What Can Metropolitan Areas Do to Reduce Transportation Energy Consumption and GHG Emissions Through Land Use Strategies?

Michael D. Meyer, Parsons Brinckerhoff

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<table>
<thead>
<tr>
<th>Strategy</th>
<th>Number of Respondent Organizations Reporting Strategy Considered as Part of Planning Process</th>
<th>DOTs</th>
<th>MPOs</th>
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<tbody>
<tr>
<td>Total number of respondents</td>
<td></td>
<td>14</td>
<td>43</td>
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<tr>
<td>Total Number of Respondents Who Have or Will Consider GHG Emissions in Planning</td>
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<td>11</td>
<td>30</td>
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<tr>
<td>Transportation system planning and design</td>
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<td>15</td>
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<tr>
<td>Construction and maintenance practices</td>
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<tr>
<td>Transportation system management and opns</td>
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<td>3</td>
<td>20</td>
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<tr>
<td>Vehicle and fuel policies</td>
<td></td>
<td>3</td>
<td>15</td>
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<tr>
<td>Land use codes, regulations, and policies</td>
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<td>2</td>
<td>18</td>
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<tr>
<td>Taxation and road pricing</td>
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<td>3</td>
<td>7</td>
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<tr>
<td>Travel demand management (passenger)</td>
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<td>19</td>
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<td>Travel demand management (freight)</td>
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<td>2</td>
<td>5</td>
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<td>Transit strategies</td>
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<td>3</td>
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<tr>
<td>Public education</td>
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<td>2</td>
<td>12</td>
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<tr>
<td>Bicycle and pedestrian</td>
<td></td>
<td>3</td>
<td>23</td>
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</tbody>
</table>
Focus of Most Land Use Strategies

- Spatial (urban) form
- Density
- Urban design
- Connectivity (and corresponding policies, e.g., parking)
Sustainable Building Energy Footprints

“No whole-building site selection evaluation framework exists for quantifying, under uncertainty, the energy consumption and GHG emissions from transportation and building systems.”

Elements of whole-building energy consumption and GHG emissions

Utility Energy

Onsite Renewable Energy

Energy Supply

Whole-Building Energy / GHGs

Transportation

Distance

Mode

Speed

Frequency

Operation

HVAC & Plumbing

System Type

Load

Lighting

System Type

Load

Conveyances

System Type

Load

Plug & Process
Relative proportion of direct, metered (site) energy consumption of building and transportation systems.
VMT and GHG Reduction Estimates from Compact Development (vs. Typical Suburban Development)

<table>
<thead>
<tr>
<th>Study</th>
<th>VMT Reductions</th>
<th>GHG Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving Cooler</td>
<td>20–60%</td>
<td>20–60%</td>
</tr>
<tr>
<td>Growing Cooler</td>
<td>20–40%</td>
<td>18–36%</td>
</tr>
<tr>
<td>Driving and the Built Environment</td>
<td>5–12 to 25%</td>
<td>5–12 to 25%</td>
</tr>
</tbody>
</table>
Driving and the Built Environment
The Effects of Compact Development on Motorized Travel, Energy Use, and CO₂ Emissions
Findings

• Developing more compactly, that is, at higher residential and employment densities, is likely to reduce VMT. More compact, mixed-use development can produce reductions in energy consumption and CO$_2$ emissions both directly and indirectly.
Findings

• The literature suggests that doubling residential density across a metropolitan area might lower household VMT by about 5 to 12 percent, and perhaps by as much as 25 percent, if coupled with higher employment concentrations, significant public transit improvements, mixed uses, and other supportive demand management measures.
Findings

• Illustrative scenarios developed by the committee suggest that significant increases in more compact, mixed-use development will result in modest short-term reductions in energy consumption and CO₂ emissions, but these reductions will grow over time.
Findings

• Promoting more compact, mixed-use development on a large scale will require overcoming numerous obstacles. These obstacles include the traditional reluctance of many local governments to zone for such development and the lack of either regional governments with effective powers to regulate land use in most metropolitan areas or a strong state role in land use planning.
Findings

• Changes in development patterns significant enough to substantially alter travel behavior and residential building efficiency entail other benefits and costs that have not been quantified in the study.
What Is Compact Development?

Successful compact development is a land use settlement pattern that features most or all of the following:

- concentrations of population and/or employment;
- medium to high densities appropriate to context;
- mix of uses;
- interconnected streets;
- innovative and flexible approaches to parking;
- pedestrian-, bicycle-, and transit-friendly design; and
- access and proximity to transit.

Urban Land Institute, *Land Use and Driving The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions*, 2010
### State/Local Gov’t Strategies that can Influence Transportation-Related GHG Emissions and Energy Use, SHRP2, C09

<table>
<thead>
<tr>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Construction and Maintenance Practices</td>
</tr>
<tr>
<td>• Transportation System Management and Operations</td>
</tr>
<tr>
<td>• Transportation Planning and Funding</td>
</tr>
<tr>
<td>• Land Use Codes, Regulations, and other Policies</td>
</tr>
<tr>
<td>• Taxation and Pricing</td>
</tr>
<tr>
<td>• Other Travel Demand Management and Public Education</td>
</tr>
<tr>
<td>• Public Education</td>
</tr>
</tbody>
</table>
| Land Use Codes, Regulations, and other Policies | · Integrated regional transportation and land use planning and visioning  
· Funding incentives and/or technical assistance for local policies for compact development, walkable communities, mixed-use development, reduced parking requirements, etc.  
· Infrastructure investments to support in-fill and transit-oriented development |
<table>
<thead>
<tr>
<th>Taxation and Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• State or local tax policies that discourage low-density development</td>
</tr>
<tr>
<td>• Congestion pricing</td>
</tr>
<tr>
<td>• Pay-as-You-Drive Insurance</td>
</tr>
<tr>
<td>• Parking pricing</td>
</tr>
<tr>
<td>• Mileage-based transportation user fees</td>
</tr>
<tr>
<td>• Vehicle registration fees based on fuel efficiency, carbon emissions, or miles driven</td>
</tr>
</tbody>
</table>
Sustainable Communities and Climate Protection Act of 2008 (SB 375)

**Blueprint Growth Strategy**

- Provide a variety of transportation choices;
- Offer housing choices and opportunities;
- Use existing assets;
- Take advantage of compact development;
- Preserve open space, farmland, natural beauty, through natural resources conservation;
- Encourage distinctive, attractive communities with quality design; and
- Encourage mixed land uses.
“These results demonstrate that GHG reductions from increasing residential density will be modest in the near-term (the next one to two decades), but can cumulate over time. If multiple policy instruments are used together (e.g. mixing residential and commercial land use, improving metropolitan job accessibility), their combined impact could be considerably larger than what would be obtained by only changing residential density.”

--California Air Resources Board, Policy Brief on the Impacts of Residential Density Based on a Review of the Empirical Literature
California Air Resources Board Land Use Strategies

- Residential Density
- Distance to Transit (Transit Access)
- Land Use Mix
- Network Connectivity
- Regional Accessibility
- Jobs-Housing Balance
Los Angeles Sustainable Corridors
Land Use and Development

• Create policy to target funding to stations with the greatest capacity to change
• Create programs and activities to enhance the identity of the Orange Line
• Enhance destinations along the corridor
• Create TOD design guidelines
• Create TOD-supportive development incentives
• Implement existing land use and specific plans
• Create new specific plans or updated Community Plans
Land Use and Development

- Revisit City's industrial land policy
- Pursue joint development of Metro property at Orange Line stations
- Pursue workforce and affordable housing
- Create "modified parking requirement" (MPR) districts
## Distance to Transit and VMT

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Year</th>
<th>Variable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewing and Cervero</td>
<td>Multiple U.S. and int’l</td>
<td>Multiple years since 1985</td>
<td>1 mile closer to transit, with no distinction for rail and bus, no outer distance for the effect</td>
<td>-2.5%</td>
</tr>
<tr>
<td></td>
<td>locations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pushkar, Hollingwort, and Miller</td>
<td>Toronto, Canada</td>
<td>1996</td>
<td>1 mile closer to rail station, from 2 miles to 1 mile from station, with no distinction for rail and bus</td>
<td>-1.3%</td>
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</tbody>
</table>
### Distance to Transit and VMT

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Year</th>
<th>Variable</th>
<th>VMT reduction per distance to station reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bento, Cropper, Mobarak, and Vinha</td>
<td>U.S.</td>
<td>1990</td>
<td>10% decrease in distance to a transit stop, with no distinction between rail and bus, no outer distance for the effect</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Bailey, Mokhtarian, and Little</td>
<td>U.S.</td>
<td>2001</td>
<td>1 mile closer to rail station, within 2.25 miles of station, ¼ mile closer to bus stop, within 0.75 miles of bus stop</td>
<td>-5.8% -2.0%</td>
</tr>
</tbody>
</table>
## Land Use Mix and VMT

<table>
<thead>
<tr>
<th>Study</th>
<th>Location (metaanalysis)</th>
<th>Year</th>
<th>Variable</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewing and Cervero</td>
<td>Various</td>
<td>1997-2009</td>
<td>Land use mix (entropy)</td>
<td>0.09% decrease in household VMT per 1% increase in entropy</td>
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<tr>
<td>Ewing and Cervero</td>
<td>Various</td>
<td>1997-2009</td>
<td>Jobs-housing imbalance</td>
<td>0.02% decrease in household VMT per 1% decrease in jobs-housing imbalance</td>
</tr>
</tbody>
</table>

California Air Resources Board, Policy Brief on Land Use Mix and VMT from a Review of the Empirical Literature
## Land Use Mix and VMT

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<th>Variable</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Frank et al.</td>
<td>Seattle</td>
<td>1999</td>
<td>Land use mix (entropy)</td>
<td>0.02% decrease in household VMT for each 1% increase in entropy</td>
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<tr>
<td>Chapman &amp; Frank</td>
<td>Atlanta</td>
<td>2001-2</td>
<td>Land use mix (entropy)</td>
<td>0.04% decrease in VMT per person for each 1% increase in entropy</td>
</tr>
</tbody>
</table>

California Air Resources Board, Policy Brief on Land Use Mix and VMT from a Review of the Empirical Literature
## Land Use Mix and VMT

<table>
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<tr>
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<th>Variable</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Kockelman</td>
<td>San Francisco Bay Area</td>
<td>1990</td>
<td>Land use dissimilarity and land use mix (entropy))</td>
<td>0.10% decrease in household VMT per 1% increase in either index</td>
</tr>
<tr>
<td>Chapman &amp; Frank</td>
<td>National</td>
<td>1990</td>
<td>Jobs-housing imbalance</td>
<td>0.06% decrease in household VMT per 1% decrease in imbalance</td>
</tr>
</tbody>
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California Air Resources Board, Policy Brief on Land Use Mix and VMT from a Review of the Empirical Literature
Portland GreenSTEP Scenario Analysis

1. Metropolitan GreenSTEP

Initial testing of a range of policies for impacts on transportation GHG emissions and other transportation related evaluation measures.

Generalized data includes:
- Urban design characteristics
- Roadway characteristics
- Marketing characteristics
- Possibly fleet and pricing

Urban design inputs go from general to more specific.

2. Sketch Planning Tool

Use a sketch planning tool to develop more detailed urban design (land use and transportation) scenarios and concepts, thus improving the Urban design inputs that go into Metropolitan GreenSTEP.

Non-geographic analysis can be done during the early organizational steps of scenario planning without using sketch planning tools (refer to discussion at page 54-55 in Step 3).

3. Metropolitan GreenSTEP

Test a select number of alternative scenarios using alternate Urban Design inputs, which can be variations of the initial generalized data or come from the detailed outputs of the sketch planning tool, converted for use in GreenSTEP.

Geographically specific information gets converted into usable data for GreenSTEP.
Denver COG Scenario Analysis

- More development around transit
- BETTER ACCESS TO TRANSIT
- More transit use
- Less driving
- Cleaner air
- More efficient water use
- LESS CONGESTION

- More development in urban centers
- LESS LAND CONSUMPTION
- Less spending on infrastructure
- LESS NEED FOR NEW WATER TREATMENT FACILITIES
Research

• Studies of changing housing and travel preferences:

Studies of the housing preferences and travel patterns of an aging population, new immigrant groups, and young adults are needed to help determine whether future trends will differ from those of the past.
Research

- **Longitudinal studies**: Federally funded empirical studies based on panel data would allow better control for socioeconomic characteristics and self-selection, thus helping to isolate the effects of different types of development patterns on travel behavior.
Studies of spatial trends within metropolitan areas:

Studies that track changes in metropolitan areas at finer levels of spatial detail over time (e.g., the evolution of employment subcenters and changing patterns of freight distribution) would help determine the needs and opportunities for policy intervention.
Research

- **Before-and-after studies** of policy interventions to promote more compact, mixed-use development:

  Careful evaluations of pioneering efforts to promote more compact, mixed-used development would help determine what works and what does not.
Research

• **Studies of threshold population and employment densities** to support alternatives to automobile travel:

Studies of the threshold densities required to support rail and bus transit would help guide infrastructure investments as well as zoning and land use plans around stations. Similar threshold information is needed to determine what development densities and land use patterns are optimal to support walking and bicycling.
Research Questions

• From a public policy perspective, does it really make a difference (given changing technology)?
• Do local officials really care? What are the co-benefits?
• What is the evolving relationship among energy cost, travel behavior, urban form and technology substitutes?
• Demographics, demographics, demographics, demographics
Research Questions

- Are current land use models (which allocate activities based on travel costs as well as other factors) robust enough to reflect the changing context? If not, how to modify?
- How can land use scenario analysis be used as part of energy analyses?