $2.19 million annually.
(http://www.macleans.ca/topstories/environment/article.jsp?content=20030811_63706_63706)

1.2 Infill and Brownfield Development

KEY RESOURCES & REFERENCES

Association of Bay Area Governments- Theory in Action, smart growth case studies from the San Francisco Bay Area:
http://www.abag.ca.gov/planning/theoryia/

Atlantic Station Live Work Play- provides information on the Atlantic Station development, the vision for the site, its history and the environmental benefits of the redevelopment project:
http://www.atlanticstation.com/infocenter/default.asp

Local Government Commission- "Creating Great Neighborhoods, Density in your Community" is a report highlighting the benefits of increased density for community development, infill and brownfield case studies and challenges in designing for density:
http://www.epa.gov/livability/pdf/density.pdf

National Association of Local Government Environment Professionals- "Unlocking Brownfields: Keys to community Revitalization", a report which identifies key components to successful brownfields revitalization programs:
http://www.nalgep.org/ewebeditpro/items/O93F4460.pdf

National Roundtable on Environment and Economy- Canada's national brownfield redevelopment strategy provides access to information on Canadian initiatives and documents:
http://www.nrtee-trnee.ca/eng/programs/Current_Programs/Brownfields_Strategy/Brownfields_Strategy_e.htm

Northeast-Midwest Institute Congress for New Urbanism- Links to chapters of the "NEMW Strategies for successful Infill Development" document:
http://www.nemw.org/infillbook.htm

US Environmental Protection Agency- "Comparing Methodologies to assess transportation and air quality impacts of brownfields and infill":
http://www.epa.gov/livability/pdf/comparing_methodologies.pdf

US Environmental Protection Agency – "Getting to Smart Growth" volumes one and two, include a wide range of policy options for smart growth planning including options for infill development:
http://www.epa.gov/smartgrowth/getting_to_sg2.htm

US Environmental Protection Agency- "Redeveloping Brownfields with Federal Transportation Funding": http://smartgrowth.org/pdf/brownfields_tea21.pdf

US Environmental Protection Agency- "Transportation and Environmental Impacts of Infill versus Greenfield Development, a Comparative Case Study Analysis":
http://www.epa.gov/livability/pdf/infill_greenfield.pdf

1.3 Pedestrian-Oriented Design

OVERVIEW

Pedestrian-oriented design (also known as New Urbanism, Neo-Traditional Design and Traditional Neighborhood development) integrates both smart growth planning and urban design principles in order to improve the pedestrian environment by making walking easier, safer and more attractive. The creation of more walkable urban environments requires both larger scale planning efforts to promote higher density, mixed use and transit-oriented communities, and urban design features that promote safety and access to local services on foot.[21]

Increasing the walkability of neighborhoods is a central feature of smart growth planning. One of the many positive outcomes of this design attribute is the reduction of VMT for short trips. This VMT savings can result in to reductions in criteria air pollutant emissions and local contributions to greenhouse gas emissions.

Analysis conducted in Portland Oregon through the Land Use Transportation and Air Quality (LUTRAQ) project indicated that vehicle miles traveled for households in highly pedestrian friendly environments were less than half that of households in pedestrian hostile neighborhoods. The LUTRAQ analysis suggests that the adoption of pedestrian-oriented design features would result in a 10% decline in local VMT per household.[22]

Elements of pedestrian-oriented design features include:

- compact and street oriented mixed-use communities
- interconnected street network
- short to medium length blocks with sidewalks of appropriate width and continuity
- narrower roadways
- accessibility to transit including safe transit facilities and waiting areas
- safe pedestrian crossings, traffic calming measures and buffers
- parks, public spaces, street furniture and attractive design features
- integration of trees into the streetscape[23]

POLICY QUANTIFICATION

Pedestrian friendly development effects reductions by impacting mode split. Mode split shifts away from automobile use as transportation choices such as walking and biking become viable.

Pedestrian Oriented Design: Rule of Thumb
Site-level VMT Reduction: 1-10%[24]

Sample Calculation

The changes in mode split are based on case study evidence of the impact of pedestrian-oriented design on mode choice. The emission savings based on 100,000 trips originated in the pedestrian-oriented design area.

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[21] SANDAG (2002) "SANDAG Model Pedestrian Guidelines": http://www.ampo.org/mpo_issues/best_practices/SANDAGPed.pdf

[22] 1000 Friends of Oregon (1997) "Making the Connections: A Summary of the LUTRAQ Project": http://www.friends.org/goods/pdfs/vol7/change.pdf

[23] US EPA "Pedestrian and Transit-Friendly Design": http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf

[24] Bounded by LUTRAQ 10% estimate

1.3 Pedestrian-Oriented Design

The calculations were derived using the following assumptions:

Assumptions	Base Case	Pedestrian Oriented Design
Total Trips per Day	100,000	100,000
Mode Split		
Automobile	95%	**90%**
Transit/Walking/Biking	5%	**10%**
Average Automobile Trip Length	5.0	**5.2**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for pedestrian design quantification based on LUTRAQ case study referenced above

Note that average automobile trip length increases in the policy case as the shorter vehicle trips are avoided in favor of pedestrian trips.

The VMT savings calculation for the pedestrian oriented design case is detailed below:

VMT Savings = (100,000 × 5.0 × 0.95) – (100,000 × 5.2 × 0.90) = 5,000 miles per day

Daily VMT Savings	
VMT BAU	475,000
VMT Pedestrian-Oriented Development	470,000
Difference	5,000
Percent Savings	**1%**

Emissions and Fuel Savings

Pedestrian Oriented Design	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**1%**	717	0.051	0.153	$146,000	73,000

Pedestrian Oriented Design	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	2.818	0.131	0.095	0.155	42.694	5.585
Tons Per Day	0.008	0.000	0.000	0.000	0.117	0.015

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Designing communities to provide a safe and desirable environment for pedestrians can have a wide variety of benefits that are recognized by members of both the transportation and public health communities. In general, the ability of people to walk within their communities can be viewed as a quality of life measure. Some of the potential benefits of pedestrian-oriented design include:

- reduced pedestrian-motor vehicle accidents, injuries and fatalities
- decreased need for additional transportation infrastructure (e.g., roads and parking lots)
- increased rates of walking within a community improve overall public health though more active lifestyles

- improved livability of a community
- greater mobility choices for all members of the community (e.g., seniors, children and low income households[25]

Pedestrian-oriented communities have also been seen to yield economic benefits to homebuyers, households and the community at large. The economic benefits associated with improved walkability include:

- increased property values in walkable neighborhoods
- anticipated growth in real estate values is greatest in pedestrian oriented communities
- more attractive destinations for tourists
- increased sales for local businesses[26]

KEY ISSUES/IMPLEMENTATION

The successful development of pedestrian oriented communities requires an emphasis on policy development and transportation and land use planning that are supportive of pedestrian initiatives. Planning and policy activities that will assist in the implementation of pedestrian projects include:

- developing state, regional and local pedestrian plans
- conducting multimodal accessibility studies and corridor/site specific studies
- developing greenway and open space plans
- revising policies to promote pedestrian safety and alternative modes of transportation
- including pedestrian considerations in all transportation improvement studies as standard operating procedures for state, local and federal governments
- ensuring co-ordination of city departments to ensure effective implementation of pedestrian plans i.e. public works and environmental services
- ensure zoning and design standards provide for the inclusion of pedestrian facilities
- updating motor vehicle codes to support pedestrian safety[27]

CASE STUDIES

Asheville, NC- Located on the site of the former Gerber baby food factory, this example of infill development in Asheville will provide residences for 1,500 people as well as eventually 230,000 square feet of office and retail space. The "urban village" is an attempt to provide all the necessities of downtown living without the need for automobile use. The city council created an "urban village" zoning district as part of a development ordinance to encourage smart growth.
(http://www.smartgrowth.org/news/article.asp?art=4113&State=34)

Portland, OR- In 1998, Portland was one of the first urban areas to adopt a comprehensive pedestrian plan to guide policies, develop projects and set priorities to promote walking in the city. The pedestrian master plan includes detailed design guidance for project implementation and portions of the plan were incorporated into the region's transportation system plan.

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[25]Mid-America Regional Council (1998) "Creating Walkable Communities: A Guide for Local Governments": http://www.bikewalk.org/assets/pdf/Creating_Walkable_Communities.pdf
[26]Local Government Commission (2001) "The Economic Benefits of Walkable Communities": http://www.lgc.org/freepub/PDF/Land_Use/focus/walk_to_money.pdf
[27]Pedestrian and Bicycle Information Center: http://www.walkinginfo.org/pp/index.htm

(http://www.trans.ci.portland.or.us/Plans/PedestrianMasterPlan/default.htm)

Rockville, MD- King Farm development located in suburban Maryland is a pedestrian oriented community that is within walking distance of Rockville's Metro transit station. Walking is facilitated through the integration of parks and open spaces into a street grid that incorporates wide sidewalks and pedestrian friendly design techniques. King Farm includes a variety of residential housing options, a retail village center, commercial developments, a community center, as well as a school that has been proposed for the site. The community design is based on new urbanist principles and aims to encourage walking and healthy living.
(http://www.kingfarm.com/vcmain.html)

KEY RESOURCES & REFERENCES

Active Living by Design- a national program aimed at developing innovative approaches to increase physical activity through community design, public policies and communications strategies:
http://www.activelivingbydesign.org/

Federal Highway Administration- The "Bicycle and Pedestrian Program" and the course on "Bicycle and Pedestrian Mobility", provide access to FHWA guidance on pedestrian design, planning and safety and links to a wide range of federal government pedestrian resources:
http://www.fhwa.dot.gov/environment/bikeped/index.htm
http://safety.fhwa.dot.gov/pedbike/univcourse/swtoc.htm

Local Government Commission- provides information on transportation related issues in California including bike and pedestrian design, health and physical activity and street design:
http://www.lgc.org/transportation/bike.html

Local Government Commission- "Why People Don't Walk and What City Planners Can Do About It", is a fact sheet that illustrates barriers and solutions to create walkable communities:
http://www.lgc.org/freepub/PDF/Land_Use/focus/plan_to_walk.pdf

National Center for Bicycling and Walking- "Pedestrian Facilities Reference Guide" provides information on a rage of design features and solutions to improve pedestrian usage:
http://www.bikewalk.org/walking/design_guide/pedestrian_design_guide_index.htm

Pedestrian and Bicycle Information Center- information on pedestrian issues, planning, safety, design guidelines, US case studies and the community walkability checklist:
http://www.walkinginfo.org/

San Diego Area of Governments- "Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region", provides a detailed discussion of design considerations for walkable communities including site design, and community and transportation planning:
http://www.ampo.org/mpo_issues/best_practices/SANDAGPed.pdf

1.3 Pedestrian-Oriented Design

Surface Transportation Policy Project- "Aging Americans: Stranded Without Options", discusses the issues that will affect the growing number of seniors aging in auto dependent communities:
http://www.smartgrowthamerica.com/agingmaterials/Aging_final.pdf

US Environmental Protection Agency- "Pedestrian and Transit-Friendly Design: A primer for Smart Growth" illustrates urban design features outlined by the Florida DOT as supportive of smart growth:
http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf

Walkable Communities Inc.-"Building Communities with Transportation" outlines key principles to building healthy communities:
http://www.walkable.org/trbpaper.pdf

Walkable Communities Inc.- images depicting exemplary to poor levels of quality for various features of walkable communities:
http://www.walkable.org/images/1_LOQWalking.jpg

1.4 Smart School Siting

OVERVIEW

Smart school siting policies are aimed at the retention of existing schools, or the construction of new schools within established communities. These policies can refocus development within existing urban areas and reduce the trend towards sprawling suburban regions fueled by the development of large schools at the urban edge.[28] Reinvestment in existing local schools with pedestrian and bicycle access can result in greater accessibility for students and parents without the need for a motor vehicle.

Policies that promote the development and reuse of smaller local schools can have a significant impact on local growth patterns and improvements in air quality. Through the changes in VMT attributed to more walkable schools, reductions can be achieved in greenhouse gas emissions and criteria pollutants. According to a recent analysis by the U.S. Environmental Protection Agency, reinvestment in neighborhood schools could achieve emissions reductions of at least 15% by altering the length and frequency of auto trips to and from school.[29]

W. Cecil Steward, Dean Emeritus of the College of Architecture at the University of Nebraska indicates that "the public school system is the most influential planning entity, either public or private, promoting the prototypical sprawl pattern of American cities."[30] Several mechanisms can facilitate smart school development including:

- removal of large minimum acreage requirements for new schools
- adjusting funding formulas to favor renovation of existing sites over new school developments
- facilitation of coordinated school planning practices with those of community and state level planning bodies[31]

POLICY QUANTIFICATION

Policy guiding school siting effects reductions through the impact on mode split and trip length. Mode split shifts away from automobile use as more transportation choices become viable. Average trip length is reduced as housing and schools are located closer to one another.

School Siting: Rule of Thumb
Site-level VMT Reduction: 15-50%[32]

Quantification Methodology

EPA discusses quantification methods in their study: "Travel and Environmental Implications of School Siting" The multiple steps involved in quantifying benefits from school siting policy are:

1. Identify alternate school siting locations
2. Specify travel characteristics of the project site and the avoided site

[28] Smart Growth America: http://www.smartgrowthamerica.org/children.html
29 US EPA (2003) "Travel and Environmental Implications of School Siting": http://www.epa.gov/livability/school_travel.htm
[30] The National Trust for Historic Preservation: http://www.nationaltrust.org/issues/schoolsRpt.pdf
[31] Ibid.
[32] The low end of the range is based on the assumptions in the above referenced EPA study which hold trip length constant, whereas the upper range adds in representative changes in trip length.

a. Data needed for each site
   - Average trip length
   - Number of trips taken
   - Mode split
b. Sources for data and analysis
c. Case Studies (see below)
d. Rules of Thumb (see box above)

3. Calculate difference in VMT, energy, emissions

VMT Savings = $VMT_0 - VMT_p = (T_0 \times TL_0 \times M_0) - (T_p \times TL_p \times M_p)$

Where: T = number of trips, TL = average trip length, M = Percent of trips utilizing automobiles. Subscripts denote base (0) and policy (p) cases.

Emissions Savings = VMT Savings x Emission Factors

Sample Calculation

The changes in mode split and trip length are based on representative modeled changes between infill and greenfield school sites. The emission savings based on 5,000 daily trips to and from the school site are illustrated in the emissions summary table.

The calculations were derived using the equation above and the following assumptions:

Assumptions	Urban-Edge Siting	Smart School Siting
Total Trips per Day	5,000	5,000
Mode Split-Bus	50%	50%
Mode Split-Automobile	46%	**39%**
Mode Split-Transit/Walking/Biking	4%	**11%**
Average Automobile Trip Length	7.0	**3.5**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split and trip length for school siting quantification based on EPA case study referenced above

The VMT savings calculation for the smart school siting case is detailed below:
VMT Savings = (5,000 × 7.0 × 0.46) – (5,000 × 3.5 × 0.39) = 9,240 miles per day

Daily VMT Savings	
VMT BAU	16,118
VMT Smart School Siting	6,878
Difference	9,240
Percent Savings	**57%**

1.4 Smart School Siting

Emissions and Fuel Savings

Smart School Siting	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	57%	1324	0.094	0.283	$269,808	134,904

Smart School Siting	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	5.207	0.242	0.176	0.286	78.898	10.321
Tons Per Day	0.014	0.001	0.000	0.001	0.216	0.028

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Smart growth and education reform advocates identify smart school siting initiatives as integral to the future environmental and social development of communities. Such policies would lead to a reduction in vehicle miles associated with school travel, and would aid in the alleviation of peak period traffic congestion.[33] Other benefits to smart school policies may include:

- more compact, energy efficient urban communities
- improved educational achievement, increased participation in extra curricular activities, improved school security and higher levels of community and parental involvement
- health benefits for students associated with walkable schools
- provides a community focal point

KEY ISSUES/IMPLEMENTATION

State policies are an integral component of smart growth school development, however a variety of local practices can impede implementation of such policies; they include:

- insufficient funding may result in maintenance deferral, further deterioration of older schools, and increased repair costs
- lack of information exchange between school boards and the community
- advisory and planning committee members may represent the vested interests of developers, construction companies etc. and may escalate cost estimates and bias the decision making process in favor of new construction
- community belief that new buildings mean better education

CASE STUDIES

National- The Council of Educational Facilities Planners International has developed new guidelines to replace its minimum size standards for schools that let site size be determined by the programs offered and functional criteria. The *Creating Connections* guide identifies the ways in which the school site impacts educational program, walkable neighborhoods, school site selection, and provides criteria for site evaluation. (http://www.smartgrowth.org/news/article.asp?art=4304)

[33] The Funders Network (2002) "Education and Smart Growth": http://www.fundersnetwork.org/usr_doc/education_paper.pdf

1.4 Smart School Siting

Maine- State efforts to minimize sprawl includes the replacement of minimum site size requirements with maximum standards. The Maine State Office of Planning produced a document to support the policy entitled *the ABC's of School Site Selection.* (Maine Department of Education. (2000). The ABCs of school site selection. Augusta: Maine Department of Education, State Planning Office.)

Maryland- An early leader in smart growth policy, the State abandoned school acreage requirements in the 1970s, and current siting requirements under the *Public School Construction Program* include smart growth criteria to obtain state funding. Furthermore, Maryland has adopted funding formulas that direct 80% of funds towards redeveloping existing schools.
(http://www.fundersnetwork.org/usr_doc/education_paper.pdf)

New Jersey- In 2002, Governor McGreevey directed the Smart Growth Policy Council to ensure school planning initiatives adhere to smart growth and community revitalization policies. The *Educational Facilities Construction and Financing Act* integrates the activities of municipal planning boards and school district by requiring school districts to file long range facility plans with local planning boards. (see Creating Communities of Learning: Schools and Smart Growth in New Jersey at:
(http://www.nj.gov/dca/osg/resources/publications.shtml)

Other States- have addressed school siting through the removal of site standards and restrictive funding policies, including: Florida, Massachusetts, Pennsylvania, and South Carolina.

KEY RESOURCES & REFERENCES

Governing Magazine –"Edge-ucation: What compels communities to build schools in the middle of nowhere?" outlines the decisions behind large urban edge school development:
http://www.governing.com/textbook/schools.htm

Local Government Commission- "New Schools for Older Neighborhoods" a report outlining the need for community based schools and case studies which outline different strategies for redeveloping local schools:
http://www.lgc.org/freepub/PDF/Land_Use/reports/new_schools_rpt.pdf

National Trust for Historic Preservation- "Why can't Johnny walk to school?" highlights the impacts of school siting policies on urban sprawl:
http://www.nationaltrust.org/issues/schoolsRpt.pdf

National Trust for Historic Preservation- Historic Neighborhood Schools Case studies:
http://www.nationaltrust.org/issues/schools/studies.html

New Schools/Better Neighborhoods- program is integrating smart growth and small school policies to accommodate new students in the Los Angeles area:
http://www.nsbn.org/about/

New Schools/Better Neighborhoods- "A New Strategy for Building Better Neighborhoods" a report presented to the Los Angeles Community Redevelopment Agency that suggests a new redevelopment model to meet the educational needs of the city:
http://www.nsbn.org/publications/cra/cra-newstrategy.pdf

1.4 Smart School Siting

Smart Growth America- Children and Schools resource page includes information on the role of schools in communities and access to reports and state information on schools and sprawl:
http://www.smartgrowthamerica.com/children.html

US Environmental Protection Agency- "Travel and Environmental Implications of School Siting" report, assesses the impact school location can have on air emissions from school transportation:
http://www.epa.gov/livability/school_travel.htm

1.5 Permitting & Zoning Reform

OVERVIEW

Local regulations pose significant barriers to smart growth through the prohibition of mixed use and mixed income developments, and the fostering of automobile dependent forms of growth. Often regulations governing land development are outdated, as many planning statutes originated as early as the 1920s.[34]

By reforming statutes, local codes and ordinances and building codes state and local governments can facilitate the development of pedestrian oriented streets, traditional neighborhood developments, mixed uses, transit-oriented developments and improved parking design.[35] These forms of urban development focus on reducing the orientation of new and existing communities away from the car towards walking, bicycling and public transit. As a result, emissions of criteria air pollutants and greenhouse gases decline due to reductions in local VMT.

The types of permitting and zoning reforms that reflect smart growth principles vary widely, some of which include:

- traditional neighborhood development codes[36]
- form-based zoning[37]
- live /work and mixed use codes
- transit area codes
- design regulations
- reduced parking requirements
- streamlined development approval process for smart growth projects
- performance criteria standards replacing zoning regulations

CO-BENEFITS

Undertaking initiatives to reform land use regulations and encouraging the implementation of smart growth projects, can result in benefits to the community beyond air quality improvements, these can include:

- increased walkability of communities
- creation of livable neighborhoods for aging populations[38]
- higher levels of daily physical activity
- decreased municipal infrastructure costs
- decreased exposure to congestion levels
- increased accessibility to a range of housing choices
- improved transportation choice
- greater diversity in urban design

KEY ISSUES/IMPLEMENTATION

Regulations governing land use must take into consideration issues of private property and public opposition to restrictive zoning policies. Local governments need to attain a successful balance between community goals and individual property rights. An overly

[34] American Planning Association (1999) "Planning Communities for the 21st Century": http://www.planning.org/growingsmart/pdf/planningcommunities21st.pdf

[35] Local Government Commission (2003) "An Executive Summary of Smart Growth Zoning Codes: A Resource Guide": http://www.lgc.org/freepub/PDF/Land_Use/sg_code_exec_summary.pdf

[36] University of Wisconsin Extension (2001) "A Model Ordinance for a Traditional Neighborhood Development": http://www.wisc.edu/urpl/people/ohm/projects/tndord.pdf

[37] American Planning Association: http://www.planning.org/conferencecoverage/2004/tuesday/formbased.htm

[38] National Governors Association: http://www.subnet.nga.org/ci/5-top20.html

prescriptive approach can restrict organic growth processes. Zoning regulations should be grounded in the government interest in advancing public health and general welfare and not simply in aesthetics.[39]

CASE STUDIES

California- In July 2004 Assembly Bill 1268 was signed into law allowing for form-based zoning in California. Form-based zoning differs from conventional zoning in that it includes a more general description of how an area should look, allowing for more flexibility to mix residential, commercial and retail uses. The current wording of the statute does not encourage mixed use development or urban form considerations in land use planning. This has resulted in the separation of land uses in most cities across the state. Although the use of form based zoning is not required by law it is already adopted in some California cities including Sonoma, Palo Alto, Hercules, Ventura and Petaluma.
(http://fisherandhall.com/OPR/WhitePaper.pdf)

Cranberry, PA- Planning officials have introduced three new zoning districts for a primarily rural section of the township to address issues associated with traditional suburban development. The districts include a Town Center district, Traditional Neighborhood Development (TND) district, and a Mixed-Use Corridor district. The Town Center and TND areas will include pedestrian-oriented street design, mixed housing styles integrate into predominantly commercial and retail zones.
(http://www.smartgrowth.org/news/article.asp?art=4343)

Maryland- Maryland's Smart Codes Program is comprised of two initiatives, the Maryland Building Rehabilitation Code Program and the Models and Guidelines Program for Infill and Smart Neighborhood Development. The Maryland Building Rehabilitation Code streamlines often confusing and restrictive renovation regulations encouraging rehabilitation of existing buildings. The Maryland Department of Planning released two reports in 2001 outlining guidelines for mixed-use compact neighborhoods and infill development. These documents are intended to assist local governments in addressing restrictive zoning and building codes that serve as disincentives more compact development. Incentives for infill development will be offered to communities that adopt the model codes.
(http://www.mdp.state.md.us/mgs/infill/InfillFinal_1.pdf)
(http://www.dhcd.state.md.us/Website/programs/smartcodes/smartcodes.aspx)

New Jersey - The New Jersey Housing and Mortgage Finance Agency's "Upstairs, Downtown" program provides below market-rate mortgage funds to support property owners to create and maintain second story residential units above commercial uses in downtown locations. The program objective is to help municipalities and small businesses revive the mercantile and housing potential of main-street and neighborhood commercial areas.
(http://www.state.nj.us/uccguide/hmfa.html)

Toronto, Ontario- In 1996 the city undertook the redevelopment of lands zoned for heavy industrial uses in the city's downtown that had suffered due to the decline in the local manufacturing sector. The plan focused on increasing the flexibility of land use in the area and replaced the traditional zoning with a system based on built form. Zoning amendments included Reinvestment Area zoning which permitted a wide variety of land uses and new building form regulations. The result is the development of a vibrant mixed-use district

[39] American Planning Association: http://www.planning.org/PEL/oct01comm.htm

which will add over 7,000 housing units to the area and 321,000 square feet of commercial space upon the completion of currently planned projects.
(http://www.cmhc-schl.gc.ca/en/imquaf/hehosu/sucopl/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=64617)

Wisconsin- The state's smart growth legislation enacted in 1999 required communities of over 12,500 people to adopt a Traditional Neighborhood Development (TND) ordinance, to help facilitate the approval of such projects. The law required the development of a model TND ordinance which was approved by the state legislature in 2001. As of 2002 41 of 57 communities developed or were in the process of developing TND ordinances. Cities such as Milwaukee revised their entire zoning code to conform with the smart growth legislation, in order to promote infill development.
(http://www.1000friendsofwisconsin.com/new/tnd/)

KEY RESOURCES & REFERENCES

American Planning Association- an overview of Enabling Legislation for Traditional Neighborhood Development Regulations from the 2001 APA National Planning Conference:
http://www.asu.edu/caed/proceedings01/SITOW/sitow.htm

American Planning Association- a summary of "Growing Smart Legislative Guidebook: Model Statutes for Planning and the Management of Change" is available online and includes tools available to help state and local governments reform planning and zoning legislation:
http://www.planning.org/growingsmart/summary.htm

Congress for New Urbanism- this site provides access to resources on new urbanism including a catalogue of smart growth model codes, state building codes, state enabling legislation and local regulations from across the United States:
http://www.cnu.org/
http://www.cnu.org/pdf/code_catalog_8-1-01.pdf

Local Government Commission- "An Executive Summary of Smart Growth Zoning Codes: A Resource Guide" provides an assessment of best practices in zoning codes to address issues such as traditional neighborhood development and transit oriented development:
http://www.lgc.org/freepub/PDF/Land_Use/sg_code_exec_summary.pdf

Maryland Department of Planning- "Managing Maryland's Growth: Smart Neighborhoods", a review of state initiatives and Smart Neighborhood Ordinances:
http://www.mdp.state.md.us/pdf/smartneighborhoods.pdf

University of Wisconsin Extension- provides an example of "A Model Ordinance for a Traditional Neighborhood Development" was adopted by the Wisconsin State Legislature in 2001:
http://www.wisc.edu/urpl/people/ohm/projects/tndord.pdf

US Department of Energy- the Smart Communities Network website provides examples of Smart Land Use Codes/Ordinances that have been adopted my state and local governments:
http://www.sustainable.doe.gov/landuse/lucodtoc.shtml

1.5 Permitting & Zoning Reform

West Coast Environmental Law- the report "Smart Bylaws summary" contains a review of how bylaws are used to reinforce smart growth principles using case studies from British Columbia as well as the United States:
http://www.wcel.org/issues/urban/sbg/summary.pdf

2.0 TRANSPORTATION ALTERNATIVES

2.1 Transit Service Improvements

OVERVIEW

Investment in existing transit services improves accessibility and can increase ridership levels, facilitating a reduction in the number of cars on the road, congestion levels and VMT. This results in improvements in regional air quality. In comparison to private vehicle transportation, transit generates fewer criteria pollutants per passenger mile of travel.[40]

Investments in transit include increasing existing service levels, enhancing operational characteristics and providing incentives to encourage greater transit ridership.[41] It is estimated that with each 1.0 percent growth in service levels (e.g., increased transit vehicle coverage and expanded operating hours) average ridership increases by 0.5 percent.[42] Additional improvements in comfort levels and reductions in fares also help to make transit a more attractive option.

Projects that can improve local and regional transit services include the following:[43]

- improve system performance through additional routes, coverage area, frequency of service and hours of operation
- increase efficiency through the introduction of high occupancy vehicle lanes (HOV) and BRT systems (See BRT brief)
- improve appearance and comfort levels of all transit facilities
- reduce fares
- develop more efficient payment systems
- enhance rider information availability
- design facilities for greater pedestrian and cyclist accessibility and safety
- provide facilities for both bicycle and automobile commuters e.g., bicycle locks and park and ride lots

POLICY QUANTIFICATION

Transit service improvements effect reductions by impacting mode split. Mode split shifts away from automobile use as alternative transportation choices are enhanced. Note that although there are many aspects through which to improve transit service, the rule-of-thumb guidance presents the easily quantifiable impact of increasing transit frequency in isolation from other potential transit service improvements.

Transit Service: Rule of Thumb
Increase in transit ridership: 0.5% per 1% improvement in transit frequency[44,45]

[40] Federal Highway Administration (2002) "Status of the Nation's Highways, Bridges, and Transit: 2002 Conditions and Performance Report": http://www.fhwa.dot.gov/policy/2002cpr/es16.htm
[41] US EPA Transportation Control Measures: http://yosemite.epa.gov/aa/tcmsitei.nsf/0/6ceff1095c3e96d7852565d9006b7766?OpenDocument
[42] Richard H. Pratt (2000) "Traveler Response to Transportation System Changes, Interim Handbook": http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_12.pdf
[43] Victoria Transport Policy Institute Online TDM Encyclopedia: http://www.vtpi.org/tdm/tdm47.htm
[44] Richard H. Pratt (2000), *op cit.*
[45] Note that this elasticity implies a percent increase in total ridership as opposed to percentage point increase in mode share. Thus 20% increase in transit services leads to 10% increase in transit ridership from, for example, 5% of all trips to 5.5%.

2.1 Transit Service Improvements

Simultaneous improvements in other areas of transit service will increase the effectiveness of policies otherwise implemented in isolation. Bento, et al, (2003) found that each 10% reduction in the distance between homes and the nearest transit stop reduces their automobile commute mode split by 1.6 percentage points, and reduces their total annual VMT by about 1%.[46] Kuby, Barranda and Upchurch (2004) also identify factors in the area around a suburban transit station that affect transit ridership. The study predicts that, on average, each 100 jobs leads to 2.3 daily boardings, each 100 residents to 9.3 boardings, each 100 park-and-ride spaces leads to 77 boardings and each bus to 123 boardings. These land use factors should generally be evaluated at a micro-scale (using small transport analysis zones) along a transit corridor or around a transit station.[47]

Sample Calculation

This sample calculation assumes transit frequency improvements in conjunction with additional transit service improvement measures resulting in a 10 percent increase in transit ridership. Strict implementation of the rule-of-thumb guidance (though not recommended) or any approach that significantly increases transit frequency should include estimates of emission increases from additional transit VMT. The emission savings calculation is based on a regional impact where 500,000 trips per day are originated.

The calculations were derived using the equation above and the following assumptions:

Assumptions	Base Case	Improved Transit Service
Total Trips per Day	5,000,000	5,000,000
Mode Split		
Automobile	95%	**94.5%**
Transit/Walking/Biking	5%	**5.5%**
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for improved transit service quantification based on Pratt (2000) study referenced above

The VMT savings calculation for the transit service improvement case is detailed below:

VMT Savings = (5,000,000 × 5.0 × 0.95) – (5,000,000 × 5.0 × 0.945) = 125,000 miles per day

Daily VMT Savings	
VMT BAU	23,750,000
VMT Improved Transit Service	23,625,000
Difference	125,000
Percent Savings	**0.5%**

[46] Antonio M. Bento, Maureen L. Cropper, Ahmed Mushfiq Mobarak and Katja Vinha, The Impact of Urban Spatial Structure on Travel Demand in the United States, World Bank Group Working Paper 2007, World Bank (http://econ.worldbank.org/files/24989_wps3007.pdf), 2003.

[47] Michael Kuby, Anthony Barranda and Christopher Upchurch, "Factors Influencing Light-Rail Station Boardings In The United States," Transportation Research A, Vol. 38, No. 3 (www.elsevier.com/locate/tra), March 2004, pp. 223-247.

2.1 Transit Service Improvements

Emissions and Fuel Savings

Improved Transit Service	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	1%	17914	1.278	3.833	$3,650,000	1,825,000

Improved Transit Service	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	70.446	3.274	2.381	3.869	1067.342	139.630
Tons Per Day	0.193	0.009	0.007	0.011	2.924	0.383

Note that the emissions savings presented in the table do not reflect increased emissions from transit as frequency increases are likely to be only a small part of the transit service improvement package. Evidence suggests that quality of service is more important in attracting riders than changes in fares or in quantity of service.[48]

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

The benefits of public transit improvements are felt beyond the users of the system and are a key component of creating more livable communities. The benefits of public transit typically include:[49]

- reduced exposure to traffic congestion[50]
- lower costs relative to automobile ownership
- less land allocated for roadway and parking infrastructure
- greater mobility choice
- decreased fuel consumption
- improved public health and safety[51]
- increased property values near high quality transit[52]
- enhanced environmental protection through reduction in air pollution emissions, preservation of land resources, and reduction of water pollution caused by runoff of impervious surfaces[53]

KEY ISSUES/IMPLEMENTATION

Implementation of an effective transit service improvement program should begin with a comprehensive plan that prioritizes investments across the entire service area. Elements of the investment plan should include:

- market research to learn what service improvements users and potential new users desire[54]

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[48] Taylor, B. and Fink, C. (2003) "The Factors Influencing Transit Ridership: An Analysis of the Literature," Working Paper, UCLA Institute of Transportation Studies, UCLA: http://www.uctc.net/papers/681.pdf

[49] Victoria Transport Policy Institute (2004) "Evaluating Public Transit Benefits and Costs": http://www.vtpi.org/tranben.pdf

[50] Public Transportation Partnership for Tomorrow (2004) "Critical relief for traffic congestion": http://www.publictransportation.org/pdf/congestion.pdf

[51] Canadian Urban Transit Association (2001) "Promoting Better Health Trough Public Transit Use": http://www.cutaactu.ca/pdf/BetterHealth.pdf

[52] Victoria Transport Policy Institute (2004) "Financing Transit Systems Through Value Capture": http://www.vtpi.org/smith.htm

[53] Shapiro, R. et al. (2002)"Conserving Energy and Preserving the Environment: The Role of Public Transportation": http://www.publictransportation.org/pdf/shapiro_report.pdf

- a coordinated list of projects that build on and reinforce one another
- a community-based consultation process
- identification of funding possibilities, potential partnerships and cost reduction strategies[55]

Key barriers to the implementation of comprehensive transit service improvements include:

- federal transportation funding formulae that tend to favor road improvements over transit
- state and local transportation funding that typically focus on road building
- land use planning that fosters low density development, making transit service less efficient
- local elected officials lack information on the full benefits of regional transit investments and supportive land use policies
- lack of (affordable) right of way

CASE STUDIES

National- a record number of ballot measures supporting transit were approved in the November 2004 elections. Twenty-two of twenty-eight initiatives passed with an average of 62% of voter approval.
(http://www.cfte.org/success/2004elections.asp#november)

Boston, MA- the Massachusetts Bay Transportation Authority (MTBA) has undertaken projects to expand the coverage of the existing system including the implementation of BRT, commuter rail and major station improvements.
(http://www.mbta.com/projects_underway/index.asp#)

Boulder, CO- in 1989 the city of Boulder replaced traditional bus routes with a custom service system that incorporated information collected through community meetings and market research. Citizen requests included increased service frequency, extended service hours, direct routing and a pleasant riding environment. The first Community Transit Network bus was launched on one route, the HOP which today has been expanded to six routes- HOP, SKIP, JUMP, BOUND, DASH and STAMPEDE. As a result, ridership is two and three times greater than the original bus patronage.
(http://www.ci.boulder.co.us/goboulder/index.html)
(http://www.ccap.org/publications_trans.htm)

Denver, CO- investments in the city's transit system have resulted in transit ridership growing by an average of 3% a year. Due to the provision of more efficient and frequent service levels, an estimated one quarter of employees in downtown Denver use transit daily. In addition, utilization of carpool lanes, regional light rail and bus service have exceeded projections.
(http://www.transitalliance.org/briefingbook/briefingbook_p6of20.htm)

London, United Kingdom- in 2001, Mayor Ken Livingstone announced his transport strategy that includes large scale improvements in London's bus, rail and underground services. The plan features simplified fares, a freeze in bus fares, smart cards, improved

[54] CCAP, "Transit Repositioning: A Framework for Improving the Market Position of Transit," March 2001. http://www.ccap.org/publications_trans.htm
[55] SPUR Report: "The Next Step in Muni Reform: A Citywide Plan for Transit Expansion" http://www.spur.org/documents/020101_report_01.shtm

rider information, facility improvements and major projects to enhance the future capacity of the system. Investments in public transit service support broader targets of creating a safer and more secure pedestrian environment. Recently the mayor released a £10 billion, five-year investment program to advance the city's transport system and further support advancements made under the initial transport plan.
(http://www.londontransport.co.uk/tfl/)
(http://www.tfl.gov.uk/tfl/downloads/pdf/investment/tfl-5-year-plan.pdf)

New York, NY- between 1995 and 2000 public transit passenger levels in the New York Metropolitan area grew by 31%. One contributor to this growth is New York City Transit's (NYCT) adoption of a fare policy that provides quantity discounts to riders and free transfers between bus and subway through the use of the MetroCard. Monthly, weekly and daily passes have been introduced for additional discounts for frequent users. NYCT has estimated that the average fare has declined by 22% between 1997 and 2000.[56,57]
(http://www.vtpi.org/tqtransi.pdf)

KEY RESOURCES & REFERENCES

American Public Transit Association- information on transit related issues, transit links, public transit publications and data:
http://www.apta.com/

Center for Clean Air Policy- The Center's "Transit Repositioning: A Framework for Improving the Market Position of Transit" presents six elements critical to improving the quality, image and use of public transportation: Market Research, Service Changes, Internal Initiatives, Partnerships, Promotion and Evaluation. Case study presentations on Repositioning efforts in Atlanta and Boulder are also available.[58]
http://www.ccap.org/publications_trans.htm

Intelligent Transportation Society of America- "Overview of Transit Signal Priority", provides an introductory guide to implementation issues for transit signal priority projects:
http://itsa.org/resources.nsf/Files/FinalTSPOverviewUpdated/$file/FinalTSPOverviewUpdate.pdf

Local Government Commission- The Local Index of Transit Availability is a tool used to assess transit service intensity in metropolitan areas:
http://www.lgc.org/freepub/land_use/lita/lita_manual.html

Mineta Transportation Institute- "Increasing Transit Ridership: Lessons from the Most Successful Transit Systems in the 1990":
http://transweb.sjsu.edu/publications/transitridership/TransitRidership.htm

Moving the Economy- provides information on innovative sustainable transportation choices including integrated mobility systems, traveler information and new mobility technologies:
http://www.movingtheeconomy.ca/

[56] Also see CCAP (1998), "Repositioning Transit in the Transportation Market: Case Studies":
http://www.ccap.org/publications_trans.htm
[57] Note: NYC subway fares increases in 2003 and the overall discount for fare cards declined. Fare increases in 2005 further reduced the bulk purchase discount.
[58] CCAP, "Transit Repositioning: A Framework for Improving the Market Position of Transit," March 2001.

2.1 Transit Service Improvements

Public Transportation Partnership for Tomorrow- promotes education and investment in public transit, includes links to information on local public transportation systems across the United States:
http://www.publictransportation.org

Pucher, J. - "Renaissance for Public Transit in the United States?" Addresses the growth in the United States' public transit between 1995 and 2000, focusing on improvements in New York City:
http://www.vtpi.org/tqtransi.pdf

Transit Co-operative Research Program- Report 95 chapters 9 and 12 examine transit ridership response to changes in transit scheduling, frequency and fares on urban bus and rail systems:
http://gulliver.trb.org/publications/tcrp/tcrp_rpt_95c9.pdf
http://trb.org/publications/tcrp/tcrp_rpt_95c12.pdf

Victoria Transport Policy Institute- "Evaluating Public Transit Benefits and Costs Best Practices Guidebook" describes the various impacts that are associated with transit improvements, including a comparative analysis of transit types, and methods to optimize the benefits of public transportation investments:
http://www.vtpi.org/tranben.pdf

Victoria Transport Policy Institute- "Transit Price Elasticities and Cross-Elasticities" examines their application in public transit planning:
http://www.nctr.usf.edu/jpt/pdf/JPT%207-2%20Litman.pdf

2.2 Light Rail Transit

OVERVIEW

In recent decades, Light Rail Transit (LRT) systems have undergone a resurgence in North America. With only 8 cities having operational systems in 1977, LRT now provides transit service in 24 cities as of 2003.[59] Further expansion of LRT in North America is imminent with 36 projects in planning or conceptual design phases, 15 in final design, and 22 in construction.[60] The American Public Transportation Association defines LRT, also known as a streetcar, trolley or tramway as "an electric railway with a 'light volume' traffic capacity when compared to heavy rail". Light rail may use shared or exclusive rights-of-way, high or low platform loading and multi-car trains or single cars. LRT has the flexibility to be implemented in either a corridor or on a system-wide basis. The key characteristics of light rail transit include:

- electric rail cars operated on tracks in a fixed guide-way
- location within part of a roadway or in completely separated rights-of-way
- station-to-station service
- stations located at intervals of approximately one-half mile to one and one-half miles
- presence of parking facilities and local bus services [61]

LRT produces minimal air and noise pollution and can facilitate reductions in VMT and air emissions both directly and indirectly through the substitution of automobile travel with transit and the creation of transit accessible land uses.[62] Unlike bus systems which also result in emissions reductions, LRT has the added benefit of "locking in" efficient land use patterns over time. Light rail systems have achieved some great successes. In Portland it is estimated that the MAX LRT system eliminates 18.2 million car trips each year. Ridership on new LRT systems in Dallas, Denver, Minneapolis and Salt Lake City has significantly exceeded initial projections.[63]

POLICY QUANTIFICATION

Light rail transit policy effects reductions by impacting mode split. Mode split shifts away from automobile use as more transportation choices become viable.

LRT: Rule of Thumb
Corridor-level VMT Reduction: 1-2%[64]

Sample Calculation

The changes in mode split are based on case study evidence of impact of LRT on transit ridership. The emission savings based on 500,000 trips originated in the area served by the LRT system. Note that emissions increases due to additional transit ridership are accounted for in the final emissions reductions table below.

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[59] American Public Transportation Association: http://www.apta.com/links/transit_by_mode/lightrail.cfm

[60] Transportation Research Board (2003), "9th Light Rail Transit Conference": http://www.trb.org/publications/circulars/ec058/ec058.pdf

[61] Light rail now: http://www.lightrailnow.org/

[62] Victoria Transport Policy Institute (2004), "Rail Transit In America: A Comprehensive Evaluation of Benefits, Report Summary": http://www.vtpi.org/railbensum.pdf

[63] Some critics contend that this may be a result of artificially low expectations for new transit ridership.

[64] Based on Polzin & Page (2003) "Ridership Trends of New Start Rail Projects": http://www.trb.org/publications/circulars/ec058/ec058.pdf

2.2 Light Rail Transit

The calculations were derived using the following assumptions:

Assumptions	Base Case	Light Rail Transit Network
Total Trips per Day	500,000	500,000
Mode Split		
Automobile	95%	**93%**
Transit/Walking/Biking	5%	**7%**
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for LRT quantification based on case studies referenced above

The VMT savings calculation for the LRT case is detailed below:
VMT Savings = (500,000 × 5.0 × 0.95) – (500,000 × 5.0 × 0.93) = 47,500 miles per day

Daily VMT Savings	
VMT BAU	2,375,000
VMT Light Rail Transit Network	2,327,500
Difference	47,500
Percent Savings	**2%**

Emissions and Fuel Savings

Light Rail Transit Network	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**2%**	3833	0.485	1.456	$1,387,000	693,500

Light Rail Transit Network	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	20.447	1.244	0.905	-11.431	399.587	51.869
Tons Per Day	0.056	0.003	0.002	-0.031	1.095	0.142

Note that the emissions savings presented above are based on U.S. average emissions rates for power plants. Regions with cleaner than average power plants can expect greater reductions, and those with dirtier plants can expect fewer reductions.

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

LRT provides many benefits that can be attributed to increased transit use such as:

- reducing the need for new highway and parking facility investments
- preserving livable neighborhood characteristics
- reducing exposure to traffic congestion[65]
- lower costs relative to automobile ownership
- greater mobility choice

[65] Public Transportation Partnership for Tomorrow (2004) "Critical relief for traffic congestion": http://www.publictransportation.org/pdf/congestion.pdf

- decreasing fuel consumption
- improving public health and safety[66]

LRT can also provide additional benefits to transit systems that can result in improved performance and ridership levels through:

- serving as a catalyst for economic development along transit corridors
- increased property values along corridors and around stations
- flexibility to service a variety of environments[67]
- increased average capacity per vehicle over many rapid transit and urban bus systems
- lower per-passenger operating costs compared to bus rapid transit
- improved safety over urban bus service due to the use of a fixed guide-way and reserved lanes
- provision of higher quality of service and comfort levels
- greater ability to attract riders who have the option to drive

KEY ISSUES/IMPLEMENTATION

In assessing the effectiveness of LRT systems, the comparison is often made with Bus Rapid Transit systems that were recently adopted in many cities (BRT). Although strong opinions exist in favor of each transit option LRT advocates argue that despite higher costs the system provides greater operating efficiencies for medium to high capacity corridors. Cost reductions for LRT result from:

- higher number of passengers per vehicle
- lower number of operators required
- longer life expectancies for vehicles

CASE STUDIES

Calgary, Canada- The operation of the city's LRT, the C-train, began in 1981 and currently consists of two lines, 36 stations and operates 116 vehicles. Downtown Calgary is a free fare zone, but travel outside the downtown area requires a fare. In 2001, Calgary Transit partnered with ENMAX and Vision Quest Wind electric Inc. to develop the Ride the Wind program which procures wind-generated electricity to power the C-Trains. Windmills located in Southern Alberta generate the wind-power, with the equivalent amount of power used by the C-Train sent to the main power grid. Using wind-generated power currently reduces CO_2 emissions by 26,000 tons annually.
(http://www.calgarytransit.com/html/about_ct.html)

Denver, CO- In November 2004, voters approved an increase in sales tax to pay for an expansion of the light rail service within the city of Denver. The $4.7 billion FasTracks Plan includes six new lines both LRT and regional rail, that will be added over the next 12 years. By 2025, 22% of peak hour trips in FasTracks corridors are expected to be made on transit. The region's current light rail transit system has exceeded its ridership projections by nearly 34 percent since opening in 1994. The system began with 15 stations and has expanded in recent years by adding two lines and nine stations. The existing service has positively impacted congestion in the corridor, attracting significant proportions of trips.
(http://www.lightrailnow.org/news/n_den_2004-01.htm)

[66] Canadian Urban Transit Association (2001) "Promoting Better Health Trough Public Transit Use": http://www.cutaactu.ca/pdf/BetterHealth.pdf

[67] American Public Transportation Association (2000) "This is Light Rail Transit": http://www.apta.com/research/info/online/documents/light_rail_bro.pdf

2.2 Light Rail Transit

Minneapolis, MN- The Hiawatha Light Rail line opened in June 2004, providing service between downtown Minneapolis and Fort Snelling. Completed in December 2004, the service now totals 12 miles and seventeen stations providing transit to the airport, Mall of America and Bloomington. The Hiawatha line eclipsed ridership targets with 1.4 million riders in the first 3 months, 96 percent higher than the goals set for the system. (http://www.metrotransit.org/rail/)

Portland, OR- The Tri-County Metropolitan Transportation District (TriMet) began operating the original Eastside MAX in 1986 and has subsequently opened three additional lines, the Westside Max, the Max Red Line and most recently the Interstate Max. The line additions quickly surpassed expected ridership with Westside Max exceeding its 2005 projection after less than 2 years of operation. Between 1990 and 2001 TriMet's ridership grew by 65%. This makes Portland one of the few regions in the country where transit ridership is growing faster than VMT. The Portland MAX system provides an example of how light rail can influence regional growth and land-use decisions. Investment along MAX corridors is estimated at $3 billion and includes both greenfield development and transit-oriented infill projects. The Eastside MAX, has become a catalyst for redevelopment and infill projects in downtown Portland. (http://www.trimet.org/inside/history/maxoverview.htm)

KEY RESOURCES & REFERENCES

American Public Transportation Association- U.S. Light Rail Transit System Links: http://www.apta.com/links/transit_by_mode/lightrail.cfm

American Public Transportation Association- "This is Light Rail Transit": http://www.apta.com/research/info/online/documents/light_rail_bro.pdf

Light Rail Transit Association- provides access to LRT news, technical data and world systems information: http://www.lrta.org/

Metropolitan Council (Minneapolis)- this fact sheet includes brief descriptions of the station designs used for Minneapolis's Hiawatha light rail transit: http://www.metrocouncil.org/directions/transit/Stations.pdf

Transportation Research Board- Transportation Research Circular 2003 "9th National Light Rail Conference": http://www.trb.org/publications/circulars/ec058/ec058.pdf

Travel Matters- Transit Planning Emissions Calculator provides emissions calculations for carbon dioxide and criteria pollutants generated, and allows users to assess different transit options: http://www.travelmatters.org/calculator/transit/

Victoria Transport Policy Institute- "Rail Transit in America A Comprehensive Evaluation of Benefits" provides an evaluation of rail transit benefits through an analysis of transportation system performance in major U.S. cities**:** http://www.vtpi.org/railben.pdf

2.3 Bus Rapid Transit

OVERVIEW

Bus Rapid Transit (BRT) consists of a variety of components used to enhance the level of service relative to traditional public transportation systems. BRT integrates a variety of technologies to provide public transportation services that are appropriate to the market for which they are designed. BRT can be broadly defined as "[a] permanent system of facilities, services and amenities that collectively improve the speed, reliability and identity of bus transit".[68] BRT systems provide a roadway-based rapid transit alternative that combines high levels of service, intelligent transportation systems (ITS) and low emission vehicle technologies.

The focus of BRT improvements is often beyond the buses themselves and aims to improve overall system performance. Operational systems integrate some or all of the following elements:

- *running ways*- vehicles can operate in exclusive transit-ways, HOV lanes, expressway or general traffic
- *stations*- are attractive, easily accessible and well integrated into the community
- *vehicles*- most often are rubber tired, high capacity, quiet and make use of available low emissions technologies
- *service*- is higher frequency all day service based on headway times, fewer stops and integrated with local service to reduce waiting times
- *intelligent transportation systems (ITS)*- include advanced digital technologies such as transit signaling priority and global positioning systems (GPS) used to provide real time service information
- *fare collection*- pre-boarding fare collection machines, smart cards and multiple door boarding reduce station times
- *route structure*- simple often color-coded routes provide direct rides, with fewer required transfers[69]

BRT enhances the quality of transit service available to the public, making public transportation a more attractive transportation alternative. Traveling by transit uses significantly less energy and produces less pollution per person per mile than the equivalent trip by private vehicle. There are currently more than 20 BRT systems in full operation or under development in the United States and Canada.

POLICY QUANTIFICATION

Bus rapid transit policy effects reductions by impacting mode split. Mode split shifts away from automobile use as more transportation choices become viable. BRT can be implemented regionally or on individual corridor basis. This quantification presents reductions based on implementation in a single corridor.

BRT: Rule of Thumb
Corridor-level VMT Reduction: 1-2%[70]

[68] Journal of Public Transportation (2002) : http://www.nctr.usf.edu/jpt/pdf/JPT%205-21.pdf
[69] Center for Transportation Excellence: http://www.cfte.org/trends/brt.asp#1
[70] Based on Los Angeles BRT program (2004): http://www.fta.dot.gov/documents/CBRT-DecisioMaking.pdf

2.3 Bus Rapid Transit

Sample Calculation
The changes in mode split are based on case study evidence of impact of BRT on transit ridership. The emission savings based on 500,000 trips originated in the area served by the BRT system. Note that emissions increases due to additional transit ridership are accounted for in the final emissions reductions table below.

The calculations were derived using the following assumptions:

Assumptions	Base Case	Bus Rapid Transit Corridor
Total Trips per Day	500,000	500,000
Mode Split		
Automobile	95%	**93%** ←
Transit/Walking/Biking	5%	**7%** ←
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for BRT quantification based on BRT case studies referenced above

The VMT savings calculation for the BRT case is detailed below:
VMT Savings = (500,000 × 5.0 × 0.95) – (500,000 × 5.0 × 0.93) = 47,500 miles per day

Daily VMT Savings	
VMT BAU	2,375,000
VMT Bus Rapid Transit Corridor	2,327,500
Difference	47,500
Percent Savings	**2%**

Emissions and Fuel Savings

Bus Rapid Transit Corridor	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**2%**	2285	0.485	1.456	$1,387,000	693,500

Bus Rapid Transit Corridor	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	10.784	1.244	0.877	1.453	405.590	53.059
Tons Per Day	0.030	0.003	0.002	0.004	1.111	0.145

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS
Bus rapid transit enhances transit use through the provision of a more convenient and efficient service. Increases in BRT ridership can result in social, economic and environmental benefits attributed to all public transit systems.[71] In addition, BRT provides transportation

[71] American Public Transit Association (2003)"the benefits of public transportation": http://www.apta.com/research/info/online/documents/benefits.pdf

benefits that may make it preferable to light rail or traditional bus service. The benefits attributable to BRT may include:

- lower economic and environmental costs associated with BRT than with automobile infrastructure facilities
- lower capital cost than rail projects
- reduced commute times
- increased transit ridership
- expanded transit accessibility in suburban regions that lack the density to make rail transportation an effective option
- implementation that can be quick and incremental
- fuller use of existing infrastructure through the use of pre-existing running ways
- adequate capacity for high volume transportation corridors
- enhanced system flexibility allows for a variety of service options in a range of urban and suburban environments
- easily integrated into transit and pedestrian oriented developments
- promotes development and redevelopment in station areas[72]

KEY ISSUES/IMPLEMENTATION

BRT systems are often considered an alternative to costly light rail transit (LRT) investments. LRT has substantially higher capital costs due to infrastructure requirements, particularly the need for an imbedded track structure and the purchase of light rail vehicles. This makes BRT an attractive investment option for smaller medium-sized cities, with costs ranging from 40 to 70 percent of LRT estimates.[73] In those urban areas where there may be a limited difference in potential BRT vs. LRT ridership, BRT is often a more cost effective option. Additionally, BRT can also add an element of service flexibility that facilitates use in suburban locations that LRT cannot provide with a fixed guideway system.

The effectiveness of a BRT system must be considered relative to other available transit options. The needs of the individual community will dictate whether BRT is the most appropriate alternative. The Center for Transportation Excellence has outlined several questions that should be considered in assessing the appropriateness of a BRT system,[74] they include:

- What is the goal?
- What are the current deficiencies in the system and what alternatives are available to solve them?
- Who is the system trying to attract?
- Is a large right of way acquisition a potential option?
- Are transit efforts aligned with other efforts?

The answers to these questions may indicate whether BRT is the most effective transit investment option. A clear relationship between BRT and land use and development has not been established. Furthermore, if an exclusive right of way is being considered the capital costs of BRT may be comparable to LRT.

[72] American Planning Association (2004) "BRT Planning, Features and Effectiveness": http://www.apa-tpd.org/newsletters/TPDMar2004.pdf

[73] Sislak, K.G. "Bus Rapid Transit as a Substitute for Light Rail Transit": http://www.apta.com/research/info/briefings/documents/sislak.pdf

[74] Center for Transportation Excellence: http://www.cfte.org/trends/brt.asp

2.3 Bus Rapid Transit

CASE STUDIES

Bogotá, Colombia- In 1998, Mayor Enrique Peñalosa was elected mayor of Bogotá, with a vision to reorient the city of 7 million inhabitants away from the automobile dependence responsible for air pollution, public safety and congestion problems. By 2000 the *TransMilenio* BRT began operation with 18,000 riders which grew to nearly 800,000 daily riders by 2004. Based on the successful BRT model in Curitiba, Brazil, the Bogotá system incorporates advanced technologies including smart cards for fare collection. The system is publicly and privately owned, with national and local governments funding capital investments only. TransMilenio is privately operated with 100 percent fare box recovery, and currently operates at a profit. Additions to the initial 38 kilometer route are currently under construction or in the planning phase, with a target of 85 percent of residents living within 500 meters of a station by 2015.
(http://gulliver.trb.org/publications/tcrp/tcrp90v1_cs/Bogota.pdf)
(http://www.apta.com/services/intnatl/intfocus/bogota.cfm)

Boston, MA- Operated by the Massachusetts Bay Transit Authority (MBTA), the Silver Line is a three phase advanced technology BRT system that will connect outlying communities with Boston's downtown core. Phase One of the project, completed in 2002, incorporates low emission compressed natural gas buses, dedicated transit lanes, rider-friendly stations and smart kiosks with real time scheduling information. In its first year of operation, ridership doubled from 7,600 daily passengers to over 14,000. When complete, the Silverline system will integrate with the city's 4 other rapid transit lines to provide the 65,000 daily riders easy access to the region's commute lines.
(http://gulliver.trb.org/publications/tcrp/tcrp90v1_cs/Boston.pdf)
(http://www.allaboutsilverline.com/)

Curitiba, Brazil- Curitiba, a city of 2.2 million possesses one of the most heavily used (55% of private trips), lowest cost transit systems in the world. The success of the city's transit system resulted from the integration of transportation and land use planning in the 1960s, and the development of plans conscious of future congestion, air pollution and pedestrian safety issues seen in other Brazilian cities. The BRT system serves as the focal point of the city's transit system with high efficiency vehicles, dedicated running lanes, prepaid fares and tube stations to maximize boarding efficiency. It is estimated that the introduction of BRT in 1991 resulted in a reduction of 27 million trips by automobile per year. Although Curitiba has one of the highest automobile ownership rates in Brazil, the city consumes 30 percent less fuel per capita and experiences among the lowest levels of ambient air pollution in Brazil. The city's efficient transit system makes this accomplishment possible.
(http://gulliver.trb.org/publications/tcrp/tcrp90v1_cs/Curitiba.pdf)

Los Angeles, CA- Bus rapid transit was initiated in the region as part of a Federal Transit Administration demonstration project. Beginning with two BRT corridors, the Metro Rapid program successfully met its objectives of increased ridership (38-42%), reduced passenger travel times (23-29%) and improved quality of service. The Metro Rapid system expanded to nine lines as of June 2004 and is targeted to expand to 28 lines by 2008. Phase one made use of easily identifiable low emissions Metro Rapid buses, transit priority signaling, more frequent service, station improvements and headway based scheduling to improve travel times. The second phase of the program will introduce exclusive bus lanes, higher-capacity buses, multiple door boarding, off-vehicle fare payment, a feeder bus network and land use planning.
(http://www.apta.com/research/info/briefings/documents/metrorapid_PT.pdf)

2.3 Bus Rapid Transit

KEY RESOURCES & REFERENCES

American Public Transit Association- access to information related to public transit in the United States including transit statistics, case studies, policy development and online publications:
http://www.apta.com/

Center for Transportation Excellence- BRT 101 provides the basics of BRT information including definitions, characteristics and comparisons to other modes of transportation:
http://www.cfte.org/trends/brt.asp#1

Federal Transit Association- includes information on a variety of BRT projects, resources and program evaluations:
http://www.fta.dot.gov/initiatives_tech_assistance/technology/2381_ENG_HTML.htm

Federal Transit Administration- "Characteristics of Bus Rapid Transit for Decision-Making for Decision-Making" details major elements of BRT systems, system performance, and benefits:
http://www.fta.dot.gov/documents/CBRT-DecisioMaking.pdf

Institute for Transportation and Development Policy- "Sustainable Transport: a Sourcebook for Policy Makers in Developing Cities", module 3b of the guidebook discusses Bus Rapid Transit and is one of 20 modules aimed at providing policy tools for developing cities:
http://www.itdp.org/STe/STe4/readSTe4/BRT.PDF

Journal of Public Transportation- an issue dedicated to Bus Rapid Transit:
http://www.nctr.usf.edu/jpt/pdf/JPT%205-21.pdf

National BRT Institute- provides links to a variety of BRT resources and projects including TRB/APTA powerpoint presentations**:**
http://www.nbrti.org/

Oregon Department of Transportation- "Bus Transit and Land Use: Illuminating the Interaction" examines the effect of land use, socioeconomics, and bus transit service on transit demand in Minnesota:
(http://www.nctr.usf.edu/jpt/pdf/JPT%206-4%20Johnson.pdf)

Transit Cooperative Research Program- "Report 90 Bus Rapid Transit, Volume 1: Case Studies in Bus Rapid Transit", includes an overview of the findings of fourteen North American and twelve international BRT examples:
http://gulliver.trb.org/publications/tcrp/tcrp_rpt_90v1.pdf

Transit Cooperative Research Program- "Report 90 Bus Rapid Transit, Volume 2: Implementation Guidelines", a detailed report on the technological, operational and financial components of BRT systems:
http://trb.org/publications/tcrp/tcrp_rpt_90v2.pdf

Transport for London- information on a wide range of initiatives to improve London's bus service which incorporate numerous features of BRT:
http://www.londontransport.co.uk/tfl/initiatives-projects/ip-buses.shtml

2.3 Bus Rapid Transit

United States General Accounting Office- "Bus Rapid Transit Shows Promise" provides a comparison of capital and operating costs for Light rail and BRT systems, as well as possible funding mechanisms for BRT projects:
http://www.apta.com/research/info/briefings/documents/d01984.pdf

WestStart-CalStart- a partner with the Federal Transit Administration, the site provides information on advanced transportation technologies in relation to Bus Rapid Transit:
http://www.calstart.org/programs/brt/

WestStart-CalStart- "Vehicle Catalog: a Compendium of Vehicles for Bus Rapid Transit Service" contains a summary of BRT vehicles in production by international and national manufacturers:
http://www.gobrt.org/vehiclecatalog.pdf

2.4 Bicycle Initiatives

OVERVIEW

Comprehensive bicycle programs can increase cycling demand through the provision of a safe traveling environment and accessible facilities for users. This allows for a fast, safe and convenient option for commuters and reduces local VMT.

The 1995 National Personal Transportation Survey (NPTS) indicated that 40% of all trips in the United States are shorter than 2 miles in length, the equivalent of a ten minute bicycle trip.[75] While not every short trip can be made by bicycle, this illustrates that there is high potential for increasing bicycle trips. As a non-polluting form of transportation, bicycles contribute to the reduction of greenhouse gases, CO, NOx and VOC emissions resulting from fossil fuel use.

Bicycle programs can include a variety of initiatives to increase safety and accessibility for cyclists. Program options may include but are not limited to:

- bicycle promotion programs[76]
- bicycle lanes and bridges
- effective bicycle signage and traffic signal improvements
- connectivity between transit and bicycling
- bicycle parking and storage
- facilities for cyclists (i.e. showers and lockers)[77]
- bike share options[78]
- mapping and educational materials
- bike rentals

POLICY QUANTIFICATION

Bicycle improvement policies effect reductions by impacting mode split. Mode split shifts away from automobile use as more transportation choices become viable. VMT is reduced at a lower rate than automobile use since bicycles are more likely to be used on shorter trips.

Bike Program: Rule of Thumb
Area-level VMT Reduction: 1-5%[79]

Sample Calculation

The representative quantification depicts a 4% increase in the percentage of total trips utilizing the walk/bike/transit mode. The emission savings based on 100,000 trips proximal to bicycle infrastructure improvements are illustrated in the table below.

The calculations were derived using the following assumptions:

[75] National Personal Transportation Survey:http://npts.ornl.gov/npts/1995/Doc/index.shtml
[76] City of Berkley Office of Transportation: http://www.ci.berkeley.ca.us/transportation/Bicycling/BikePlan/PromotionPrograms.html
[77] City of Portland Office of Transportation: http://www.trans.ci.portland.or.us/bicycles/BikeCentral.htm
[78] Toronto Community Bicycle Network: http://communitybicyclenetwork.org/index.php?q=bikeshare
[79] Based on the Federal Highway Administration's (1994) 'The National Bicycling and Walking Study' Goal.

2.4 Bicycle Initiatives

Assumptions	Base Case	Bike Infrastructure
Total Trips per Day	100,000	100,000
Mode Split		
Automobile	95%	**91%**
Transit/Walking/Biking	5%	**9%**
Average Automobile Trip Length	5.0	**5.1**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*Targeted change in mode split based on FHWA's National Bicycle and Walking Study

The VMT savings calculation for the improved bicycling programs is detailed below:
VMT Savings = (100,000 × 5.0 × 0.95) – (100,000 × 5.1 × 0.91) = 10,000 miles per day

Daily VMT Savings	
VMT BAU	475,000
VMT Improved Bike Infrastructure	465,000
Difference	10,000
Percent Savings	**2%**

Emissions and Fuel Savings

Bicycle Programs	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**2%**	1433	0.102	0.307	$292,000	146,000

Bicycle Programs	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	5.636	0.262	0.190	0.310	85.387	11.170
Tons Per Day	0.015	0.001	0.001	0.001	0.234	0.031

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Bicycle programs increase the rate of cycling within communities, which benefits users and non-users. In addition to the air quality improvements associated with reduced VMT, other benefits typically include:

- reduced traffic on local roads resulting in lower travel times, transportation costs, air pollution and energy consumption
- decreased noise pollution attributable to automobile use
- improved health and quality of life resulting from regular activity that reduces the risk of heart disease, stroke and obesity
- declining public and private health care expenditures due to improved air quality and more active lifestyles
- expanded cost-effective transportation options for low-income families
- lower per employee cost of commuting and reduced commute times
- lower employer health care expenditures due to reductions in health insurance costs and better employee performance
- improved safety of cyclists through infrastructure investments

- reduction in the need for parking facilities[80]

KEY ISSUES/IMPLEMENTATION

Bicycle programs, if successfully implemented result in increased bicycle miles traveled and a variety of social, environmental and economic benefits. However the successful implementation of such strategies can be hindered by a variety of implementation challenges which may include:

- land use patterns that favor automobile dependence and destinations that are often at inaccessible distances for bicycles
- natural factors (such as weather and hilliness) can limit the potential for cycling in some locations and times of year
- automobile oriented transportation planning has resulted in wider, faster roadways that are unsafe and poorly designed for cyclists
- bicycle transportation must be recognized as an important component to regional mobility needs at all levels of government and not an "add on"
- funding often reflects the lack of prioritization for non-motorized modes of transportation
- public attitudes that perceive cycling options as unsafe[81]

CASE STUDIES

San Francisco, CA- In 1997 San Francisco adopted a comprehensive bicycle plan which is currently being updated. As a result of the implementation of the bicycle plan and the broader city and regional bicycle programs, the city is widely acknowledged as one of the most bicycle friendly locations in the United States.
(http://www.bicycle.sfgov.org/site/dptbike_index.asp?id=4302)

Cherry Creek, CO- Cherry Creek North will become the home to the state's first "bicycle day care center" entitled Bike Rack which aims to promote bicycle commuting to the region. It will provide free indoor storage, changing and storage facilities for clothing and a wide range of information and cycling support services. The Bike Rack is supported by the developer of the mixed use community of Clayton Lane, which will house the facility rent free.
(http://www.bizjournals.com/denver/stories/2004/06/21/story7.html?page=1)

Davis, CA- The City of Davis has one of the highest rates of bicycle use in the United States with over 20 percent of all trips in the city by bike. Bicycle infrastructure within the city has facilitated the growth of cycling as a form of transportation. Bicycle facilities include: widespread parking racks near stores, offices and public spaces, off street bike paths, wide on street bike lanes, grade separated bike bridges and tunnels to cross major roadways.
(http://www.walkinginfo.org/task_orders/to_5/intro.pdf)

Portland, OR - The city has undertaken projects to facilitate the use of bicycles for recreational and non-recreational purposes. Programs include both the expansion of the city's cycling infrastructure (i.e. parking, bikeway and commuter shower and storage facilities) as well as education and safety information. Between 1997 and 2002 the bikeway

[80] Pedestrian and bicycle information center http://www.bicyclinginfo.org/pp/benefits/index.htm
[81] Puget Sound Regional Council "Regional Bicycle and Pedestrian Implementation Strategy for the Central Puget Sound Region":
http://www.psrc.org/projects/nonmotorized/implementation/ch5.pdf

system increased from 97 miles to 232 miles with improvements to bicycle bridges across the network. As a result, bicycle traffic increased 189 percent on the four main Willamette bicycle bridges.
(http://www.co.multnomah.or.us/dbcs/LUT/bridges/morrison_bridge/BikePed%20pdfs/Increase%20Bikes.pdf)

Bogotá, Columbia- As part of an integrated strategy to decrease automobile use, the City of Bogotá introduced a program to promote bicycle use within the capital. The program includes the development of a physically protected bicycle path network of over 300 kilometers, the largest in South America. Bicycle trips increased from 0.6% in 1997 to 1.5% in 2003.[82] The bicycle promotion programs are part of a sustainable urban design strategy aimed at providing alternatives to automobile use.
(http://www.movingtheeconomy.ca/content/cs_bogata.html)

KEY RESOURCES & REFERENCES

City of Portland Office of Transportation- Access to Portland's Bicycle Programs website including the bicycle master plan and regional resources:
http://www.trans.ci.portland.or.us/Bicycles/DEFAULT.HTM

DeMaio, Paul- "Will Smart Bikes Succeed as Public Transportation in the United States?" published in the Journal of Public Transportation: Volume 7, No. 2. (2004)
http://www.nctr.usf.edu/jpt/pdf/JPT%207-2%20DeMaio.pdf

Federal Highway Administration- "National Bicycling and Walking Study Five Year Status Report by the U.S. Department of Transportation**":**
http://www.fhwa.dot.gov/environment/bikeped/study.htm

Federal Highway Administration- "Improving Conditions for Bicycling and Walking: a best practices report":
http://www.walkinginfo.org/task_orders/to_5/intro.pdf

Federal Highway Administration- "Guidebook on Methods to Estimate Non-Motorized Travel" includes an overview of methods and supporting documentation:
http://www.fhwa.dot.gov/tfhrc/safety/pubs/vol1/title.htm
http://www.fhwa.dot.gov/tfhrc/safety/pubs/vol2/title.htm

Pedestrian and Bicycle Information Center- provides a clearing house of information on bicycle and pedestrian issues including qualities of bicycle friendly cities:
http://www.bicyclinginfo.org/
http://www.bicyclinginfo.org/de/friendly.htm

Pedestrian and Bicycle Information Center- "Bicycle Facility Selection: a Comparison of Approaches" includes technical information and case studies on a variety of bicycle facility designs:
http://www.bicyclinginfo.org/pdf/bikeguide.pdf

[82] *Fundación Ciudad Humana* estimate based on traffic count data (personal communication from Carlos Pardo, July 30, 2004). Also see, the Institute for Transportation and Development Policy: http://www.itdp.org/news/bogota900.html.

2.4 Bicycle Initiatives

San Francisco Department of Parking and Traffic Bicycle Program- information on city bicycling facilities, information and planning initiatives
http://www.bicycle.sfgov.org/site/dptbike_index.asp

Texas Transportation Institute: "Bicycle and Pedestrian Travel Demand Forecasting: Literature Review" discusses travel demand forecasting models used in a variety of locations across the United States:
http://tti.tamu.edu/documents/1723-1.pdf

University of Minnesota- developed a comprehensive bibliography of bike cost and benefits research:
http://www.hhh.umn.edu/centers/slp/bike_bib.htm

3.0 FISCAL TOOLS & INCENTIVES

3.1 Targeted Infrastructure Funding

OVERVIEW

State governments direct the investment of billions of dollars of state and federal funding of transportation and other key infrastructure (schools, sewers, utilities). The reorientation of transportation and infrastructure spending towards efficient transportation and land use alternatives can enhance smart growth and air quality objectives. States can also use this 'power of the purse' to withhold funding from projects that do not conform to such policies, providing a strong disincentive for sprawling growth patterns.[83,84 ,85]

Targeting infrastructure funds to existing urban and suburban areas can help redirect growth inward, thereby relieving development pressures on greenfield areas at the urban fringe. Some states direct growth by prioritizing infrastructure funding for preferred areas, as defined by local governments and/or state criteria. Similarly, some states have adopted fix-it-first policies to instruct state agencies to build upon and maintain existing assets before investments are made in new infrastructure.[86]

Targeted infrastructure funding can help states to grow in a more compact manner and provides greater accessibility and mobility options for individuals. Funding to enable and support denser development may be one of the most effective means for state and local governments to reduce VMT and criteria pollutant emissions in addition to slowing the loss of natural and agricultural land to development.

CO-BENEFITS

By reducing the growth of new urban greenfield areas through targeted infrastructure spending additional benefits can be achieved, including:

- reduced pressure on agricultural, open space and environmentally sensitive areas
- more efficient use of funds through greater inter-departmental coordination
- lowered infrastructure costs
- revitalization of downtown areas
- more efficient transit operation with higher development densities

KEY ISSUES/IMPLEMENTATION

Barriers to the effective implementation of targeted infrastructure funding programs can include:[87]

- contradictory government policies that promote smart growth principles while maintaining incentives supporting uncontrolled growth
- lack of political leadership to co-ordinate land use, transportation and environmental decisions
- local level regulations that do not effectively support smart growth goals

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[83] Center for Clean Air Policy, "Two for the Price of One: Smart Growth and Clean Air," December 2004. http://www.ccap.org/transportation/smart_two.htm

[84] Linking Vision with Capital: Challenges and Opportunities in Financing Smart Growth, September 2001 http://www.housingamerica.org/order.cfm.

[85] Real Estate Research Corporation (1974), "The Costs of Sprawl: Detailed Cost Analysis," prepared for the Council on Environmental Quality; the Office of Policy Development and Research, Department of Housing and Urban Development; the Office of Planning and Management, Environmental Protection Agency. See: http://www.smartgrowth.org/pdf/costs_of_sprawl.pdf

[86] National Governors Association (2004) "Fixing It First: Targeting Infrastructure Investments to Improve State Economies and Invigorate Existing Communities": http://www.nga.org/cda/files/0408FIXINGFIRST.pdf

[87] 1000 Friends of Maryland (2001) "Smart Growth: How is Your County Doing? A Report on the Metropolitan Baltimore Region": http://www.friendsofmd.org/data/smartgrowth.pdf

- resistance by local decision makers to implement state policies to actively redirect growth
- vague comprehensive plans with limited guidance on how to achieve goals or measure progress towards them

CASE STUDIES

Atlanta- The Livable Centers Initiative (LCI) is an effort by the Atlanta Regional Commission to promote residential development, mixed uses, greater connectivity and expanding transportation and options within the region's towns and activity centers. The program developed from initial provisions within the 2025 RTP proposal to fund planning studies and transportation projects in these centers, and has been extended to include corridors and emerging centers in the 2030 RTP. Initial funding for the LCI program included $1 million annually over five years to fund planning studies, and $350 million for transportation projects resulting from LCI studies.
(http://www.atlantaregional.com/qualitygrowth/programsummary.html)

California- California's *Business, Transportation and Housing Agency* has placed a priority on shifting money to efficient locations.[88] The Bay Area's *Metropolitan Transportation Commission* began the Transportation for Livable Communities Program (TLC) in 1998 to provide funding for community based transportation projects that support mixed-use and affordable housing development. The programs include planning and capital grants, and the Housing Incentive Program. Approximately $54 million of Surface Transportation Program (STP) and Transportation Enhancement Activity (TEA) funds available under TEA-21 have been earmarked for TLC capital grants.
(http://www.transact.org/ca/TLC_fact_sheet.pdf)

The *Sacramento region's Master Transportation Plan* (MTP) update will build from the Blueprint visioning process (see brief 4.1),[89] incorporating the technical data, strategies and principles developed to work with local governments to develop the land use allocation that underpins the plan. The MTP update will be coordinated with the update of the SIP as well as the next Regional Housing Plan, making it possible for the first time to truly integrate planning for land use and housing, air quality and transportation. SACOG's 2025 Master Transportation Plan (developed in 2002) allocated $500 million over 23 years to a regional community design initiative that promotes smart growth development and the reduction of automobile travel. Public agencies can independently or in partnership with private sector organizations apply for available funds.
(http://www.sacog.org/regionalfunding/communitydesign.cfm)

Maryland- in order to direct growth patterns within the state, the 1997 *Smart Growth and Neighborhood Conservation Initiative* outlined a policy whereby projects in areas designated for growth would receive priority funding over others. The investment of state infrastructure funds was limited to the priority funding areas designated by state and local governments. Projects are reviewed annually by both planning and transportation departments to ensure compliance with smart growth objectives.
(http://www.epa.gov/ecocommunity/case1/smartgrowth.htm)

Massachusetts- The Office of Commonwealth Development (OCD), which directs smart growth policies in the housing, transportation, energy and environment agencies,

[88] See, http://www.bth.ca.gov/aboutus/index.asp.
[89] http://www.sacregionblueprint.org/sacregionblueprint/

coordinates the allocation of $2 billion in state and federal funding to direct development in areas supported by pre-existing infrastructure. One of the central OCD initiatives is the *Commonwealth Capital* policy which strives to coordinate capital spending programs to ensure consistency between development projects and sustainable development principles. Commonwealth Capital serves as a tool to influence municipal land use practices by rewarding municipalities engaged in smart growth planning. The state has also introduced a *Fix-It-First Policy* which prioritizes maintenance of existing infrastructure over new construction. Fix-It-First has extended to transportation policy focusing on repairing the state's existing roads and highways and enhancing opportunities for transit and non-motorized transportation options.
(http://www.mass.gov/ocd/comcap.html)

New Jersey- in 2002, Governor James McGreevy issued *Executive Order 4* establishing the Smart Growth Policy Council. The council's mandate was to ensure that State transportation and infrastructure funding, inter-departmental procedures, programs, and projects were consistent with the State Plan and smart growth principles. The state plan placed a high priority on investments in areas with existing infrastructure that would help create more compact growth patterns.
(http://www.nj.gov/dca/osg/commissions/sgpc.shtml)

KEY RESOURCES & REFERENCES

Metropolitan Transportation Commission- provides information on the Transportation for Livable Communities Programs in the San Francisco Bay Area:
http://www.mtc.ca.gov/planning/smart_growth/tlc_grants.htm

National Governors Association- a policy issue brief, "Fixing It First: Targeting Infrastructure Investments to Improve State Economies and Invigorate Existing Communities":
http://www.nga.org/cda/files/0408FIXINGFIRST.pdf
http://www.nga.org/cda/files/0408FIXFIRSTCHART.pdf

1000 Friends of Maryland- "Smart Growth: How is Your County Doing?" provides an overview of issues faced in Maryland counties with the implementation of their Priority Funding Areas:
http://www.friendsofmd.org/data/smartgrowth.pdf

US Environmental Protection Agency- Redeveloping brownfields with federal transportation funding:
http://smartgrowth.org/pdf/brownfields_tea21.pdf

3.2 Road Pricing

OVERVIEW

Road pricing[90] is a market-based mechanism that applies a user fee to the existing transportation infrastructure to more efficiently balance the supply and demand. The function of road pricing is twofold; it attempts to manage congestion levels while generating revenue used to maintain transportation networks. In a large number of U.S. cities studies have been conducted on such pricing mechanisms.[91] Increasingly, local and regional governments aim to implement road pricing strategies as a tool to address air quality and growing levels of congestion on urban roadways. Road pricing can lead to air quality improvements by increasing average operating speeds, reducing variations in speed, and encouraging drivers to take transit thereby lowering overall VMT. As traffic flow improves, emission rates per mile of travel also decrease.[92]

Some forms of road pricing initiatives utilize variable fees that are assessed based on the time of day, level of congestion or occupancy of the vehicle. Programs can focus on providing an incentive to shift trips to off-peak times, less congested routes, alternative modes of travel or higher occupancy vehicles. Further, new automated technologies have made tolling much less obstructive, allowing toll collection along the route which lessens the impact of congestion. Structures of pricing schemes include:

- *variable tolls*- fees are charged to travel on a road network, and may be collected electronically along the route, from toll booths along the network or at entrance and exit ramps. Time variable fees can be used to encourage a modal shift during periods of high congestion
- *high occupancy toll (HOT) lanes*- HOT lanes generally consist of HOV lanes that allow single occupancy vehicles access for a fee. HOT lanes facilitate greater use of the designated lanes, relieve congestion, raise revenue and continue to provide incentives for modal shift
- *cordon pricing*- is a congestion management tool that charges vehicles entering high use areas such as central business districts. Fees are collected through tolls at access points to the cordoned area, area permits or parking permits

Relatively small shifts in peak demand trips can achieve significant improvements in congestion levels.[93] Estimates indicate that charging 8¢ to 19¢ per mile could reduce congestion by 5-10 percent, VMT by 1.5-3 percent, and emissions by 3-6 percent.[94]

Road pricing can be an effective mechanism to reduce SOV use and regional VMT and may be most beneficial when used to directly fund transportation alternatives such as public transit. However, pricing may be viewed as simply a revenue generating tool if not supported by policies and programs to promote alternative modes of transportation. Pricing levels should ideally be sufficient to effect a transition to higher occupancy vehicles --and in combination with improvements to transit, bicycle and pedestrian facilities-- to result in significant reductions in VMT.

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[90] Road pricing can include value pricing and congestion pricing.

[91] For many of these, see the U.S. Department of Transportation's Intelligent Transportation Systems (Its) Projects Book, see http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/95k01!.pdf

[92] TCRP (2003) "TCRP Report 95: Road Value Pricing": http://trb.org/publications/tcrp/tcrp_rpt_95c14.pdf

[93] Federal Highway Administration (2002) "Status of the Nations Highways, Bridges and Transit: 2002 Conditions and Performance Report": http://www.fhwa.dot.gov/policy/2002cpr/ch16.htm

[94] California Air Resources Board (1998) "Can Transportation Pricing Strategies Be Used for Reducing Emissions?": http://www.arb.ca.gov/research/resnotes/notes/98-1.htm

3.2 Road Pricing

POLICY QUANTIFICATION

Road policies effect reductions by decreasing the number of trips taken, encouraging modal shifts, and improving emission rates due to congestion mitigation. Improvements in emission per VMT rates result from fewer trips and a shift in time of road use. Although not quantified here, road pricing may achieve additional reductions by reducing average trip lengths and potentially encouraging more compact development. With road pricing, commuters avoid the marginal trip reducing number of trips taken and VMT. A case study of Washington, DC's Capital Beltway project demonstrates the benefit of pricing on variables such as traffic flow, mode share, and fuel savings in comparison to more traditional alternatives.[95]

Road Pricing: Rule of Thumb
Area-level VMT Reduction: 1-3%[96]

Sample Calculation

The changes in mode split and trips per day are based on typical changes brought about through the implementation of road pricing programs as represented in the EPA studies referenced above. Number of trips is reduced and mode split is impacted as travelers find alternate methods or avoid travel all together. It is possible that travelers will chose closer destinations when faced with road pricing, but the impacts of such behavior are difficult to estimate. The emission savings based on 500,000 trips in the business-as-usual case are illustrated in the emissions summary table.

The calculations were derived using the following assumptions:

Assumptions	Base Case	Road Pricing Program
Total Trips per Day	500,000	**492,500**
Mode Split		
Automobile	95%	**94%**
Transit/Walking/Biking	5%	**6%**
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*changes in number of trips and mode split based on case studies referenced above

The VMT savings calculation for the road pricing programs case is detailed below:
VMT Savings = (500,000 × 5.0 × 0.95) – (492,500 × 5.0 × 0.94) = 60,250 miles per day.

Note that this approach assumes zero marginal emissions impact due to increased transit utilization (i.e., no new transit vehicle trips are assumed to be needed at this scale of ridership increase).

Daily VMT Savings	
VMT BAU	2,375,000

[95] Evaluation of Toll Options Using Quick-Response Analysis Tools: A Case Study of the Capital Beltway, Patrick DeCorla-Souza, AICP, Team Leader, Federal Highway Administration, TRB Annual Meeting, January 2003. For more information, see: http://www.fhwa.dot.gov/steam/smitemldoc.htm

[96] Based on California Air Resources Board (1998), Op Cite.

VMT Road Pricing Program	2,314,750
Difference	60,250
Percent Savings	**3%**

Note that reductions in emissions may also be achieved by improved traffic flow as road pricing both reduces traffic and shifts it to non-peak hours, but such savings are not reflected here.

Emissions and Fuel Savings

Road Pricing Program	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	3%	13,814	0.625	1.875	$2,814,758	1,407,379

Road Pricing Program	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	34.464	1.602	1.165	1.893	522.176	68.311
Tons Per Day	0.094	0.004	0.003	0.005	1.431	0.187

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Studies indicate that any road pricing aimed at alleviating congestion at peak times could have positive impacts on air quality.[97] In addition, pricing schemes can provide various benefits for local and regional transportation and economic systems including:

- greater stability in transportation funding
- improved economic efficiency in transportation
- increased revenue to fund transportation improvements
- promotes a more equitable distribution of highway costs between drivers and taxpayers[98]

The reduction in roadway congestion levels delivers additional benefits to road users, the economy and society as a whole through:

- decreased levels of driver stress and loss of time
- enhanced driver safety due to reduced accidents
- improved freight efficiency
- reductions in lost productivity to businesses
- lower fuel consumption[99]

KEY ISSUES/IMPLEMENTATION

The implementation of most road pricing methods will require consideration of a wide range of issues, some of which include:[100]

[97] G. Santos & L. Rojey & D. Newbery, 2000. "The Environmental Benefits from Road Pricing," Cambridge Working Papers in Economics 0020, Department of Applied Economics, University of Cambridge. http://www.econ.cam.ac.uk/dae/repec/cam/pdf/wp0020.pdf

[98] Minnesota Department of Transportation, 2002. *Twin Cities HOV Study*: http://www.dot.state.mn.us/information/hov/pdfs/hov_sec10.pdf

[99] Between $40-140 billion per year nationwide is wasted fuel and lost productivity, Market Strategies -- Congestion Pricing. http://www.arb.ca.gov/planning/sip/sipsummit/2004/day2g_market_strategies.pdf

[100] For more information on tolling see, http://www.transalt.org/press/media/2002/021024nytimes.html

- existence of adequate alternatives to driving
- spill over traffic impact on parallel un-priced routes or communities bordering cordon areas
- social equity concerns
- method of fee collection
- enforcement
- treatment of trucks, commercial vehicles and taxis
- possible exemptions for alternative fuel or low emission vehicles
- residential discounts
- implementation costs
- economic impacts
- public education and acceptance
- possible relocation of employers to sprawling, but road-pricing free areas

CASE STUDIES

London, UK- In February 2003 London mayor, Ken Livingstone, introduced the central London congestion pricing scheme. After a year of operation, the program has met its initial goals of reducing congestion, traffic emissions and improving bus reliability within central London. Congestion pricing has coincided with continued investment in London's public transit system, to provide improved mobility options within central London. In August 2004, the mayor announced a revision to the Transport strategy that included a western extension of the program.
(http://www.londontransport.co.uk/tfl/cc-ex/index.shtml)
(http://www.londontransport.co.uk/tfl/downloads/pdf/congestion-charging/cc-12monthson.pdf)

New York-New Jersey- In 2000, the New Jersey Turnpike Authority introduced the *E-Z Pass* system of electronic tolling along with a new pricing policy with differential rates for peak and off peak travel. The New York and New Jersey Port Authority, followed suit later that year with a similar variable pricing structure and the elimination of the commuter discount in order to fund transportation improvements and reduce congestion. With the tolling infrastructure in place, studies indicate that opportunities exist in New York City to achieve reductions in inbound traffic of up to 13%
(http://www.rpa.org/pdf/RPA_Congestion_Pricing_NY.pdf)

San Diego, CA- In 1998, San Diego developed its HOT lanes project to alleviate congestion and to make use of under-utilized high occupancy vehicle (HOV) lanes. As part of this effort, the *FasTrak* project on Interstate 15 (I-15) charges SOV drivers an electronically collected per-trip toll to take advantage of the express lanes. Typical charges range from $0.50 to $4.00 and are based on real time traffic levels of the HOT lanes. Carpools and vehicles with two or more occupants are still able to use the express lanes without charge. Revenue from the project covers its own operating expenses and provides funding for a public transit express bus service.
(http://argo.sandag.org/fastrak/)

Singapore- The city state was one of the first places to manage the demand for road use through road pricing programs in the 1970s. Singapore has subsequently updated its congestion charging technologies through the introduction of an electronic road pricing system in 1998. Vehicles are required to possess an electronic in-vehicle unit (IU), in which a stored value smart card is inserted and road charges are deducted upon entry into the

central business district. Charges vary dependant on time of day and distance traveled on the road network.
(http://www.lta.gov.sg/motoring_matters/index_motoring_erp.htm)

United Kingdom- In an attempt to address current and future traffic congestion concerns, the British government is focusing on a nationwide road pricing scheme which may charge up to £1.30 per mile for highway use. The satellite based system would apply to all 30 million users of Britain's highway network by 2014 and is estimated to cut traffic by 4%. The use of satellite based road pricing for tractor trailers (lorries) will be introduced in Britain in 2008 following the lead of Switzerland, Germany and Austria.
(http://www.guardian.co.uk/transport/Story/0,2763,1265630,00.html)

Other Places- A variety of projects across the United States have been undertaken as part of the U.S. Department of Transportation's *Value Pricing Pilot Program*. Projects funded under this program include: HOV to HOT lane conversions, cordon tolls, FAIR Lanes, and road pricing readjustments.
(http://www.fhwa.dot.gov/policy/otps/projdesc.htm)

KEY RESOURCES & REFERENCES

Energy Outreach Center- "Road Relief Tax and Pricing Shifts for a Fairer, Cleaner, and Less Congested Transportation System in Washington State" evaluates road pricing alongside other transportation pricing mechanisms:
http://www.climatesolutions.org/pubs/pdfs/roadrelief.pdf

Hubert H. Humphrey Institute of Public Affairs-Value Pricing Homepage sponsored by the US DOT addresses issues surrounding value pricing, HOT lane evaluation and information on the FHWA pilot program:
http://www.hhh.umn.edu/centers/slp/projects/conpric/index.htm

Hubert H. Humphrey Institute for Public Affairs- "Buying Time Guidebook: A Guidebook for Those Considering Congestion Relief Tolls in Their Communities", outlines the political and institutional issues of congestion tolling:
http://www.hhh.umn.edu/centers/slp/projects/conpric/resource/vpguide.pdf

Minnesota Department of Transportation- High Occupancy Toll Lanes is a document that provides background information and an overview to HOT lane development in the US:
http://www.dot.state.mn.us/information/hov/pdfs/hov_sec10.pdf

Regional Plan Association- provides information on regional planning for the New York-New Jersey-Connecticut area including projects assessing congestion pricing alternatives for New York City:
http://www.rpa.org/

Texas Transportation Institute- "HOT Lanes in Houston Six Years of Experience":
http://www.nctr.usf.edu/jpt/pdf/JPT%207-3%20Burris.pdf

Transport for London- is the body responsible for transportation in London and provides information on transportation initiatives including congestion charging updates and transit information:
http://www.londontransport.co.uk/tfl/

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Transport for London- "Congestion Charging: Update on Scheme Impacts and Operations February 2004" is the latest official update on congestion charging in London: http://www.londontransport.co.uk/tfl/downloads/pdf/congestion-charging/cc-12monthson.pdf

Transit Cooperative Research Program- Report 95, Chapter 14, "Road Value Pricing" provides detailed information on the results of pricing projects nationally and internationally:
http://trb.org/publications/tcrp/tcrp_rpt_95c14.pdf

University of California Energy Institute- "Road Pricing and Public Transport" examines the benefits that may arise from road pricing through its effects on the speed and service frequency of public transport:
http://www.ucei.berkeley.edu/PDF/EPE_010.pdf

US Department of Transportation- the FHWA Highway Community Exchange includes a discussion group, references and project lists on value pricing.
http://knowledge.fhwa.dot.gov/cops/hcx.nsf/home?openform&Group=Value%20Pricing&tab=WIP

US Environmental Protection Agency- Transportation Control Measures Program outlines congestion pricing examples, issues and implementation:
http://yosemite.epa.gov/aa/tcmsitei.nsf/0/647e950797e1f217852566de0055789e?OpenDocument

3.3 Commuter Incentives

OVERVIEW

Commuting to and from work contributes to traffic congestion and air quality problems in many urban areas of the United States. Adopting commuter benefit packages and reducing the number of automobiles commuting during peak hours can potentially lessen traffic congestion, improve air quality and minimize the environmental impacts associated with drive-alone commuting.

Best Workplaces for Commuters, established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Transportation (DOT), is an example of a program promoting employer-based commuter incentives for transit and carpooling.[101] Similar programs exist nationally through partnerships with MPOs, transit providers, city and regional governments and employers to provide benefits to employees and employers making use of alternatives to single occupancy vehicle travel.

Commuter incentive programs take advantage of a variety of options used to reduce SOV trips for workplace travel. Employers can adopt programs that best suit the needs of their employee base, some methods include:[102]

- subsidizing employees commuting costs with tax-free transit benefits[103]
- allowing the use of pre-tax dollars to pay for alternative commute costs (e.g., vanpool and transit)
- facilitating tele-work and alternative work schedule programs
- providing incentives to carpool, vanpool, bicycle or walk
- promoting parking programs such as parking cash-out or preferential carpool and vanpool parking
- guaranteed ride home programs
- promoting federal parking cash-out

A study done by the City of Boulder reported: if half of all U.S. employees reduced their SOV commuter trips by participating in alternative commuter programs, the congestion and air pollution benefits would be equivalent to taking 15 million cars off the road at a savings of $12 billion in fuel costs.[104]

POLICY QUANTIFICATION

Commuter incentive programs effect reductions by impacting mode split and potentially the number of trips in the case of telecommuting. Travelers shift away from single occupancy automobile trips as other transportation choices and alternatives become competitive.

Commuter Incentive: Rule of Thumb
Employer VMT Reduction: 5-25%[105]

[101] EPA Best Workplaces for Commuters Campaign page: http://www.commuterchoice.gov/campaign/index.htm
[102] Arlington Transportation Partners: http://www.commuterpage.com/atp/ben-programs.cfm
[103] Smart Commute: http://www.smartcommute.org/ForEmployersSS.htm
[104] City of Boulder: http://www.ci.boulder.co.us/comm/pressrelease/2003/0929.html
[105] Although individual workplace reduction will vary, the range of 5 to 25% was based upon Washington State's Commuter Program, which included results for a several larger workplaces, as part of the state's Commute Reduction Law. CCAP also used the Commuter Model to confirm that this range was reasonable. http://www.epa.gov/otaq/transp/traqmodl.htm#commuter

3.3 Commuter Incentives

Sample Calculation
The changes in mode split are based on case study evidence of impact of commuter choice on transit ridership. The emission savings based on a commuter choice program where 5,000 trips are originated. While the order of magnitude reductions here are achievable at most workplaces, they are more likely when implemented with parking cash out in a workplace with multiple transportation options.

The calculations were based on the following assumptions:

Assumptions	Base Case	Commuter Incentives
Total Trips per Day	5,000	5,000
Mode Split		
Automobile	95%	**77%**
Transit/Walking/Biking	5%	**23%**
Average Automobile Trip Length	11.0	11.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for commuter choice quantification based on referenced case studies

The VMT savings calculation for the commuter choice case is detailed below:
VMT Savings = (5,000 × 11.0 × 0.95) – (5,000 × 11.0 × 0.77) = 9,900 miles per day

Daily VMT Savings	
VMT BAU	52,250
VMT Commuter Incentives	42,350
Difference	9,900
Percent Savings	**19%**

Emissions and Fuel Savings

Commuter Incentives	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**19%**	1419	0.101	0.304	$289,080	144,540

Commuter Incentives	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	5.579	0.259	0.189	0.306	84.534	11.059
Tons Per Day	0.015	0.001	0.001	0.001	0.232	0.030

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

3.3 Commuter Incentives

CO-BENEFITS

Commuter incentive programs result in a variety of benefits to employees and employers in addition to those resulting from reduced VMT associated with workplace commuting. These co-benefits include:[106]

- lowered commute costs for employees
- reduced stress and commute times with declining roadway congestion
- improved transportation options and transportation equity
- reduced demand for new road and parking infrastructure
- improved employee retention and recruitment
- employer tax savings[107]

KEY ISSUES/IMPLEMENTATION

Studies indicate that employer support of alternative modes can result in a significant shift away from SOV use to other modes of transportation. It is estimated that it costs employers about $1–2 per day to encourage an employee to switch workplace commute modes. Key factors in successful programs include:"[108]

- providing incentives for alternative modes
- parking supply restrictions/parking pricing mechanisms
- tailoring support and incentives to those suited for the specific work site
- combining programs that inform employees of commuting options with supporting services and incentives
- making a wide range of commuting alternatives available

CASE STUDIES

Aspen, CO- the city provides municipal employees with a variety of transportation incentives, including free bus passes, guaranteed rides home, and a financial benefit for employees who give up their drive to work alone. In addition, the municipality provides lockers, showers, and a small bike fleet, and offers a car-sharing program for employees and residents, in an effort to encourage walking and biking.
(http://www.commuterchoice.gov/campaign/denver.htm)

California- The state parking cash out law requires that specific employers offer the option of cash in lieu of parking to employees. Case studies indicated a decline in commute related vehicle emissions ranging between 5 and 24% for the eight California firms studied.
(http://www.arb.ca.gov/planning/tsaq/cashout/cashout.htm)
(http://www.arb.ca.gov/research/resnotes/notes/98-3.htm)

Minneapolis, MN- Downtown Minneapolis employers implemented variations of parking cash out programs which resulted in an average modal shift of 11% and increased bus ridership of 47%. Parking cash out allows employees greater choice for their commute to work.
(http://www.mplstmo.org/pages/parking_alt.htm)

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[106] For more information, see CommuterChoice.com: http://www.commuterchoice.com/index.php?page=employers&sub=employers_benefits

[107] EPA Best Workplaces for Commuters (2001) "Commuter Tax Benefits: Implementing Commuter Benefits Under the Commuter Choice Leadership Initiative": http://www.bwc.gov/pdf/fedtax.pdf

[108] CommuterChoice.com (2002)"Commuter Choice Primer": http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/13669.html

3.3 Commuter Incentives

Maryland- As a component of the Commuter Choice Maryland program, the state's employers can claim a tax credit for 50% of the eligible costs of providing commuter benefits, up to a maximum of $50 per participating employee per month. The credit can apply to transit fares, company vanpool programs, Guaranteed Ride Home Programs and cash in lieu of parking. This allows employers to save on taxes, reduce parking demand and costs, and recruit and retain valuable employees. (http://www.mdot.state.md.us/CommuterChoice/What%20is%20Commuter%20Choice/introduction)

San Antonio, TX- the United States Automobile Association (USAA) worked with San Antonio's Metropolitan Planning Organization, Metropolitan Council of Governments to create an employee vanpool commuter program. Over 800 USAA employees at the San Antonio location are transported via vanpool to and from work. Employees pay a minimum of $21 every two weeks, which is automatically deducted from their paychecks. USAA estimates that employees save between $5200 and $7100 annually. (http://www.bwc.gov/pdf/vanpool.pdf)

Washington, DC- federal employees in DC (and certain federal agencies nationwide) receive a transit subsidy that provides them an incentive to leave their car at home during the work week. The monthly subsidy was increased to $105 per month in 2005. (www.fta.dot.gov/initiatives_tech_assistance/customer_service/2172_ENG_HTML.htm)

Other Places- EPA's *Best Workplaces for Commuters*[109] campaigns exists in a number of metropolitan areas, and includes programs to support transit (bus and train), vanpools, carpools, emergency ride home and parking cash-out. Participating regions include: Colorado, Houston (TX), Metro NY-NJ-CT, Sacramento (CA), San Francisco Bay Area (CA), Tucson (AZ) and Washington DC Metro. (http://www.commuterchoice.gov/campaign/index.htm)

KEY RESOURCES & REFERENCES

Center for Urban Transportation Research- "Commuter Choice Program Case Study Development and Analysis" assesses the factors that may affect the success of commuter choice programs:
http://www.nctr.usf.edu/pdf/527-06.pdf

Commuter Check- is a national program in which employers in participating cities may offer employees commuter checks as transit or vanpool vouchers, and provides support to public and private measures to reduce congestion:
http://www.commutercheck.com/home.html

Commuter Choice - aims to help employers connect with service providers in their local areas who can help implement relevant Commuter Choice programs at their worksites:
http://www.commuterchoice.com/

CommuterChoice.com- "Commuter Choice Primer: An Employer's Guide to Implementing Effective Commuter Choice Programs":
http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/ccp/CommuterChoicePrimer.pdf

[109] EPA Best Workplaces for Commuters: http://www.bestworkplacesforcommuters.gov/

3.3 Commuter Incentives

Federal Transit Administration- provides access to information on Internal Revenue Service Revenue Procedure 2003-85 for Qualified Transportation Fringe Benefits:
http://www.fta.dot.gov/library/policy/cc/2004lqtd.html

International Telework Association and Council- website provides information and resources about telework as well as 2004 telework statistics:
http://www.workingfromanywhere.org/about/index.htm

Metro Commuter Services- the real cost of driving alone calculator:
http://www.metrocommuterservices.org/cost.htm

Transportation Cooperative Research Program- Strategies for Increasing the Effectiveness of Commuter Benefits Programs, Report 87 provides a detailed assessment of commuter benefits programs TCRP study results:
http://gulliver.trb.org/publications/tcrp/tcrp_rpt_87.pdf

US Environmental Protection Agency- *Best Workplaces for Commuters Program* website contains a number of case studies detailing the employer-specific and regional Commuter Choice programs, including a description of the plan, implementation approaches, emissions and cost savings and a variety of technical guides and tools for implementation:
http://www.bwc.gov/about/index.htm

US Environmental Protection Agency – the Commuter Model, was designed by EPA to help local communities and state agencies evaluate regional and employer-based Commuter Choice programs:
http://www.epa.gov/otaq/transp/traqmodl.htm

US Environmental Protection Agency- the *Business Benefits Calculator* enables employers to enter information on how their organizations will implement Commuter Choice programs and provides estimates on cost savings, emissions and traffic-related reductions:
http://www.bwc.gov/resource/calc.htm

US Environmental Protection Agency- the document "TDM Case Studies and Commuter Testimonials" includes a variety of case studies from area wide to single site programs, and single and multiple TDM strategy approaches:
http://www.epa.gov/otaq/transp/trancont/tdmcases.pdf

3.4 Pay As You Drive Insurance (PAYD)

OVERVIEW

Pay-As-You-Drive automobile insurance is a system where participants are assessed based on the number of vehicle miles traveled in combination with traditional risk based rates. PAYD goes beyond what current insurance companies are offering in premiums to low distance drivers. Shifting to this type of mileage-based auto-insurance system allows motorists to reduce their costs while encouraging them to drive less.

Providing drivers financial incentives to drive less could result in a reduced annual VMT, air pollution, fuel use, and greenhouse gas emissions.

Insurance companies including Norwich Union,[110] GMAC and Onstar,[111] and Progressive[112] Insurance have undertaken PAYD pilot project in the UK, Minnesota, Arizona, Indiana, Illinois, and Pennsylvania.

Berkeley professor Aaron Edlin calculates that driving would be cut back by 10% if the per-mile PAYD fee reflected the true marginal cost of driving, including costs incurred by other road users. The level of VMT impact is ultimately determined by level of tax, participation and implementation effectiveness. Implemented nationally, the PAYD program could result in an insurance of $8 billion a year on insurance premiums and an additional $9 billion savings in reduced congestion. [113,114]

POLICY QUANTIFICATION

Pay-As-You-Drive insurance is likely to effect reductions through the impact on number of trips, trip length and mode split. The length and number of trips will be reduced due to increased costs, and mode split will shift away from automobile use as transportation alternatives become relatively less expensive. The quantification does not attempt to break down the reductions estimated in the literature into the component parts, but instead presents a top-down estimate of impacts.

PAYD: Rule of Thumb
Participant VMT Reduction: up to 10%[115]

Sample Calculation

The changes in total VMT are based on Edlin's study. The emission savings based on 4,000,000 automobiles registered in the state and a 5 percent participation rate in the PAYD program (= 200,000 participants).

The calculations were based on the following assumptions:[116]

[110] Norwich Union: http://www.norwichunion.com/pay_as_you_drive/
[111] Onstar: http://www.onstargm.com/promo/html/promo_mileage.htm
[112] Progressive Insurance: https://tripsense.progressive.com/home.aspx
[113] Aaron S. Edlin (2002), "Per-Mile Premiums for Auto Insurance":
http://www.bepress.com/cgi/viewcontent.cgi?article=1031&context=aaronedlin
The 10% incorporates a price elasticity of –0.15 into VMT demand estimates.
[114] Aaron S. Edlin, 2002. "Per-Mile Premiums for Auto Insurance," NBER Working Papers 6934, National Bureau of Economic Research, Inc.
[115] Based on the study, Premiums for Auto Insurance, Aaron S. Edlin, Univ. of California Berkeley, 2002.

3.4 Pay As You Drive Insurance (PAYD)

Assumptions	Base Case	Pay-As-You-Drive Insurance
VMT per Day	131,506,849	130,849,315
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

The VMT savings calculation for the PAYD case is detailed below:
VMT Savings = (200,000 × 12,000 **/** 365) – (200,000 × 10,800 / 365) = 657,534 miles per day.

Daily VMT Savings	
VMT Standard Insurance	131,506,849
VMT with PAYD Insurance	130,849,315
Difference	657,534
Percent Savings	**0.5%**

Emissions and Fuel Savings

Pay-As-You-Drive Insurance	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	0.5%	94231	6.720	20.160	$19,200,000	9,600,000

Pay-As-You-Drive Insurance	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	370.567	17.221	12.525	20.352	5614.513	734.492
Tons Per Day	1.015	0.047	0.034	0.056	15.382	2.012

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Advocates of the PAYD insurance system expect that such policies would not only lead to a reduction in miles driven and pollutant emissions, but could provide an increasingly progressive and economically efficient system of vehicle insurance.[117] Other benefits may include:

- reduced need for expanded roadways and parking infrastructure
- better affordability for low distance drivers
- increased consumer control over the price paid for insurance
- improved driver safety through reductions in VMT[118]

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[116] This emissions table is based on the standard guidebook assumptions relating to VMT per driver (12,000/year), and emissions factors. The reductions are calculated using the 10% reduction in VMT resulting from the PAYD policy as quantified by Edlin (2002).

[117] Institute for Public Policy Research (2002), "Implementing Pay-As-You-Drive Vehicle Insurance": http://www.ippr.org.uk/uploadedFiles/events/ToddLitman.pdf

[118] A 10 percent reduction in driving is estimated to result in a 12-15 percent reduction in crashes, Michigan Land Institute: http://www.mlui.org/growthmanagement/fullarticle.asp?fileid=16582

3.4 Pay As You Drive Insurance (PAYD)

KEY ISSUES/IMPLEMENTATION

PAYD automobile insurance programs are implemented by private insurance companies, with government playing the role or regulator. State governments may need to remove regulatory barriers to allow companies to provide mileage-based insurance options.

PAYD insurance requires the collection of accurate monthly mileage data that can be obtained through regular odometer readings. However, companies offering PAYD options are beginning to make use of sophisticated Global Positioning System Technology in recent pilot projects.

The insurance industry may be reluctant to shift from existing practices to ones that may result in a long term reduction in premiums. In addition, complex regulatory structures, which often do not support innovations, may impede implementation. [119]

CASE STUDIES[120]

Britain- British insurer Norwich Union is conducting a pilot test in Great Britain. Also, UK-based software developer Carlton Business Systems plans to offer its "Insure per Mile" system to British customers starting in February 2004.
(www.norwichunion.com/pay_as_you_drive/index.htm?plp_ci_payd)

Israel- Israeli insurance company Aryeh, has partnered with PAZ, the nation's largest petroleum company to offer mileage based insurance premiums. Using a system originally designed to monitor fuel purchases for large company and government fleets and to facilitate automatic payment at the fuel pump, the PAZOMAT system can collect odometer readings automatically through a wireless transmitter installed in the vehicle. When a vehicle is refueled at PAZ stations equipped with a receiver at the fuel pump, the mileage data is recorded for monthly billing. Approximately 15 percent of all vehicles currently have the equipment installed for automatic payment purposes.
(http://www.vtpi.org/tdm/tdm79.htm)

Netherlands- One of the Netherlands' major insurance companies, Polis Direct has introduced a form of Pay-As-You-Drive auto insurance under the name "Kilometre Policy". Per-kilometer premiums are calculated varying with the type of policy with participants paying an "advance premium," which is 90% of their current premium. Motorists receive a rebate or pay extra based on how much they drive, up to 50% of their premium at the end of each policy term. Most motorists drive significantly less than their policy's maximum annual kilometers, and it is expected to reduce annual mileage by upwards 10%.Mileage data is collected during annual vehicle inspections and recorded in the national vehicle registration database.
(http://www.ce.nl/eng/pdf/03_4224_35_summary.pdf)

Ontario, Canada- Aviva Canada has begun a pilot program for Pay-As-You-Drive insurance in Canada. The "Autograph" program will involve 5,000 drivers in Ontario and is based on technology used by Progressive Casualty Insurance in the U.S. A device installed in the vehicle tracks participants' driving patterns, with the driver retaining the option of downloading the information and submitting it to the insurer in order to calculate premiums. Discounts of up to 25% are available based on actual miles traveled.

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[119] The Victoria Transport Policy Institute report: http://www.vtpi.org/tdm/tdm79.htm provides an overview of industry and consumer concerns to PAYD, including privacy and equity concerns.
[120] In Norway, 5,000 volunteers are included in the pilot program for PAYD insurance.

3.4 Pay As You Drive Insurance (PAYD)

(https://secure.avivacanada.com/autograph/product.php?content=AUTOGRAPH_CONSUMER&language=ENGLISH)

Oregon - In July 2003, Oregon passed House Bill 2043, which created an incentive program for insurance companies to test PAYD insurance premiums. Under the law, insurance companies that offer mileage-based or time-based rating plans are given a $100 tax credit for each vehicle carrying this type of policy. The law applies only to the tax years between 2005 and 2010, and establishes a limit of $1 million on the total credits that may be claimed by all of the insurance companies during that time.
(http://www.oeconline.org/climate/howpaydworks/view?searchterm=PAYD)

Texas - Progressive Auto Insurance, headquartered in Ohio, has tested a PAYD insurance pilot program that assesses rates based on mileage driven, geographic location and time of day. The PAYD option was made possible after state legislation passed in 2001 and rules were outlined for mileage based insurance rates.
(http://www.epa.gov/projectxl/progressive)

Other states- such as Georgia[121] have passed laws to enable or encourage insurers to offer PAYD, while still other states have included PAYD in their GHG Reduction Plans including: Connecticut, Maine, New York, and Rhode Island

KEY RESOURCES & REFERENCES

Edlin, Aaron-"Per-Mile Premiums for Auto Insurance" in Economics for an Imperfect World: http://www.bepress.com/cgi/viewcontent.cgi?article=1031&context=aaronedlin

Georgia Institute of Technology-"Commuter Choice and Value Pricing Insurance Incentive Program" is a component of the Value Pricing Pilot Program of the US Depatment of Transportation and the Federal Highway Administration:
http://www.hhh.umn.edu/centers/slp/projects/conpric/projects/gawk.pdf

Litman, T- "Distance-Based Vehicle Insurance: as A TDM Strategy" compares several case studies and evaluates the criticisms of such and approach to reduce automobile mileage: http://www.vtpi.org/dbvi.pdf and technical report http://www.vtpi.org/dbvi_com.pdf

Litman, T- "Pay-As-You-Drive Pricing for Insurance Affordability" paper illustrates the ability to increase the affordability of insurance through PAYD programs:
http://www.vtpi.org/payd_aff.pdf

Northwest Environment Watch- Pay-as-you-drive information fact sheet:
http://www.northwestwatch.org/reforms/PAYD_facts.pdf

Progressive Casualty Insurance- information on Progressive's TripSense Program:
https://tripsense.progressive.com/

State Environmental Resource Center- provides background information on national PAYD programs and implementation mechanisms:
http://www.serconline.org/payd/background.html

[121] Georgia General Assembly: http://www.legis.state.ga.us/legis/2003_04/fulltext/hb201.htm

3.5 Green Mortgages

OVERVIEW

Location Efficient Mortgages (LEM),[122] Energy Efficient mortgages,[123] and Smart Commute[124] are initiatives that provide discounted mortgages to people who chose to buy a home in compact, energy efficient, mixed-use communities serviced by public transportation.

In these communities, residents have the opportunity to walk, bike or take public transportation from their homes to stores, schools, recreation, and work. Lenders recognize that living in these types of communities reduces, if not eliminates, the homebuyers need to drive, thereby lessening the homebuyer's transportation and energy costs.[125]

These financing mechanisms increase the ability of borrowers to afford homes in location efficient communities. Studies by Holtzclaw et al. illustrate correlation between increasing residential densities and declining automobile use and ownership.[126] Consequently, the adoption of green mortgage programs has the potential to decrease greenhouse gas emissions, and criteria air pollutants through the provision of a wider variety of transportation choices.

Green mortgage programs must be integrated into a comprehensive location efficiency strategy for new and existing housing, in order to achieve effective emissions reductions. The stand-alone policy does not guarantee that the new residents will make more use of the transportation options than the previous residents did, thus air quality improvements are not guaranteed. However, if green mortgages are used to incent infill/brownfield or transit-friendly housing developments, the air quality improvements can be substantial.

POLICY QUANTIFICATION

Green mortgages seek to encourage development in transit friendly areas. They effect reductions by directing development towards infill/brownfield locations. Thus, like the infill/brownfield measure, they achieve emissions reductions through the impact on mode split and trip length. Green mortgages can be used to purchase (as opposed to building) homes in transit friendly areas as well. However, unless the buyer can be shown to have a different transportation profile than the seller, changes in emissions are negligible. Thus, green mortgages are most effective when used to encourage TOD or other environmentally friendly development.

Green Mortgages: Rule of Thumb
Household VMT Reduction: 15-50%[127]

[122] Location Efficient Mortgage: http://www.locationefficiency.com/
[123] Fannie Mae: http://www.efanniemae.com/sf/mortgageproducts/options/energyefficient.jsp
[124] *Ibid*.
[125] Transportation costs (especially for automobiles) are the second highest average household expense in the United States, behind homeownership. Green mortgage programs typically target second-car ownership and are thus not likely to eliminate household automobile expenses.
[126] Holtzclaw et al. (2002) "Location Efficiency: Neighborhood and Socioeconomic Characteristics Determine Auto Ownership and Use- Studies in Chicago, Los Angeles and San Francisco": http://www.reconnectingamerica.org/pdfs/LOCEFFIC.PDF
[127] Based on a combination of TOD and Infill reductions (see policy briefs 1.1 and 1.2).

3.5 Green Mortgages

Sample Calculation
The changes in mode split are based on changes in mode split and trip length. The emission savings based on 100 homes built (800 trips per day) are illustrated in the emissions summary table.[128]

The calculations were derived using the following assumptions:

Assumptions	Base Case	Green Mortgages
Total Trips per Day	800	800
Mode Split		
Automobile	95%	**87%**
Transit/Walking/Biking	5%	**13%**
Average Automobile Trip Length	5.0	**3.4**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split snd trip length for quantification based on greenfield vs. brownfield trip characteristics

The VMT savings calculation for the road pricing programs case is detailed below:
VMT Savings = (800 × 5.0 × 0.95) – (800 × 3.4 × 0.87) = 1,468 miles per day

Daily VMT Savings	
VMT BAU	3,800
VMT Green Mortgages	2,332
Difference	1,468
Percent Savings	**39%**

Emissions and Fuel Savings

Green Mortgages	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**39%**	210	0.015	0.045	$42,877	21,439

Green Mortgages	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	0.828	0.038	0.028	0.045	12.538	1.640
Tons Per Day	0.002	0.000	0.000	0.000	0.034	0.004

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS
In addition to the savings in energy, greenhouse gas emissions and personal transportation costs, green mortgage options provide a financial tool that includes social and economic benefits such as:

- providing affordable housing for lower income participants through low down payments, competitive interest rates and flexible criteria for financial quantification
- supporting public transportation systems

[128] This household participation rate has not been achieved to date and might be considered as a longer-term target for a newly established pilot program.

- promoting urban revitalization initiatives

KEY ISSUES/IMPLEMENTATION

LEM, Smart Commute and Energy Efficient mortgage programs require the development of partnerships between both public and private sector interests to effectively link housing and transportation issues. Some of the challenges to implementation are:

- effective local public transportation must be readily accessible
- public awareness and education regarding the availability of green mortgage options
- integration of financial institutions into smart growth programs

CASE STUDIES

National- LEM mortgages are currently available in four metropolitan areas: Seattle, San Francisco, LA and Chicago. Consumers in these markets can access local LEM lenders and calculate online the benefits of purchasing homes in specific neighborhoods. (http://www.locationefficiency.com/)

Georgia- In January 2004, the *Atlanta Smart Commute Initiative* was launched, aimed at the encouraging families to purchase homes near and make use of regional transit services. The initiative makes use of green mortgage principles to provide incentives for homebuyers to locate close to regional transit stations, as well as providing an initial six month pass on Atlanta's MARTA system. (http://www.fanniemae.com/newsreleases/2004/2927.jhtml?p=Media&s=News+Releases)

Massachusetts- The *Take the T Home* program is a partnership between MassHousing, regional transit authorities and local financial institutions to provide low or zero downpayment mortgage options to Mass Transit riders near transit stations. (http://www.masshousing.com/portal/server.pt?space=Opener&control=OpenObject&cached=true&parentname=CommunityPage&parentid=1&in_hi_ClassID=514&in_hi_userid=2&in_hi_ObjectID=214&in_hi_OpenerMode=2&)

Maryland- Partnerships between Fannie Mae and Baltimore area financial institutions has resulted in the *Baltimore Smart Commute Initiative*. The provision of greater flexibility in mortgage terms aims to provide incentives to purchase homes near transit stations. (http://www.smartgrowth.org/news/article.asp?art=3571&state=21)

Portland, OR- the recently introduced *Portland Regional Smart Commute Initiative* provides financial incentives for prospective buyer to purchase homes near transit. Lenders will be able to qualify potential transportation savings as an additional income of $200-250 per month. Additional benefits for program participants include free transit passes for a month and a credit for Flexcar use. This initiative is a partnership between TriMet, the Portland Development Commission, Flexcar, Metro, the city of Portland's Transportation Office and the Portland Metropolitan Association of Realtors. (http://www.smartgrowth.org/news/article.asp?art=4342&State=38&res=1024)

Washington DC- Fannie Mae introduced Washington's *Smart Commute* program in 2003. Prospective home buyers who live in Washington, D.C., Northern Virginia and Suburban Maryland are eligible to receive a 50 percent discount for six months on Metrobus or Metrorail along with favorable terms on their mortgage. (http://www.fanniemae.com/newsreleases/2003/072303.jhtml?p=Media&s=News+Releases

3.5 Green Mortgages

The Smart Commute program is also underway across the country in cities such as Philadelphia (PA), El Paso (TX), Louisville (KY), Minneapolis (MN), Pittsburgh (PA), Salt Lake City (UT), State College (PA), Delaware, and New Jersey.

KEY RESOURCES & REFERENCES

Canadian Mortgage and Housing Corporation- "Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighborhood Sustainability", highlights the importance of macro scale urban structures on greenhouse gas emissions reductions
http://www.cmhc.ca/publications/en/rh-pr/socio/socio050.pdf

Fannie Mae Foundation- "Retracting Suburbia: Smart Growth and the Future of Housing", a report highlighting the way housing can be used to support smart growth policies:
http://www.fanniemaefoundation.org/programs/hpd/pdf/hpd_1003_danielsen.pdf

Location Efficiency and Location Efficient Mortgages- access to Fannie Mae's LEM programs in Seattle, San Francisco, Los Angeles and Chicago:
http://www.locationefficiency.com/

National Association of Realtors- includes links to information on green homes and green mortgages:
http://www.realtor.org/libweb.nsf/pages/fg313#topicc

Natural Resources Defense Council- using Residential Patterns and Transit to Decrease Auto Dependence and Costs:
http://www.smartgrowth.org/library/cheers.html

Reconnecting America- Location Efficiency: "Neighborhood and Socioeconomic Characteristics Determine Auto Ownership and Use- Studies in Chicago, Los Angeles and San Francisco", John Holtzclaw et al. illustrate the importance of density in determining auto ownership and use:
http://www.reconnectingamerica.org/pdfs/LOCEFFIC.PDF

Washington Regional Smart Commute Initiative:
http://www.mwcog.org/planning/smart_commute/

4.0 STATE & LOCAL PROGRAMS

4.1 Comprehensive Smart Growth Programs

OVERVIEW

Comprehensive Smart Growth Programs at both state and local levels of government have arisen in response to community concerns over the social, economic and environmental costs of building road-centered, automobile-dependent, low density developments in North America over the last 50 years. The principles of smart growth provide a framework through which decisions as to how and where communities grow can be viewed.[129]

Comprehensive smart growth programs employ multiple strategies and a coordinated approach to policy development to address the impacts of conventional growth patterns. The creation of regulatory bodies to ensure the coordination and implementation of smart growth plans and policies helps ensure that branches of the government do not adopt contradictory initiatives. Key elements needed to successfully implement smart growth policies include:

- comprehensive regional planning
- regional cooperation
- funding for efficient transportation alternatives
- targeted infrastructure spending
- incentives to redevelop the center city
- elimination of regulatory or financial disincentives that encourage sprawl
- strong political leadership

MPO studies from around the country show smart growth policies have the potential to reduce regional and statewide VMT reductions by 3-25 percent, as seen in the table below. The VMT savings from these analyses result from a combination of transit improvements, land use modifications and complementary policies such as open space protection and measures (including in some cases, congestion pricing, zoning, etc). With the exception of Sacramento's Blueprint project however, the savings may not fully capture micro-scale trips, trip-chaining and/or induced travel.

Regional VMT Reductions from Smart Growth and Transit

Study Location	Regional VMT Reduction (from business-as-usual)	Implementation Timeframe
Albany[130]	**7 - 14%**	2000 – 2015
California[131]	**3 - 10%**	2000 – 2020
Portland[132]	**6 - 8%**	1995 – 2010
Puget Sound[133]	**10 - 25%**	2005 – 2050

[129] Smart Growth Network (2002) "Getting to Smart Growth: 100 Policies for Implementation": http://www.smartgrowth.org/pdf/gettosg.pdf

[130] Capital District Transportation Committee, *New Visions 2021*, Draft approved October 2000.

[131] Parsons Brinckerhoff, for the California Energy Commission, *California MPO Smart Growth Energy Savings MPO Survey Findings*. September, 2001.

[132] Cambridge Systematics, Inc. and Parsons, Brinckerhoff, Quade & Douglas. *Making the Land Use Transportation Air Quality Connection: Analysis of Alternatives*. Vol. 5. Prepared for Thousand Friends of Oregon. May, 1996.

[133] CCAP estimate based on Puget Sound Regional Council, *Destination 2030*: http://www.psrc.org/projects/mtp/ and the USDOE, Energy Information Administration, *Annual Energy Outllook*: http://www.eia.doe.gov/oiaf/aeo/.

Sacramento[134]	**7%**	2001 – 2015
Salt Lake City[135]	**3%**	2000 – 2020

POLICY QUANTIFICATION

By adopting a multi-faceted policy approach – including shifting regional development patterns to more centrally-located communities – comprehensive smart growth programs effect emissions reductions through changes in mode split, number of trips taken and average trip length.

Comprehensive Smart Growth: Rule of Thumb
Regional VMT Reduction: 3-20%[136]

Sample Calculation

The comprehensive smart growth estimate is based on top down case study evidence rather than the bottom-up impacts to individual variables.

Daily VMT Savings	
VMT BAU	25,000,000
VMT Comprehensive Smart Growth	22,500,000
Difference	2,500,000
Percent Savings	**10%**

Emissions and Fuel Savings

Comprehensive Smart Growth	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**10%**	358273	25.550	76.650	$73,000,000	36,500,000

Comprehensive Smart Growth	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	1408.926	65.477	47.619	77.381	21346.845	2792.599
Tons Per Day	3.860	0.179	0.130	0.212	58.485	7.651

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

The successful implementation of comprehensive smart growth programs reduces congestion and VMT, which improves air quality and provides environmental, social and economic co-benefits. Environmental benefits include:[137]

- reducing the rate of land use change, habitat loss and fragmentation

[134] SACOG, Preferred Blueprint Scenario: http://www.sacregionblueprint.org/sacregionblueprint/the_project/discussion_draft_preferred_scenario.cfm.
[135] Envision Utah, Quality Growth Strategy and Technical Review, January 2000: http://envisionutah.org/January2000.pdf
[136] Based on the MPO smart growth studies referenced above.
[137] US EPA (2001) "Our Built and Natural Environments": http://www.epa.gov/smartgrowth/pdf/built.pdf

- improving levels of water pollution resulting from surface water runoff
- protecting ground water resources
- reducing levels of air pollutant deposition

Social benefits include:

- reduced rates of obesity by increasing levels of physical activity[138]
- fewer health related impacts of vehicle emissions[139]
- reduced climate change impact on health[140]
- greater social equity due to improved transportation and housing choices[141]

Researchers at Rutgers University estimate that smart growth strategies, relative to conventional growth patterns, can yield an economic savings of $250 billion over the next 25 years.[142] Developers, new home buyers and commercial tenants, as well as local and state governments would reap these savings. Additional benefits include:

- decreased expenditure on public infrastructure i.e. roads, sewers, schools[143]
- lower private costs for transportation i.e. fuel, car insurance
- reduced costs of congestion to individuals and businesses[144]
- lower public and private health care expenditures

KEY ISSUES/IMPLEMENTATION

Among critics of smart growth policies, one of the most commonly cited issues is the potential impact on housing affordability. Policies that restrict growth such as urban growth boundaries and zoning regulations limit the supply of available land, thus driving up the cost of housing. Studies conducted in the Atlanta region indicate that the availability of new housing in and around job centers for middle and low income families is increasingly limited.[145,146 ,147 ,148]

Barriers to implementation of comprehensive smart growth programs found at both the state and local levels include:[149]

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[138] Environmental and Energy Study Institute (2004) "The Public Health Effects of Sprawl: http://www.eesi.org/publications/Briefing%20Summaries/10.2.03%20Briefing%20Summary.pdf

[139] New England Journal of Medicine (2004) "The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age":http://content.nejm.org/cgi/content/short/351/11/1057

[140] Pollution Probe (2004) "Primer on Climate Change and Human Health": http://www.pollutionprobe.org/Reports/climatechangeprimer.pdf

[141] Atlanta Neighborhood Development Partnership Inc: http://www.andpi.org/mici/

[142] Burchell, R., and D. Listokin *Linking Vision With Capital: Challenges and Opportunities In Financing Smart Growth*, Center for Urban Policy Research, Edward J. Bloustein School of Planning and Public Policy, Rutgers and the Research Institute for Housing America, Institute Report No. 01-01, September 2001. : http://www.housingamerica.org/docs/RIHA01-01.pdf

[143] Center for Clean Air Policy (2003) "State and Local Leadership on Transportation and Climate Change": http://www.ccap.org/pdf/statetransport_climat.pdf

[144] Texas Transportation Institute (2004) "2004 Urban Mobility Study": http://mobility.tamu.edu/ums/report/

[145] Atlanta Neighborhood Development Partnership Inc: http://www.andpi.org/mici/

[146] Burchell and Listokin, *op cit.*

[147] National Association of Realtors, "2004 American Community Survey: Homebuyers Favor Shorter Commutes, Walkable Neighborhoods: http://www.realtor.org/sg3.nsf/pages/NARSGA2004Survey?OpenDocument

[148] Nelson, A. "Effects of Urban Containment on Housing Prices and Landowner Behavior,"Lincoln Institute of Land Policy, *Land Lines* newsletter, May 2000. http://www.lincolninst.edu/pubs/pub-detail.asp?id=298

[149] Vermont Forum on Sprawl (2001) "Growing Smarter: Making Smart Growth Work": http://www.vtsprawl.org/Pdfs/bestresource.pdf

- lack of public participation in the planning process
- prevalence of 'not in my back yard' (NIMBY) attitudes
- inconsistency between local plans and land use regulations
- land use regulations that continue to discourage smart growth e.g., large lot sizes
- state and federal transportation infrastructure spending policies often pull investments to previously undeveloped areas, with transportation spending often focusing on new highways
- finance redevelopment in the urban core is often difficult and more expensive
- mixed use developments face complex and time consuming approval processes

CASE STUDIES

Portland, OR- The greater Portland region adopted an Urban Growth Boundary (UGB) in 1979, in to protect the state's open space and natural heritage resources. To oversee the management of the UGB and direct regional planning initiatives, the region established Metro, the only directly elected regional government in the United States. Metro is responsible for regional land use and transportation planning and ensuring local government plans agree with regional goals. Metro is also responsible for the development of the 2040 Growth Concept which aims to discourage sprawl and to encourage redevelopment in designated urban centers and transit accessible corridors over the next 50 years.

In order to accommodate the 1990's rapid population growth of 2.4% per year within the UGB, Metro implemented policies to foster more compact, transit oriented communities. These policies included the expansion of the transit system and completion of light rail lines, more compact development forms, fees to reflect the full cost of driving, enhancements to pedestrian and cycling environments and improved access to transit and other alternatives to SOV use. As part of its GHG reduction goal, the city plans to reduce metropolitan area per capita VMT to 10 percent below the 1995 level. Completion of this objective is targeted for 2010, five years earlier than required by the State Transportation Planning Rule. (http://www.northwestwatch.org/press/portlandgrowth.pdf) (http://www.metro-region.org/article.cfm?articleID=231)

The recent ballot Measure 37 threatens to hamper successful growth management efforts in Oregon, by allowing compensation or a zoning waiver in cases where land use regulation has reduced the fair market value of the property. The State Legislature may yet respond to the measure to lessen its impacts on communities and protected lands.[150]

Maryland- In 1997, under Governor Parris Glendening, Maryland adopted a comprehensive set of programs that formed the State's nationally recognized smart growth initiative. The focal point of the initiative is the Priority Funding Area legislation that restricts State funding for roads, sewers, schools and public infrastructure projects to areas within designated development zones. Other programs in the legislative package are: the Rural Legacy Program (to preserve agricultural and open space resources), the Brownfields program, the Live Near Your Work and the Job Creation Tax Credit. In 2003 Governor Ehrlich signed an Executive Order continuing Maryland's smart growth initiative by providing assistance from state agencies to support quality development in designated areas. (http://www.epa.gov/ecocommunity/case1/smartgrowth.htm)

Massachusetts- The Office of Commonwealth Development (OCD) was created in 2001 to safeguard both built and natural environments through the integration of state level

[150] 1000 Friends of Oregon, http://www.friends.org/issues/m37.html.

policies, programs and regulations to achieve sustainable development goals. The OCD includes the agencies responsible for environmental affairs, transportation and construction, housing and community development and energy resources. The office aims to promote the co-ordination and cooperation of all agencies to achieve efficient and effective state investment in smart growth. During its first year the Office of Commonwealth Development partnered with the Massachusetts Bay Transit Authority (MTBA) in a transit-oriented development program. The *Commonwealth Capital* policy strives to coordinate capital spending programs to ensure consistency between development projects and sustainable development principles. The *Fix-It-First* policy prioritizes maintenance of existing infrastructure over new construction.
(http://www.mass.gov/ocd/)

New Jersey- Governor James McGreevy addressed the issues associated with sprawl through Executive Order 4, issued in 2002, which established the Smart Growth Policy Council. The council's mandate is to develop and implement inter-departmental procedures, programs, and projects that are consistent with the State Plan and smart growth principles. In addition, Executive Order 4 provides enforcement tools, such as updated municipal land use laws, to assist local government and communities in achieving smart growth objectives. Strong emphasis has also been placed on open space preservation to conserve existing natural and agricultural areas and redirect growth towards higher density regions. Other programs include brownfield redevelopment, commuter rail service improvements and the "upstairs downstairs" program which encourages property owners to build residences above downtown commercial units.
(www.state.nj.us/cgi-bin/governor/njnewsline/view_article.pl?id=624)

KEY RESOURCES & REFERENCES

American Planning Association- policy guide of smart growth includes the APA adopted definition of smart growth, description and history of the issues and APA smart growth policy motions and their outcomes:
http://www.planning.org/policyguides/smartgrowth.htm

Brookings Metropolitan Policy Program – "Redefining the challenges facing metropolitan America and promoting innovative solutions to help communities grow in more inclusive, competitive, and sustainable ways." The website includes reports, commentary and analysis:
http://www.brookings.edu/metro/metro.htm

Canadian Mortgage and Housing Corporation- "Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighborhood Sustainability", highlights the importance of macro scale urban structures on greenhouse gas emissions reductions
http://www.cmhc.ca/publications/en/rh-pr/socio/socio050.pdf

Center for Clean Air Policy- "Two for the Price of One: Smart Growth and Clean Air," a background primer for a policy forum hosted by CCAP and LGC in December 2004, provides an overview of 1) Clean Air Act structure and the federal policy framework as it relates to the implementation of smart growth and other state and federal air quality and transportation policies and programs, 2) transportation planning and emissions modeling, and 3) implementation of land use and air quality policies and programs.
http://www.ccap.org/transportation/smart_two.htm

Fannie Mae Foundation- "Retracting Suburbia: Smart Growth and the

Future of Housing", a report highlighting the way housing can be used to support smart growth policies:
http://www.fanniemaefoundation.org/programs/hpd/pdf/hpd_1003_danielsen.pdf

Georgia Tech – Released in 2004 the Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality (SMARTRAQ) study illustrates the relationship between urban form, transportation and health. The study emphasized the connection between areas of higher residential and employment density, mixed land uses and street connectivity with lower levels of VMT and air pollution emissions and elevated levels of physical activity and transit use:
http://gtresearchnews.gatech.edu/newsrelease/smartgrowth.htm

Metro-region- information on the Portland regional 2040 Growth Concept, adopted as part of the Region 2040 growth plan in 1995, in addition to other regional land use initiatives:
http://www.metro-region.org/article.cfm?articleID=231

National Association of Local Government Environmental Professionals- the report "Smart Growth is Smart Business" highlights the economic advantages to smart growth and provides profiles of businesses that have accounted for smart growth in their business strategies:
http://www.resourcesaver.com/file/toolmanager/CustomO93C337F52733.pdf

National Center for Smart Growth Research and Education- provides information on smart growth research at the University of Maryland, including information on the state's past and present smart growth policies:
http://www.smartgrowth.umd.edu/index.htm

Planetizen – updated daily, this website provides information on all aspects of planning, urban design and development. A key feature is its daily news clips from around the world:
http://www.planetizen.com/

Smart Growth America- "Measuring Sprawl and its Impact: The Character & Consequences of Metropolitan Expansion", a report that evaluates and measures urban sprawl and its impacts, including the sprawl index which ranks major US cities:
http://www.smartgrowthamerica.org/sprawlindex/sprawlindex.html

Smart Growth Network- "Getting to Smart Growth I & II: 100 Policies for Implementation", outlines 10 principles of smart growth and policies that can be used to implement them:
http://www.smartgrowth.org/pdf/gettosg.pdf
http://www.smartgrowth.org/pdf/gettosg2.pdf

US Environmental Protection Agency- "Our Built and Natural Environment, a Technical Review of the Interactions between Land Use, Transportation and Environmental Quality. In the report, the U.S. EPA summarizes technical research on the relationship between the built and natural environments, as well as current understanding of the role of development patterns, urban design, and transportation in improving environmental quality.
http://www.epa.gov/livability/pdf/built.pdf

4.2 Public Participation in Planning

OVERVIEW

Smart growth principles are implemented most effectively when supported by efforts to actively engage and educate the public. Public involvement in the planning process generates greater awareness of existing regional patterns of growth and the implications of unsustainable development patterns. This participation, including input from poor and minority communities, helps to counter-act NIMBY attitudes that may be a barrier to smart growth planning.[151]

The development of new techniques and technologies enhances or sometimes obviates traditional forms of public consultation such as public meetings. Some of the methods used to expand communication with the public on smart growth issues include:

- **Community Design Charrettes**- are interactive collaborative processes that involve all interested parties in workshops, focus group discussions and design sessions, and can be incorporated into site specific project designs as well as long term local and regional planning processes[152]
- **Visioning** - a technique that allows the public, assisted by technical experts to develop a vision for what the community would look like given specific public policy decisions. The process often includes the development of growth scenarios that project the tradeoffs between various growth patterns[153]
- **Visual Preference Surveys-** provide a visual means for participants to compare, contrast and select preferred physical characteristics of their community. They are used to help citizens and planners visualize the impact of policy and development proposals, resulting in informed planning and regulatory decisions[154]
- **Computer simulation technologies**- include Computer Aided Design (CAD) and Geographic Information Systems (GIS) applications. GIS based models have been used to aid community members in assessing the environmental, economic and transportation impacts of land use decisions. Examples include PLACE^{3}S and INDEX models that draw on parcel level and use data to determine the effect of alternative growth scenarios on community indicators[155]

POLICY QUANTIFICATION

There is no generalized method of quantifying the benefits from including the public in the planning process. Benefits are contingent upon designed scope, level of effort and efficacy of the programs to increase public participation and eventual implementation.

CO-BENEFITS

The integration of public participation into land use and transportation planning processes enhances the development of smart growth initiatives. Benefits include:

- making planning decisions that more accurately reflect community values
- enhancing community awareness of growth related issues

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[151] Title VI, 42 U.S.C. § 2000d et seq., was enacted as part of the landmark Civil Rights Act of 1964. It prohibits discrimination on the basis of race, color, and national origin in programs and activities receiving federal financial assistance. This law is forms the legal basis for ensuring full participation by minority groups in federal and state planning processes.

[152] National Charrette Institute: http://www.charretteinstitute.org/charrette.html

[153] Smart Growth BC (2001) "Citizen Involvement Tools": http://www.smartgrowth.bc.ca/downloads/J1_ToolKitPart_III.pdf

[154] Local Government Commission: http://www.lgc.org/freepub/land_use/participation_tools/visual_surveys.html

[155] Federal Highway Administration (2004) "GIS Tools for Transportation and Community Planning": http://www.fhwa.dot.gov/tcsp/case7.html

- increasing public support for policies
- improving the quality of planning through increased accountability
- reducing conflict among parties and increasing implementation speed
- increasing the stability and longevity of the plan, program or policy[156]

KEY ISSUES/IMPLEMENTATION

Public participation in planning processes can benefit from micro-simulation computer simulation tools such as INDEX and PLACE^{3}S. These computer visualization tools allow the public to "see" new development projects and plans and thus can bolster support for good planning. However the use of computer based techniques often is prohibitively costly for most local planning organizations. The dissemination of accessible tools will be important in achieving the full benefits of computer simulation techniques.

Good planning effectively engages citizens in development issues central to the planning process. However, this requires a strong commitment from both planners and the public. Sherry Arnstein's "Ladder of Citizen Participation"[157] published in 1969 outlines levels of public participation ranging from non-participation to tokenism to citizen power. The decision to implement specific public participation techniques depends upon the desired degree of citizen involvement.

Public participation in planning processes can help ensure community buy-in and support for project implementation. However there is the risk that if a project or vision with public support is not adopted it can breed skepticism around the planning process.

CASE STUDIES

Sacramento Area Council of Governments (SACOG) - the Sacramento Region *Blueprint Transportation and Land Use Study* was recognized with an EPA Smart Growth Award for its use of state-of-the-art Geographic Information Systems (GIS) and web based modeling techniques that provide data on the effects of current and future land use decisions. Participants in community workshops are able to examine the impact of growth scenarios on indicators such as traffic congestion, air pollution, employment, housing availability and open space in order to help design a community vision. This process determined a preferred growth strategy that will guide development in the Sacramento region and ultimately be integrated into the region's LRTP. Initial quantified estimates of Blueprint's preferred growth alternative show reductions of up to 25 percent in per capita VMT and 15 percent in criteria pollutants.
(http://www.sacregionblueprint.org/sacregionblueprint/)

Salt Lake City, UT- *Envision Utah* was initiated in 1996 as a public-private community partnership mandated to assess the region's predicted growth and to develop strategies to preserve the quality of life in the state. The process included extensive public participation in the form of community workshops to provide participants with hands-on experience balancing population growth, community preservation and open space protection. Four Growth management scenarios were constructed and presented for public evaluation through surveys and public meetings. The scenarios represented a range of density and transportation options, supported by in-depth modeling of emissions, growth and

[156] Local Government Commission: http://www.lgc.org/freepub/land_use/participation_tools/community_planning.html
[157] Arnstein, S. (1969) "A Ladder of Citizen Participation": http://lithgow-schmidt.dk/sherry-arnstein/ladder-of-citizen-participation.html

infrastructure costs. The result of the three year process was a Quality Growth Strategy based on public support for the second highest density scenario. Envision Utah developed a successful process that builds community support and credibility for smart growth. (http://www.envisionutah.org/)

Southern California Area of Governments (SCAG)- the *Southern California Compass Growth Vision Report* released in June 2004, concentrated mixed use, higher density pedestrian and transit oriented development in urban areas and along transit corridors. The process integrated advanced technical modeling used to analyze the dynamics of the region's development, with a series of regional and sub-regional hands on workshops to assess community values and vision. The community workshops served as the core of the public participation process and were used to formulate alternative growth scenarios from which a preferred growth strategy emerged. (http://www.socalcompass.org/about/report/pdf/fullreport.pdf)

Washington DC- In February 2005, the Urban Land Institute adopted a participatory GIS-based approach using INDEX Paint the Region, for its Reality Check growth visioning exercise. The process involved 300 regional stakeholders and developed alternative growth scenarios for the Washington region. The INDEX tool provided real-time simulation and impact assessment to enhance the interactive planning process. (http://ivic02.residentinteractive.com/programs/web.show_html2?xinput=1914456&parentid=1299410)

KEY RESOURCES & REFERENCES[158]

Federal Highway Administration- a case study that outlines GIS tools for transportation and community planning:
http://www.fhwa.dot.gov/tcsp/case7.html

Local Government Commission- provides tools and information on public participation and land use planning including visual preference surveys, computer simulation and participatory land use mapping:
http://www.lgc.org/freepub/land_use/participation_tools/visual_surveys.html

PlaceMatters.Com- provides descriptions of community planning and visioning tools, case studies, and other resources on place-based planning.
http://www.placematters.com/

National Charrette Institute- information and links to resources about charrettes and the urban design process:
http://www.charretteinstitute.org/

Surface Transportation Policy Project- "Asking Transit Users about Transit-Oriented Design", addresses the use of visual preference surveys in transit facility planning:
http://trb-pi.hshassoc.com/publications/00059.pdf

Surface Transportation Policy Project California- provides highlights of visioning activities in California and across the United States:
http://www.transact.org/ca/RegionalVisioning.pdf

[158] For more smart growth resources, see http://www.neighborhoodcoalition.org/Smartgrowth/default.asp

4.2 Public Participation in Planning

The Orton Family Foundation- the website provides information on community planning tools including *CommunityViz™,* a GIS-based decision support software for community planning:
http://www.orton.org/programs/viz/index.shtml

US Department of Transportation- the FHWA/FTA guide to public involvement techniques including information on public meetings, participant feedback and finding new communication techniques:
http://www.planning.dot.gov/Pitool/1-intro.asp

US Environmental Protection Agency- *"The History of Envision Utah"* is an in-depth look at the development of Envision Utah process:
http://www.epa.gov/smartgrowth/pdf/envision_utah.pdf

4.3 Open Space Programs

OVERVIEW

Open space preservation programs are a means to protect natural and agricultural areas considered significant community spaces, recreational lands, plant and animal habitats, environmentally sensitive areas or productive agricultural lands.[159]

Currently 86% of the land used to grow fruits and vegetables is threatened by development pressures.[160] Many states and localities acknowledge the social, economic and environmental benefits of open space preservation and have actively used them to promote smart growth initiatives. Maintaining open space areas enhances local quality of life and helps to direct growth into already established communities.

Open space preservation improves local and regional air quality through the maintenance of the natural features of open space. Features such as vegetative land cover, especially mature stands of trees, remove pollutants from the air and provide a sink for carbon dioxide. Open space areas can also encourage people to bicycle and walk if coupled with provision of integrated, safer and more attractive transportation corridors. This results in fewer VMT (especially for local trips) which translates into reduced traffic congestion and less vehicular emissions.[161]

Open space preservation programs integrate a wide number of tools at both state and local levels to achieve land conservation targets, including:[162]

- protective rural zoning
- tax incentives
- transferable development rights
- matching funds
- urban growth boundaries
- conservation easements[163]

CO-BENEFITS

Benefits resulting from open space protection depend upon the location of the protected space relative to the population centers and trip destinations. Thus, no generalized method of quantification is provided. Policies protecting open space on the edges of communities, can promote emissions reductions, while open space protection within city boundaries can increase emissions by driving development further from the central city. Open space protection is most effective at reducing vehicle emissions when coordinated with policies such as TOD and infill that can help guide growth into more efficient locations and minimize leap-frog and ex-urban development.

Strong public and political support for open space preservation efforts is attributed to the wide range of benefits associated with preservation programs. These include:[164]

- protection of water supply and quality, including the filtration of pollutants, flood control and protecting aquifer recharge areas
- provision of wind buffers to control erosion

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[159] Smart Growth Online: http://www.smartgrowth.org/about/principles/principles.asp?prin=6
[160] American Farmland Trust, http://www.farmland.org/farmingontheedge/index.htm
[161] USDA Forest Service: http://www.fs.fed.us/ne/syracuse/
[162] For more information, see http://www.planning.org/cpf/resources.htm or http://www.smartgrowth.org/about/principles/resources.asp?resource=6&type=12&res=800
[163] Maryland Environmental Trust: http://www.conservemd.org/policy/smartgrowth/index.html
[164] Wake County (2003) "Open Space Plan": http://www.wakegov.com/general/openspace/plan.htm

- preservation of plant and animal habitats
- enhancement of non-motorized transportation options through improved pedestrian and bicycle routes
- health benefits attributed to increased outdoor recreation opportunities
- provision of social and educational opportunities
- protection of valued natural heritage features and productive agricultural lands

In addition to the social and environmental implications of open space and agricultural preservation, there are a wide range of economic benefits including:[165]

- maintain farms and forests
- increase property value and property tax revenues
- reduce infrastructure costs
- potential increases in tourism expenditures in local communities
- economic activities associated with a sustainable timber industry
- enhanced quality of life, attractive places to live and works
- cost effective approach to preserve environmental quality
- smart growth programs reduce infrastructure costs

KEY ISSUES/IMPLEMENTATION

Although public support for open space preservation initiatives remains high, key issues must be addressed to ensure their effectiveness. These include:

- ensuring open space preservation occurs in conjunction with measures to promote more sustainable growth patterns in order to avoid leap frog development patterns
- the need for well-defined selection criteria for selecting which areas to protect
- funding for land protection policies or acquisition
- maintaining adequate lands for housing development
- strong opposition from the development industry
- the rights of individual property owners vs. societal benefits

CASE STUDIES

Florida- In 1999 the *Florida Forever Act* established the largest land conservation program in the United States. The program dedicated $3 billion over ten years to the state's open space resources in both natural and urban areas. This follows the successful completion of the Preservation 2000 program that protected 1.75 million acres of natural land between 1990 and 2000 for endangered species habitat and large land acquisitions. The expansion of the state wide preservation program to include urban communities will provide funding for parkland, trail and open space preservation.
(http://www.dep.state.fl.us/lands/acquisition/p2000/)

Maryland- Maryland's *Rural Legacy Program,* launched in 1997 is the focal point of land conservation efforts under the state's smart growth initiative. As of September 2002, the program has permanently protected over 32,000 acres of land from future development. The program provides up to $140 million dollars over five years to acquire agricultural, forest and open spaces under development pressure. This program supplements state wide smart growth initiatives to redirect growth away from ecologically sensitive rural regions towards already established urban centers.
(http://www.dnr.state.md.us/rurallegacy/)
(http://www.conservemd.org/purchased/rurallegacy/)

[165] New York State Department of Environmental Conservation (2002) "Open Space Conservation Plan": http://www.dec.state.ny.us/website/opensp/2002/FnlChapter2_OSP.PDF

4.3 Open Space Programs

New Jersey- The *Garden State Preservation Act* passed in 1999 created a model for open space preservation programs in the United States. Through a dedicated sales tax used to match county and municipal funds, the program will generate $2 billion over ten years to fund open space and farmland conservation efforts. Over the first five years the state preserved 120,000 acres of farmland and 250,000 acres of open space, with a goal 1,000,000 acres permanently protected by 2009. The program includes special measures to preserve land in the New Jersey Pinelands region through the use of "Pinelands Development Credits". Developers who own land in Regional Growth Areas can purchase development credits from landowners in preservation and agricultural production areas to increase density in their projects.
(http://www.state.nj.us/dep/greenacres/preservation.htm)

New York- Released in 2002, the *Open Space Conservation Plan* outlines the State's land preservation initiatives. In an effort to achieve Governor Pataki's target of one million acres of land under preservation, programs have been initiated in the state through annual budget allocations, State Environmental Protection Fund and the Clean Water/Clean Air Bond Act. Since their adoption, these mechanisms have provided over $378 million in funding used to preserve 394,000 acres. In addition, open space programs have been targeted in the State Energy Plan as a mechanism to reduce suburban sprawl, and promote air quality objective.
(http://www.dec.state.ny.us/website/opensp/)

Ontario, Canada- The development pressures facing the Oak Ridges Moraine in southern Ontario, forced the provincial government to take a legislative approach to land conservation. Passed in 2001, the Oak Ridges Conservation Act establishes the Oak Ridges Moraine Conservation Plan to direct land use across the moraine. Included in the preservation efforts were agreements with developers to exchange environmentally sensitive land on the moraine for developable land in existing built up areas. Further action to protect the province's open spaces was taken in October with the release of the Greenbelt Protection Plan and legislation. The legislation protects an additional 1 million acres, bringing the total land preserved in the region to 1.8 million acres. The Greenbelt Protection Plan is a key component to the province's growth strategy aimed at redirecting growth into its urban centers.
(http://www.mah.gov.on.ca/userfiles/HTML/nts_1_31_1.html)
(http://www.premier.gov.on.ca/english/news/Greenspace102804.asp)

Portland, OR- In the 1970s Portland began protecting the agricultural and natural spaces that surrounded the city. The city established an urban growth boundary (UGB) to redirect growth into Portland's existing regional centers. The UGB is an integral component of Portland's success in protecting rural land. Greater Portland added nearly half a million new residents in the past decade with most of the growth going to already established mid-density suburban neighborhoods. The region took a comprehensive approach that integrated open space preservation policies with urban land use and transportation planning. It is estimated that in the absence of such policies Portland would have lost between 88 and 279 square miles of rural land, farmland, and open space to development pressures.
(http://www.northwestwatch.org/scorecard/portland04.asp)

Washington- The state enacted the Growth Management Act (GMA) in 1990 as a response to the unplanned and uncoordinated growth that was occurring in the state. The act

motivated local comprehensive plans that make provisions for 20 years of growth including, land use, housing, capital facilities, transportation, utilities, shorelines, and rural areas. Undertaking the designation of natural resource lands, critical areas such as wetlands for conservation is the mandatory first step in participation. Goals, such as protecting the environment, maintaining open space and habitat areas alongside transportation and efficient land use guide plans and regulations developed under GMA. Currently, 29 counties and 218 cities are fully planning under these guidelines. .
(http://www.cted.wa.gov/DesktopDefault.aspx?TabId=7I15)

KEY RESOURCES & REFERENCES

American Farmland Trust- has helped win permanent protection for over a million acres of American farmland:
http://www.farmland.org/

Bay Area Open Space Council- "Regional Strategies for Preserving Our Open Space Heritage" a report outlining Bay Area open space preservation programs and projects:
http://www.openspacecouncil.org/Documents/OSC/ProgramDescription2004.03.28.pdf

Brookings Institution- "TDRs and Other Market-Based Land Mechanisms: How They Work and Their Role in Shaping Metropolitan Growth":
http://www.brookings.edu/urban/pubs/20040629_fulton.pdf

Brookings Institution- "The Link between Growth Management and Housing Affordability: the Academic Evidence":
http://www.brookings.edu/es/urban/publications/growthmang.pdf

Lincoln Institute of Land Policy- "Reinventing Conservation Easements," an article by Jeff Pidot in *Land Lines*, April 2005.
http://www.lincolninst.edu/pubs/pub-detail.asp?id=1010

Maryland Environmental Trust- Land Conservation Center includes information on Maryland's conservation programs as well as public policy tools to support land conservation:
http://www.conservemd.org/policy/keygrowth/

National Governors Association- the website provides information on topics associated with working lands conservation, including the growth and quality of life tool kit, transfer of development rights and background papers on private land conservation:
http://preview.nga.org/Files/pdf/01022PRIVATELANDS.pdf

New Jersey Pinelands Commission- is an example of a comprehensive management plan used to preserve an at risk landscape from development:
http://www.state.nj.us/pinelands/infor/broch/

Ontario Ministry of Municipal Affairs and Housing- website contains information on the greenbelt protection plan, the benefits of greenbelts and the planning process:
http://www.mah.gov.on.ca/userfiles/HTML/nts_1_16289_1.html

The Trust for Public Land- State funding profiles provide a brief overview of state open space preservation programs:
http://www.tpl.org/tier3_cdl.cfm?content_item_id=872&folder_id=706

4.3 Open Space Programs

The Trust for Public Land- "Economic Benefits of Parks and Open Space": http://www.tpl.org/tier3_cdl.cfm?content_item_id=1145&folder_id=727

US Department of Energy- Smart Communities Network Land Use Planning Strategies provides links to state and local organizations, online open space planning resources: http://www.sustainable.doe.gov/landuse/open.shtml

4.4 Municipal Parking Programs

OVERVIEW

Parking pricing and supply restrictions are two methods used to deter personal vehicle use, especially single occupancy vehicle (SOV) use, in areas with easily accessed transit alternatives. Parking supply restrictions, like parking pricing, encourage utilization of transit, cycling and walking. Parking supply restrictions have additional benefits such as freeing up land for other purposes and lowering maintenance costs. These management policies ensure the appropriate supply of parking for a given area by neither subsidizing nor otherwise encouraging the building of excess parking spaces.

When designed in conjunction with other land use and pricing measures, parking pricing policies are one of the most effective ways to reduce VMT, congestion and air pollution. Employee programs that offer parking cash – a program that allows employees or other receiving free parking spaces to opt out of having a space and instead receive compensation – are particularly successful. Studies conducted by the US Environmental Protection Agency of various employee parking programs indicate a 12-39 percent reduction in VMT and a 66-81 percent reduction in SOV use to worksites. Similarly, community wide pricing programs resulted in a 19-31 percent reduction in vehicle trips.[166]

There are several specific methods for reducing the demand for parking, some of which include:

- smart growth parking codes[167]
- maximum parking requirements for new developments
- limiting total available parking
- new or increased parking fees within transit accessible areas
- taxation of parking providers
- employee parking cash out [168]

POLICY QUANTIFICATION

Parking policies effect reductions by impacting mode split and number of trips taken. The mode split shifts away from automobile use as more transportation choices become cost competitive. Number of trips diminishes as the marginal trip is avoided. Automobile trips shifted from SOV's to carpools are captured in the 'trips taken' number.

Parking Program: Rule of Thumb
Site-level VMT Reduction: 15-30%[169]

Sample Calculation

The changes in mode split are based on typical changes brought about through the implementation of parking programs as represented in the EPA studies referenced above.

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[166] US EPA (1997) "Opportunities to Improve Air Quality through Transportation Pricing Programs": http://www.epa.gov/oms/market/pricing.pdf

[167] Local Government Commission, "Overcoming Obstacles to Smart Growth through Code Reform": http://www.lgc.org/freepub/PDF/Land_Use/sg_code_exec_summary.pdf

[168] US EPA Transportation Control Measures: http://yosemite.epa.gov/aa/tcmsitei.nsf/9bd6f3b7217f80c28525652f0053e105/f7c81d21f88949a8852565d9007181a8?OpenDocument

[169] Quantification for parking program based on EPA studies referenced above

4.4 Municipal Parking Programs

The emission savings based on 100,000 trips in the business-as-usual case are illustrated in the emissions summary table.

The calculations were derived using the following assumptions:

Assumptions	Base Case	Municipal Parking Programs
Total Trips per Day	100,000	**90,000**
Mode Split		
Automobile	95%	**85%**
Transit/Walking/Biking	5%	**15%**
Average Automobile Trip Length	5.0	5.0
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*quantification for parking program based on EPA study referenced above

The VMT savings calculation for the parking programs case is detailed below:
VMT Savings = (100,000 × 5.0 × 0.95) – (90,000 × 5.0 × 0.85) = 92,500 miles per day.

Note that this approach assumes zero marginal emissions impact due to increased transit utilization (i.e., no new transit vehicle trips are assumed to be needed at this scale of ridership increase).

Daily VMT Savings	
VMT BAU	475,000
VMT Parking Pricing	382,500
Difference	92,500
Percent Savings	**19%**

Emissions and Fuel Savings

Municipal Parking Programs	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**19%**	13256	0.945	2.836	$2,701,000	1,350,500

Municipal Parking Programs	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Annual Emission Reductions (Tons)	52.130	2.423	1.762	2.863	789.833	103.326
Tons Per Day	0.143	0.007	0.005	0.008	2.164	0.283

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Parking supply and pricing mechanisms in conjunction with incentives for public transit use result in a variety of benefits to the local municipality, including:

- reduced demand for parking infrastructure
- increased use of public transit to accessible destinations
- efficient means to achieve air quality and congestion objectives
- support of infill redevelopment
- increased revenues for municipalities

- increased affordability of housing due to smaller parking requirement and lower housing development costs[170]

KEY ISSUES/IMPLEMENTATION

Successful municipal parking programs require the coordination of municipal planning and transportation bodies to effectively address local sustainable transportation initiatives. Further implementation issues include:

- parking programs are more effective if required by municipal by-law vs. voluntary measures
- parking requirements often do not reflect current parking demand in urban centers. Current research and data are required to develop more context-specific parking requirements[171]
- parking management options may require high levels of political commitment to overcome local business or employer opposition
- developers may be reluctant to limit the parking availability if they believe it will have a negative impact on the long-term marketability of their property
- demand for parking may be displaced to surrounding communities without parking restrictions
- parking policies in central areas could encourage employers to locate in more sprawling locations

CASE STUDIES

California- The state parking cash out law requires that specific employers offer the option of cash in lieu of parking to employees. Case studies indicated a decline in commute related vehicle emissions ranging between 5 and 24% for the eight California firms studied. (http://www.arb.ca.gov/planning/tsaq/cashout/cashout.htm)

Minneapolis, MN- Downtown Minneapolis employers implemented variations of parking cash out programs which resulted in an average modal shift of 11% and increased bus ridership of 47%. Parking cash out allows employees greater choice for their commute to work.
(http://www.mplstmo.org/pages/parking_alt.htm)

Portland, OR- Portland replaced minimum parking requirements with maximum standards that vary with transit accessibility. This initiative has benefited both city planning sustainability aims and developers seeking lower project costs
(http://www.smartgrowth.org/pdf/PRKGDE04.pdf)

[170] Victoria Transport Policy Institute (2004)"Parking Requirement Impacts on Housing Affordability": http://www.vtpi.org/park-hou.pdf

[171] Forinash et al. (2004) "Smart Growth Alternatives to Minimum Parking Requirements," Transportation Research Board 83rd Annual Meeting. January 2004.

4.4 Municipal Parking Programs

KEY RESOURCES & REFERENCES

California Department of Transportation- "Statewide Transit-Oriented Development (TOD) Study, Parking and TOD: Challenges and Opportunities": http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Parking%20and%20TOD%20%20Report.pdf

California Environmental Protection Agency, Air Resources Board- parking cash-out incentives, includes eight case studies: http://www.arb.ca.gov/research/resnotes/notes/98-3.htm

US Environmental Protection Agency-Transportation Control Measures: Program Information Directory: http://yosemite.epa.gov/aa/tcmsitei.nsf/0/f7c81d21f88949a8852565d9007181a8?OpenDocument

US Environmental Protection Agency- "Parking Alternatives: Making way for Urban Infill and Brownfield Redevelopment": http://www.smartgrowth.org/pdf/PRKGDE04.pdf

US Environmental Protection Agency- "Opportunities to Improve Air Quality through Transportation Pricing Programs" provides a discussion of transportation pricing mechanisms as well as detailed case studies: http://www.epa.gov/otaq/transp/publicat/pub_mrkt.htm

Victoria Transport Policy Institute- "Parking Requirement Impacts on Housing Affordability": http://www.vtpi.org/park-hou.pdf

West Coast Environmental Law- The Smart Bylaws Guide provides information on scaling parking requirements to neighborhood needs: http://www.wcel.org/issues/urban/sbg/Part4/parking/

4.5 Safe Routes to School

OVERVIEW

Safe routes to School programs encourage parents and children to walk and bike to school through the provision of safer pedestrian environments. By creating more walkable and bikeable communities, these initiatives help achieve air quality targets while promoting local health benefits. The potential reduction in vehicle miles traveled associated with school transportation can lead to declining air pollution, fuel consumption and greenhouse gas emissions.

Studies conducted on traffic congestion and automobile emissions in Santa Rosa, California indicate that during the school year there is an increase of 30 percent in vehicles on the road during school drop off hours.[172] Reducing reliance on automobiles for school transportation would not only reduce VMT, but also improve traffic flow for others as well. Improving and expanding Safe Routes to School encourages children to participate in programs such as "Walk to School Wednesdays" and the "Walking School Bus."[173]

School zones, particularly at the urban edge where zones tend to be larger, are hot spots for vehicle exhaust during peak hours. Safe Routes to School programs, by reducing the number of vehicles, can help reduce peak concentration of vehicle emissions.

POLICY QUANTIFICATION

A Safe Routes policy effects emissions reductions through a shift in mode split primarily towards walking and biking modes.

Safe Routes to School: Rule of Thumb
Site-level VMT Reduction: 0-5%[174]

Quantification Methodology

Estimating changes in mode split is the principle step in quantifying the impact of the Safe Routes policy. Pilot case studies can be used to obtain estimated shifts in mode split. Targeted changes in mode split may also be used.

1. Determine travel characteristics of school
   - Average trip length
   - Number of trips taken
   - Mode split
2. Estimate changes in mode split
   - Case studies
   - Targeted changes
3. Calculate difference in VMT, energy, emissions

VMT Savings = VMT0 – VMTp= (T0 ´ TL0 ´ M0) – (Tp x TLp x Mp)

[172] US EPA (2003) "Travel and Environmental Implications of School Siting": http://www.epa.gov/livability/school_travel.htm

[173] Active and Safe Routes to School: http://www.saferoutestoschool.ca/

[174] Based on Marin County Case Study demonstrating 57% increase in walking and biking modes (from a base of 4%). "Safe Routes to School, Marin County" Programs: http://www.saferoutestoschools.org/marin.html

Where: T = number of trips, TL = average trip length, M = Percent of trips utilizing automobiles. Subscripts denote base (0) and policy (p) cases.

Emissions Savings = VMT Savings x Emission Factors

Sample Calculation

The changes in mode split are based on the Marin County case study.[175] The emission savings based on 5,000 trips to and from the school site are illustrated in the emissions summary table.

The calculations were derived using the equation above and the following assumptions:

Assumptions	Base Case	Safe Routes to School
Total Trips per Day	5,000	5,000
Mode Split-Bus	50%	50%
Mode Split-Automobile	46%	**44%**
Mode Split-Transit/Walking/Biking	4%	**6%**
Average Automobile Trip Length	7.0	**7.2**
Price per Gallon Gasoline	$2.00	$2.00
MPG	25.0	25.0
Grams CO2 per Gallon	9,816	9,816

*mode split for safe routes quantification based on Marin County case study referenced above

Note that average automobile trip length increases in the policy case as the shorter vehicle trips are avoided in favor of pedestrian and bicycle trips.

The VMT savings calculation for the Safe Routes to School case is detailed below:
VMT Savings = (5,000 × 7.0 × 0.46) – (5,000 × 7.2 × 0.44) = 266 miles per day

Daily VMT Savings	
VMT BAU	16,100
VMT Safe Routes to School	15,834
Difference	266
Percent Savings	**2%**

Emissions and Fuel Savings

Safe Routes to School	VMT Reduction (%)	CO_2 (annual metric tons)	N_2O (annual metric tons)	CH_4 (annual metric tons)	Annual Fuel Cost Savings	Annual Fuel Savings (Gallons)
Total	**2%**	38	0.003	0.008	$7,767	3,884

Safe Routes to School	NOx	PM-10	PM-2.5	SO_2	CO	VOC
Annual Emission Reductions (Tons)	0.150	0.007	0.005	0.008	2.271	0.297
Tons Per Day	0.000	0.000	0.000	0.000	0.006	0.001

[175] *Ibid*

4.5 Safe Routes to School

For additional calculation details and an opportunity to input your own data and assumptions, please see the Guidebook Emissions Calculator. Please see the appendix for information on a variety of transportation models.

CO-BENEFITS

Safe Routes to School programs are championed by community and health organizations in hope of improving the health and safety of school age children in local communities. Benefits of such programs include:[176]

- reduction in traffic congestion associated with school transportation
- reduction in child pedestrian and cycling injuries and fatalities
- increased physical activity among school aged children
- increased independence and community interaction for children and parents

KEY ISSUES/IMPLEMENTATION

Safe Routes to School programs follow several models depending on the needs and resources of the local community. The most successful programs incorporate options from four primary models, they include:

- *Engineering Model* i.e., expanded sidewalks, traffic calming measures, crosswalks
- *Education/Encouragement Model* i.e., the generation of interest in safe walking and cycling options for parents and students
- *Enforcement Model* i.e., the enforcement of traffic laws around school zones to alter driver behavior
- *Dedicated Resource Model* i.e., based on legislation which directs state funds to local Safe Routes to School Programs[177]

CASE STUDIES

California- State level initiatives have taken a national lead in Safe Routes to School program development. Legislation directing $25 million in funding for engineering measures to promote Safe Routes to School was renewed in 2001 until 2005. (http://www.dot.ca.gov/hq/LocalPrograms/saferoute2.htm)

Marin County, CA- In Marin County, communities are actively participating in Safe Routes to School programs. Schools involved in the initial pilot projects experienced a 57% increase in the number of students walking and biking to school. Projects included safe routes mapping, walk and bike to school days, frequent rider miles cards, walking school buses and classroom education. (http://www.saferoutestoschools.org/marin.html)

New York City, NY- Inspired by the success of the Bronx Safe Routes to School program, New York City Department of Transportation announced funding for both a "Safe Routes to School" and a "Walk to School" program targeting 135 priority school locations. (http://www.nyc.gov/html/dot/html/about/pr2004/pr04_30.html)

Other States- Many state and local governments have undertaken Safe Routes to School programs including Florida, Texas, Washington and Arizona. (http://www.transact.org/report.asp?id=49)

[176] Local Government Commission (2001) "California Safe Routes to School Initiative": http://www.lgc.org/freepub/PDF/Land_Use/safe_routes_to_school.pdf

[177] STPP Inventory of Safe Routes to School programs: http://www.transact.org/report.asp?id=49

4.5 Safe Routes to School

KEY RESOURCES & REFERENCES

Active and Safe Routes to School- Provides examples of programs, resources for students and links to international Safe Routes to School programs:
http://www.saferoutestoschool.ca/

California Department of Health Services Safe Routes to School Program- provides links to California's Safe Routes to School resources and Walk to School days:
http://www.dhs.ca.gov/epic/sr2s/

California Office of Traffic Safety- "Transportation tools to improve children's health and mobility", a fact sheet examining California's state initiatives:
http://www.dhs.ca.gov/epic/sr2s/documents/SR2STranspoTools.pdf

International Walk to School Week- provides information on international involvement in Walk to School Week:
http://www.iwalktoschool.org/

Local Government Commission- outlines issues surrounding schools and smart growth communities, provides resources and links to LGC research and programs:
http://www.lgc.org/community_design/schools.html

Maryland Department of Transportation- "Maryland Safe Routes to School Guidebook" includes information on state programs and the development and implementation of local plans and programs:
http://fha.state.md.us/fha/cphs/chn/pdf/SR2S_Guidebook_1.pdf

National Center for Biking and Walking- case studies of Safe Routes to School programs:
http://www.bikewalk.org/safe_routes_to_school/SR2S_case_studies.htm

TECHNICAL APPENDIX

REGIONAL TRANSPORTATION, LAND USE AND AIR QUALITY MODELING

This Technical Appendix includes discussion of regional transportation, land use and air quality modeling including:

A. Accounting for Land Use in the 4-Step Modeling Process
B. Specific Local Limitations of Travel Models
C. Micro scale Sketch Models
D. Emissions Calculators
E. Regional Scenario Modeling
F. Regional Visioning Scenarios

Reader's note: The following section provides an overview of transportation and land use modeling, a discussion of such tools' limitations and an introduction to factors that may affect transportation and air quality analyses. The section includes a brief sampling – in no way intended to be comprehensive or represent endorsements – of both regional and site-specific models used by transportation and air quality professionals, both in the United States and around the world. We also have included a discussion of regional visioning scenarios which, while not modeling per se, have important and growing linkages to the tools identified here.

A. Accounting for Land Use in the 4-Step Modeling Process

When doing regional planning most MPOs use regional transportation models known as travel demand models (or forecasting models). These complex tools use a series of mathematical equations to represent the supply and demand for regional travel. These are defined as: trip generation, trip distribution, mode choice, and trip assignment. The first three of these steps estimate the demand for travel and the fourth step then allocates the demand for travel with the supply of travel (i.e., road or transit network).

The 4-step transportation modeling process is linked to mobile source emissions via the US EPA's Mobile emissions model for everywhere except California, where MPOs rely on the Emissions Factors model (EMFAC) model.[178] These tools contain complex mobile source emissions factors that calculate the resulting NOx, PM, VOCs and other criteria pollutant emissions for the MPO regions.

In 4-step models, land use is a basic input, developed by local planning officials through a process of negotiation. This approach often reflects the land use outcomes *desired* by local politicians, while discounting other factors that are known to influence development patterns, such as travel accessibility and traffic congestion. There are a number of models that address this shortcoming through integrated modeling of both transportation and land use, [179] although they are thought to be used in fewer than twenty metropolitan areas.[180]

B. Specific Local Limitations of Travel Models

[178] For information on Mobile and EMFAC, see http://www.epa.gov/otaq/mobile.htm and http://www.fresnocog.org/training/Background%20Information_2.pdf, respectively.
[179] These include UrbanSim, TRANUS, MEPLAN, DRAM-EMPAL, METROSIM, PECAS and MetroScope.
[180] It's also worth noting that land use projections from these models are not typically "official," and are generally revised by local planning officials.

Beyond the broad focus of accounting for regional land use patterns, today's travel models have several areas in which they are unable to estimate local travel choices or land use patterns. These include:

- **Localized travel patterns.** Regional forecasting models do a poor job of accounting for localized travel and land use patterns, including mixed use development and local transit services. This is primarily due to the spatial scope of these models. Travel demand models divide regions into hundreds or thousands of geographic units called transportation analysis zones (TAZs). Thus, travel demand models are designed to forecast trips length and type between TAZs but are less able to account for shorter trips taken within TAZs.
- **Non-motorized trips.** The spatial limitations cited above mean that travel demand models are also extremely limited when it comes to accounting for nonmotorized trips (i.e., walking or biking). For example, in Atlanta, GA a mixed-used, infill development called Atlantic Station has received accolades for its travel and emissions benefits; site-specific studies have found half the VMT and significant reductions in NOx and VOCs vs. a comparable greenfield site.[181] However, a typical regional travel model would likely fail to estimate the full richness of benefits from an Atlantic Station-type development by not accounting for newly generated walking and biking trips taken within the TAZ, which are created in part from the mixed-use element of the site.[182]
- **Local site and roadway design.** Travel demand models typically fail to capture other local aspects of so-called smart growth development, such as traffic calming (especially in and around intersections), building site design (again mixed-use characteristics) and other road characteristics of smart growth neighborhoods.
- **Induced travel.** Building a new road or adding lanes is the traditional approach to addressing traffic congestion. In the short-term, such capacity expansion can lead to reduced travel times and improved traffic flow. The economic theory of supply and demand, however, indicates that more of a good is consumed after supply increases. Thus, over time, new roads and lanes fill up with more traffic resulting in more driving overall. Increased road capacity can also ease access to more distant destinations and make development economically attractive in more remote locations. Various studies show that each ten percent increase in metropolitan-area lane-miles leads to a four to nine percent increase in travel demand over the long-term.[183] Induced travel, is only partially represented in most travel demand models.

So, while travel models are the best tools we have for forecasting travel patterns on a regional scale, it is clear from the examples cited that they also may fail to capture some VMT reductions (and emissions benefits) from local smart growth developments.

C. Microscale Sketch Models

In part to fill the gaps inherent in regional modeling, planners and developers have built computer-based tools to simulate the travel and emissions impacts of small scale, site-specific developments. While more simplistic than regional 4-step models, these 'local' models give a rough sense of how local land use impacts emissions by capturing such elements as: site design; local transit service; mix of uses; and other characteristics typically associated with smart-growth style developments. This is important because such

[181] http://www.epa.gov/smartgrowth/topics/atlantic_steel.htm
[182] The Atlanta Regional Council's (the local MPO) travel demand model included some adjustments as well as off-line analyses to estimate the VMT and emission benefits from the Atlantic Station development. Other less-high profile projects are less likely to see this time and effort.
[183] *Working Together to Address Induced Demand.* Eno Transportation Foundation, Washington, D.C., 2002 p. 16.

developments may support densities that will ultimately bolster transit, walking and biking options locally and over the long-term, may even provide regional benefits (e.g., reduced congestion) from more diverse, sustainable transportation networks. Further, these tools often allow the public to visualize the design, density and environmental impact of local planning decisions.

Current examples of sketch planning tools include: Smart Growth Index, Community Viz and PLACE3S. These desktop models allow planners to vary the "3 Ds" density, design (e.g., street grid, sidewalks) and diversity (mix of uses), as well as local transit service. The use of scenario-based tools can also help educate the public by letting them "see" the impact of land use changes. It is no coincidence that these tools estimate the travel and emissions benefits that the larger models miss. These microscale models can fall short, however, when it comes to capturing the VMT or emissions impacts from either changes in regional development or adjustments to regional transit service (i.e., LOS changes or inter-TAZ route adjustments). While these computer simulations are not perfect, using them in conjunction with regional travel models can help MPOs better understand and illustrate the benefits of local land use decisions. Below we highlight a few examples of *transportation sketch modeling tools*:

- **Planning for Community, Energy, Economic, and Environmental Sustainability (PLACE3S)** is a land use and urban design method created specifically to help communities understand how their growth and development decisions can contribute to improved sustainability. For more information, see http://www.sustainable.doe.gov/articles/place3s.shtml
- The **Smart Growth Index** (SGI) is a GIS sketch model for simulating alternative land-use and transportation scenarios, and evaluating their outcomes using indicators of environmental performance: regional growth management plans, land-use, transportation and neighborhood plans, land development reports, environmental impact reports, and special projects, e.g. brownfield redevelopment, annexation, etc. For more information, see http://www.epa.gov/smartgrowth/topics/sg_index.htm
- **CommunityViz** was developed by The Orton Family Foundation, the nonprofit Vermont- and Colorado-based operating foundation that assists small cities and towns with growth and development pressures. CommunityViz provides GIS-based analysis and 3D modeling that allow people to envision land use alternatives and understand their potential impacts. For more information, see http://www.communityviz.com/

The PlaceMatters.com website also offers a listing of tools to assist planning and impact assessment. For more information see http://www.smartgrowthtools.org/index.php

D. Emissions Calculators

In recent years there have been a large number of tools, allowing individuals, businesses and governments to quantify the greenhouse gas emissions from their daily activities. Most of the tools are available free of charge and are web-based. Below we list several of the more frequently cited calculators, emphasizing those focusing on transportation and climate emissions.

- Focusing on transportation, **TravelMatters** provides users with information and tools to evaluate the impact of their daily transportation choices on global atmospheric processes. Whether calculating the greenhouse gas contribution of a journey-to-work in a personal automobile, or the combined emissions of a transit fleet using natural gas instead of diesel fuel, the emissions calculator at TravelMatters helps to link the

abstract trends of climate change to concrete decisions made in daily life. For more information, see http://www.travelmatters.org/

- The ICLEI **Climate Calculator**, http://www3.iclei.org/co2/co2calc.htm and the World Resources Institute's **Safe Climate carbon footprint calculator**, http://safeclimate.net/calculator/ both allow user to quantify and save carbon dioxide emissions from transportation travel scenarios, including a variety of modes.
- US EPA's **COMMUTER Model**, http://www.epa.gov/otaq/transp/traqmodl.htm#commuter, allows the user to calculate the transportation and emissions benefits of Best Workplaces for Commuters and other voluntary strategies to reduce drive-alone commuting trip. The tools offers two levels of analysis: regional analyses on programs covering an urban area, a central business district or a highly-traveled corridor and site-specific analyses enable benefits to be projected for programs at individual worksites.
- **Bicycle and Pedestrian Planning Tools.** FHWA has several tools on bicycle and pedestrian planning strategies and approaches. For more information on quantifying non-motorized travel, please see *Guidebook on Methods to Estimate Non-Motorized Travel, http://www.fhwa.dot.gov/tfhrc/safety/pubs/vol1/title.htm*. Also see the Victoria Policy Institute's *Quantifying the Benefits of Nonmotorized Transportation For Achieving Mobility Management Objectives*. This paper discusses methods for evaluating the benefits of improved walking and cycling conditions, increased nonmotorized travel, and shifts from motorized to nonmotorized modes. Please see, http://www.vtpi.org/nmt-tdm.pdf

E. Regional Scenario Modeling

- **MetroQUEST** is a computer simulation tool that allows users to create and compare future scenarios of their region. The consequences of their choices are illustrated using colorful maps and graphs and a wide range of smart growth indicators from air quality to unemployment. For more information, see http://www.envisiontools.com/questsite/index.html

For More Information on Land use and Transportation Models…

US and Canadian reviews of land use, sustainability and transportation models
Federal Highway Administration (Emissions analysis for Transportation Control Measures)
http://www.fhwa.dot.gov/environment/cmaqeat/descriptions.htm

Environmental Protection Agency (Statewide modeling and inventories)
http://www.epa.gov/otaq/models.htm

US Department of Energy (Land Use Planning Tools)
http://www.sustainable.doe.gov/landuse/tools.shtml

Canadian government review of greenhouse gas emissions calculators
http://www.on.ec.gc.ca/community/ecoaction/greenhousecalcs-e.html

F. Regional Visioning Scenarios

While public participation is an important part of planning, the public participation component of the transportation planning process has often been an after thought --

meaning that the details of the planning process is still typically complex and mysterious to the general public. However, recent advances in visualization scenarios including charrettes, board games, and computer simulations have helped engage the public early by allowing them to see how increased density in their community can in fact improve their quality of life by provide rich housing and retail diversity while adding to the community's bottom line by reducing fiscal spending on new infrastructure (i.e., sewer and water lines).

To use one example, the Blueprint project in Sacramento, California has been recognized for its use of state-of-the-art Geographic Information Systems (GIS) and web based modeling techniques to provide data on the effects of current and future land use decisions. Participants in community workshops are able to examine the impact of growth scenarios on indicators such as traffic congestion, air pollution, employment, housing availability and open space in order to help design a community vision. This process has determined a preferred growth strategy that will guide development in the Sacramento region and ultimately be integrated into the region's LRTP. Initial quantified estimates of Blueprint's preferred growth alternative show reductions of up to 25 percent in per capita VMT and 15 percent of criteria pollutants.

A Final Comment: The Need for Public Input in Regional Scenario Analyses
Most transportation planners agree that good planning requires a proper regional perspective coupled with strong public input, as seen in the examples above. Many of the elements required for a successful regional plan are included in Part I of the CCAP Transportation Emissions Guidebook, including: comprehensive regional planning targeted infrastructure spending, incentives and transit improvements. Yet in order to create and implement at truly comprehensive regional plan public involvement is a fundamental first step.

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