CAN SMART GROWTH POLICIES CONSERVE ENERGY AND REDUCE EMISSIONS?

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This article examines the role that smart growth can play in achieving planning objectives, including energy conservation and emission reductions. Smart growth policies include zoning code changes to allow more compact, diverse and mixed development (e.g., higher buildings, attached and multi-family housing, commercial within residential neighborhoods); reduced and more flexible parking requirements; improvements to alternative modes (more sidewalks and paths, and better public transit service); more public investments in existing developed areas (brownfield cleanups, more redevelopment of urban schools and parks); regulations and incentives that discourage urban expansion; and financial incentives that reward compact, infill development (lower development fees and utility rates for infill to reflect public cost savings, and location-efficient mortgages which reflect the transport savings in such locations).[1, 2, 3, 4]

This is an important and timely issue. Many existing land use development policies tend to favor sprawl and automobile dependency.[5] Smart growth policy reforms can help create more accessible, multi-modal communities where residents tend to drive less and rely more on alternative modes. However, such reforms tend to face institutional inertia and political opposition. It is therefore important to have accurate information on their potential impacts and benefits.

This article summarizes existing literature on land use impacts on travel activity, energy consumption and pollution emissions. It discusses the overall economic, social and environmental benefits of smart growth. It examines claims that smart growth policies are ineffective and harmful.

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[1] Blais, P. (2010). Perverse cities: Hidden subsidies, wonky policy, and urban sprawl. UBC Press (www.perversecities.ca).

[2] ITE (2010). Smart growth transportation guidelines: recommended practice, Institute of Transportation Engineers (www.ite.org).

[3] SGN (2002). Getting to smart growth: 100 policies for implementation. Smart Growth Network and International City/County Management Association; at www.epa.gov/smartgrowth/getting_to_sg2.htm.

[4] USEPA (2009). Essential Smart Growth Fixes for Urban and Suburban Zoning Codes. U.S. Environmental Protection Agency; at www.epa.gov/smartgrowth/pdf/2009_essential_fixes.pdf.

[5] Levine, J. (2006). Zoned out: Regulation, markets, and choices in transportation and metropolitan land-use. Resources for the Future.

DO LAND USE POLICIES AFFECT TRAVEL, ENERGY CONSUMPTION AND EMISSIONS?

There is extensive research showing that *land use* (also called *built environment*) factors affect travel activity, energy consumption and pollution emissions.[6, 7] This implies that smart growth land use policies can help achieve various planning objectives including energy conservation and emission reductions.

Some critics claim there is little evidence of these impacts and benefits,[8] and that smart growth policies harm consumers.[9] I disagree. I believe that there is abundant evidence that smart growth land use policies can provide substantial reductions in per capita vehicle travel, energy use and pollution emissions; that these can provide numerous economic, social and environmental benefits; and that there is growing consumer demand for smart growth communities.[10]

It is true, as critics argue, that compact development (i.e., higher density) alone has only modest impacts, and these effects partly reflect self-selection (people who, for any reason cannot drive tend to choose smart growth locations).[11] However, plenty of good research indicates that land use factors (regional accessibility, density, mix, street connectivity, walkability, public transit proximity, and efficient parking management) do significantly affect vehicle travel, fuel use and emissions.[12] Table 1 summarizes these impacts based on my review of this literature.

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[6] Bartholomew, K. and Ewing, R. (2009). Land use-transportation scenarios and future vehicle travel and land consumption: A meta-analysis. *Journal of the American Planning Association*, 75(1):13–27.

[7] Frank, L. D., Greenwald, M. J., Kavage, S., and Devlin, A. (2011). An assessment of urban form and pedestrian and transit improvements as an integrated GHG reduction strategy. Washington State Department of Transportation.

[8] Fruits, E. (2011). Compact development and greenhouse gas emissions: A review of recent research. *Center for Real Estate Quarterly Journal*, 5(1):2–7; at www.pdx.edu/sites/www.pdx.edu.realestate/files/media_assets/quarterly_report/march_2011/01%20Fruits%20Quarterly%202011-02.pdf.

[9] Pisarski, A. (2009), ULI *Moving Cooler* report: Greenhouse gases, exaggerations and misdirections. Retrieved May 6, 2011, from http://www.newgeography.com/content/00932-uli-moving-cooler-report-greenhouse-gases-exaggerations-and-misdirections.

[10] Litman, T. (2011). Evaluating smart growth savings. Victoria Transport Policy Institute; at www.vtpi.org/sg_save.pdf.

[11] Ewing, R. and Cervero, R. (2010). Travel and the built environment: A meta-analysis. *Journal of the American Planning Association*, 76(3):265–294.

[12] Brandes, U., MacCleery, R., Peterson, S. J., and Johnston, M. (2010). Land use and driving: The role compact development can play in reducing greenhouse gas emissions: Evidence from three studies. Urban Land Institute.

Table 1: Land Use Impacts on Travel[13]

Factor	Definition	Travel Impacts
Density	People or jobs per unit of land area (acre or hectare).	Increased density tends to reduce per capita vehicle travel. Each 10% increase in urban densities typically reduces per capita VMT by 2-3%.
Mix	Degree that related land uses (housing, commercial, institutional) are mixed	Increased land use mix tends to reduce per capita vehicle travel, and increases use of alternative modes, particularly walking for errands. Neighborhoods with good land use mix typically have 5-15% lower vehicle-miles.
Regional Accessibility	Location of development relative to regional urban center.	Improved accessibility reduces per capita vehicle mileage. Residents of more central neighborhoods typically drive 10-30% fewer vehicle-miles than residents of more dispersed, urban fringe locations.
Centeredness	Portion of commercial, employment, and other activities in major activity centers.	Increased centeredness increases use of alternative commute modes. Typically 20-50% of commuters to major commercial centers drive alone, compared with 80-90% of commuters to dispersed locations.
Connectivity	Degree that walkways and roads are connected and allow direct travel between destinations.	Improved roadway connectivity can reduce vehicle mileage, and improved walkway connectivity tends to increase walking and cycling.
Roadway design and management	Scale, design and management of streets.	More multi-modal street design and management increases use of alternative modes. Traffic calming tends to reduce driving and increase walking and cycling.
Walking and Cycling conditions	Quantity and quality of sidewalks, crosswalks, paths and bike lanes, and the level of pedestrian security.	Improved walking and cycling conditions increases nonmotorized travel and can reduce automobile travel, particularly if implemented with land use mix, transit improvements, and incentives to reduce driving.
Transit quality and accessibility	Quality of transit service and degree to which destinations are transit accessible.	Improved transit service quality increases transit ridership and can reduce automobile trips, particularly for urban commuting.
Parking supply and management	Number of parking spaces per building unit or acre, and how parking is managed.	Reduced parking supply, increased parking pricing and other parking management strategies can significantly reduce per capita vehicle travel. Cost-recovery parking pricing (users pay directly for parking facilities) typically reduces automobile trips by 10-30%.
Site design	The layout and design of buildings and parking facilities.	More multi-modal site design can reduce automobile trips, particularly if implemented with improved transit services.
Efficient transport pricing	More marginal-cost pricing for congestion, roads, parking facilities and vehicle insurance.	Affected travel typically declines 10-30%, depending on circumstances.

[13] Litman, T. (2005), Land use impacts on transport. Victoria Transport Policy Institute; at www.vtpi.org/landtravel.pdf.

Academics tend to be cautious so generally report lower-bound estimates of impacts and benefits. For example, one National Academy of Sciences report concluded that smart growth policies can be counted on to provide only modest emission reductions.[14] It used lower-bound estimates of impacts and assumed little change in future housing preferences, ignoring demographic and economic trends (aging population, rising fuel prices, increasing traffic congestion, increasing health and environmental concerns, etc.) that are increasing demand for smart growth locations.[15] If these factors are considered, the predicted impacts and benefits of smart growth significantly increase.[16]

That land use factors besides density significantly affect vehicle travel can be considered good news because it expands the menu of policies that can help achieve planning objectives. For example, smart growth can be applied in rural and suburban locations where high densities are inappropriate by improving land use mix, roadway connectivity, and walkability to create walkable villages.

CUMULATIVE IMPACTS

Smart growth can provide large cumulative impacts. In automobile-dependent, sprawled locations virtually every adult resident owns an automobile and uses it for most travel, and average trip lengths are relatively long. In multi-modal, smart growth locations residents tend to own fewer vehicles, drive fewer annual miles, and rely more on alternative modes. Even larger vehicle travel reductions occur where smart growth is implemented with efficient road, parking and fuel pricing; such pricing reforms tend to be more effective (price elasticities increase) at reducing vehicle travel if travelers have viable alternatives.

Figure 1 shows how location affects vehicle ownership, mileage and mode share in the Portland, Oregon region. Transit-oriented neighborhoods, with good transit and mixed land use, have far lower vehicle ownership and use, and more walking, cycling and public transit use than other areas. Residents of areas with high quality transit drive 23% less, and residents of areas with high quality public transit *and* mixed land use drive 43% less than elsewhere in the region, indicating that land use and transportation factors have about the equal impacts on travel activity.

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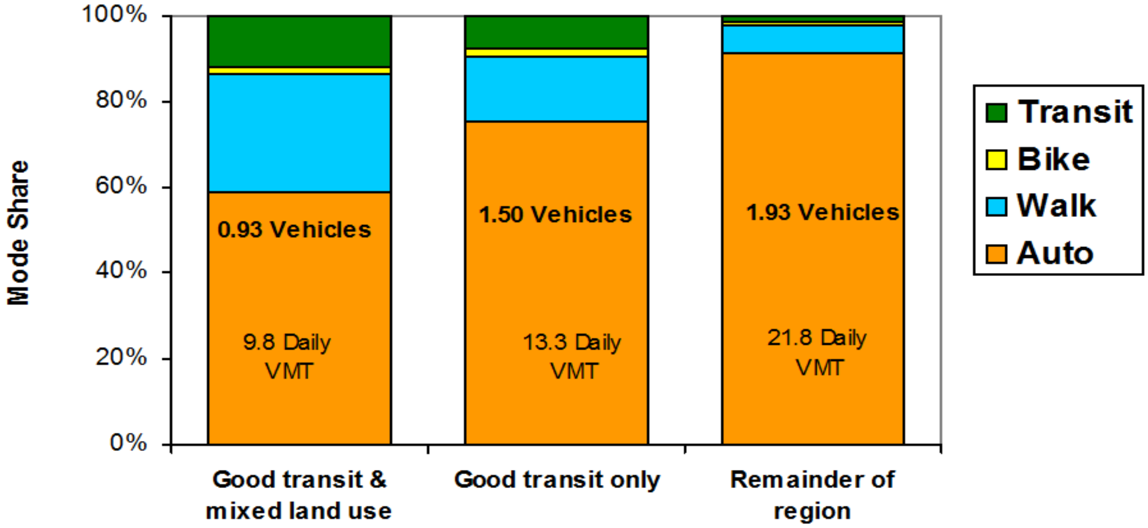
[14] Transportation Research Board (2009). *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions*. Special Report No. 298. National Academy of Sciences, 2009; at http://onlinepubs.trb.org/Onlinepubs/sr/sr298prepub.pdf.

[15] Nelson, A. C. (2006). Leadership in a new era: Comment on "Planning leadership in a new era." *Journal of the American Planning Association*, 72(4):393–409; http://law.du.edu/images/uploads/rmlui/conferencematerials/2007/Thursday/DrNelsonLunchPresentation/NelsonJAPA2006.pdf.

[16] Calthorpe Associates (2010). The role of land use in reducing VMT and GHG emissions: A critique of TRB Special Report 298; at www.calthorpe.com/files/TRB-NAS%20Report%20298%20Critique_0.pdf.

Figure 1: TOD Impacts On Per Capita Vehicle Ownership and Use[17]



A U.S. Environmental Protection Agency (EPA) study identified substantial energy conservation and emission reductions if development shifts from the urban fringe to infill.[18] The study found that individual households that shift from urban fringe to infill locations typically reduce VMT and emissions by 30-60%, and in typical U.S. cities, shifting 7-22% of residential and employment growth into existing urban areas could reduce total regional VMT, congestion and pollution emissions by 2-7%.

Another EPA study calculated both transportation and building energy savings from smart growth land use policies.[19] Travel to a building often uses as much energy as is consumed in the building.[20] Residents reduce total building and transportation energy consumption 64% by living in an attached energy efficient (green) home in an urban location, and by 75% by living in a multifamily energy efficient home, compared with the same household living in a typical detached single-family house in an auto-dependent suburb, as indicated in Figure 2. Housing location and type have greater impacts on total energy use than do vehicle or home energy efficiency, as indicated in Figure 3.

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[17] Gloria Ohland and Shelley Poticha (2006). *Street smart: streetcars and cities in the twenty-first century*. Reconnecting America (www.reconnectingamerica.org).
[18] Environmental Protection Agency (2007). Measuring the air quality and transportation impacts of infill development; at www.epa.gov/dced/pdf/transp_impacts_infill.pdf
[19] Hernandez, D., Lister, M., and Suarez, C. (2011). Location efficiency and housing type: Boiling it down to BTUs. Environmental Protection Agency; at www.epa.gov/smartgrowth/location_efficiency_BTU.htm.
[20] Wilson, A. and Navaro, R. (2007). Driving to green buildings: The transportation energy intensity of buildings. *Environmental Building News*, 16(9); at www.buildinggreen.com/auth/article.cfm?fileName=160901a.xml.

Figure 2: Residents Transport and Home Energy Consumption[21]

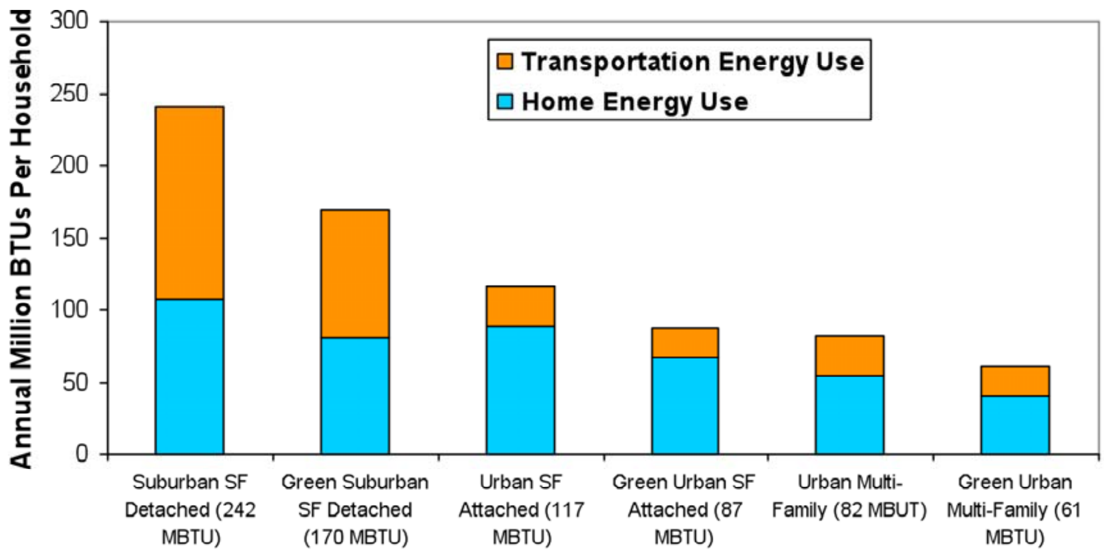
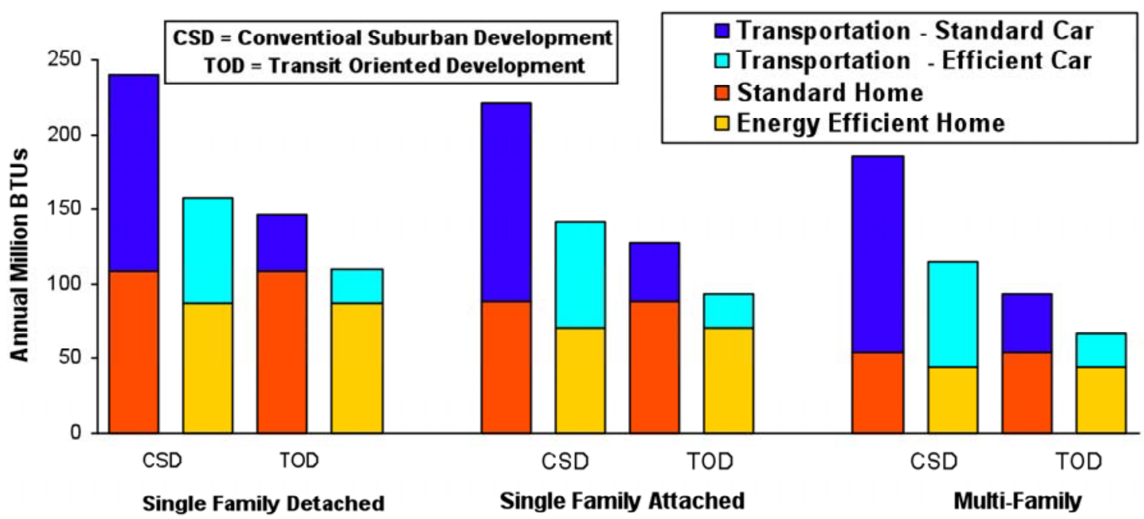


Figure 3: Residents Transport and Home Energy Consumption[22]



[21] JRC (2009), *BTU Charts and Slides*, Jonathan Rose Companies (www.rose-network.com): at www.rose-network.com/resources/charts-and-slides.

[22] JRC (2011). Location Efficiency and Housing Type—Boiling it Down to btus. Jonathan Rose Companies for the U.S. Environmental Protection Agency; at www.epa.gov/smartgrowth/pdf/location_efficiency_BTU.pdf.

COMPREHENSIVE BENEFIT ANALYSIS

Smart growth tends to provide various economic, social and environmental benefits, as summarized in Table 2.

Table 2: Smart Growth Benefits[23, 24]

Economic	Social	Environmental
Reduced development costs	Improved transport options and mobility, particularly for non-drivers	Greenspace & habitat preservation
Reduced public service costs	Improved housing options	Energy savings
Reduced transportation costs	Community cohesion	Air pollution reductions
Economies of agglomeration	Preserves unique cultural resources (historic sites, older neighborhoods, etc.)	Water pollution reductions
Supports industries that depend on high quality environments (tourism, farming, etc.)	Increased physical exercise and health	Reduced "heat island" effect.

As a result, smart growth policies that create more accessible, multi-modal communities (better walking, cycling and public transit) tend to provide more total benefits than most other energy conservation and emission reduction strategies, as illustrated in Table 3.

Table 3: Smart Growth Benefits[25]

Planning Objective	Energy Efficient Buildings	Fuel Efficient Vehicles	Smart Growth
Congestion reduction			✓
Road and parking cost savings			✓
Consumer cost savings			✓/×
Improved traffic safety			✓
Improved mobility options			✓
Energy conservation	✓	✓	✓
Pollution reduction	✓	✓	✓
Land use objectives			✓
Physical fitness & health			✓

(✓ = supports objective × = contradicts objectives)

[23] Litman, T. (2009), Evaluating transportation land use impacts. *World Transport Policy & Practice*, Vol. 1, No. 4, pp. 9-16; at www.vtpi.org/landuse.pdf.

[24] Burchell, R.W. and Mukherji, S. (2003) Conventional development versus managed growth: the costs of sprawl. American Journal of Public Health, Vol. 93, No. 9, September, pp. 1534-1540; at www.ncbi.nlm.nih.gov/pmc/articles/PMC1448006.

[25] Todd Litman (2009), *Win-Win Transportation Emission Reduction Strategies*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/wwclimate.pdf.

Current demographic and economic trends are increasing demand for smart growth location.[26] Although market surveys indicate that most North American households prefer single-family homes, they also indicate growing consumer preference for smart growth features such as accessibility and modal options (reflected as short commutes and convenient walkability to local services).[27] Twenty years ago less than a third of households preferred smart growth home locations, but this is projected to increase to two thirds of households within two decades.[28]

This is not to suggest that suburban living and automobile travel will end. Even with aggressive smart growth policies most North Americans will continue to live in single-family homes and rely primarily on automobile travel. However, the current stock of large-lot, single-family, suburban houses is predicted to satisfy market demand for the foreseeable future, while the market for smaller-lot and attached housing in accessible, multi-modal communities will grow. It therefore makes sense to implement smart growth policy reforms that help satisfy these demands, such as allowing more compact and mixed development, reducing zoning code parking requirements, and improving walking and cycling conditions and public transit service quality.

EVALUATING CRITICISMS

Some critics claim that research on smart growth's ability to reduce vehicle travel and emissions is ambiguous, and that smart growth policies have little impact on travel activity.[29] For example, Fruits claims that "At a theoretical level there is no obvious connection between compact development and mode choice." However, there are theoretical reasons to conclude that smart growth policies in general, and increased density in particular, reduce automobile travel and encourage use of alternative modes. Increased land use density increases the portion of destinations within walking and cycling distances, and increases the cost efficiency of alternative mode improvements (sidewalks and transit services) by increasing potential users per area. Potential impacts on mode choice are even greater when other smart growth policies are considered, such as increased land use mix, improved road and pathway connectivity, and complete streets roadway policies.[30], [31]

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[26] Litman, T. (2009). Where we want to be: Home location preferences and their implications for smart growth. Victoria Transport Policy Institute; at www.vtpi.org/sgcp.pdf.

[27] Belden Russonello & Stewart (2011). The 2011 Community Preference Survey: What Americans are looking for when deciding where to live. National Association of Realtors; at www.realtor.org/press_room/news_releases/2011/04/smart_growth.

[28] Nelson, A. C. (2009). The new urbanity: The rise of a new America. The Annals of the American Academy of Political and Social Science, 626(1):192–208; summary at www.froogalizer.com/news/research-on-homeownership-rate-through-2030.html.

[29] Litman, T. (2011). Evaluating criticism of smart growth. Victoria Transport Policy Institute; at www.vtpi.org/sgcritics.pdf.

[30] ITE (2010). Designing walkable urban thoroughfares: a context sensitive approach: Recommended practice. Institute of Transportation Engineers (www.ite.org).

Fruits claims that "some studies have found that more compact development is associated with greater vehicle-miles traveled" citing Crane (1996).[32] This is untrue. Crane presented theoretical analysis indicating that grid street systems may under some conditions increase vehicle travel compared with hierarchical street systems; previous research he cites indicates that higher densities do reduce vehicle travel. Subsequent research shows that more connected street systems do significantly reduce automobile travel.[33] Ewing and Cervero find that roadway connectivity has the second greatest impact on travel activity, after regional accessibility, of all land use factors analyzed.[34]

Fruits cites other studies (footnotes 4-7) which he claims indicate that density has little impact on vehicle travel and emissions, and therefore concludes, "Such insignificant results indicate that compact development policies should not be based on expectations of reduced motor vehicle usage." This conclusion is unjustified:

- There is little doubt that policies that increase density tend to reduce vehicle travel and emissions. Compact neighborhoods typically generate 20-40% less vehicle travel per capita than conventional, lower-density neighborhoods. These reductions result partly from density itself and partly from associated factors such as increased regional accessibility, land use mix and transport diversity (better walking and public transit options). To the degree they are interrelated, policies that increase density will reduce vehicle travel and emissions. For example, encouraging more compact, urban infill instead of lower-density urban-fringe development will almost certainly reduce per capita vehicle travel because it increases density, accessibility, mix and transport diversity.
- Density is just one of several land use factors that affect travel activity. Integrated smart growth policies can significantly reduce vehicle travel, energy use and emissions.
- Most studies do show a statistically significant relationship between density (isolated from other factors) and vehicle travel, only a few do not.
- Energy conservation and emission reductions are just two of many smart growth benefits. Other benefits include reduced costs of providing public services, household transportation cost savings, improved accessibility for non-drivers, reduced traffic fatality rates, improved public fitness and health, openspace preservation, and reduced stormwater management costs.

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[31] SACOG (2011). Complete streets resource toolkit. Sacramento Area Council of Governments; at www.sacog.org/complete-streets/toolkit/START.html.

[32] Crane, R. (1996). Cars and drivers in the new suburbs: Linking access to travel in neotraditional planning. *Journal of the American Planning Association*, 62(1):51–65; at www.uctc.net/papers/239.pdf.

[33] Handy, S., Tal, G. and Boarnet, M.G. (2010), *Draft policy brief on the impacts of network connectivity based on a review of the empirical literature*. Research on Impacts of Transportation and Land Use-Related Policies, California Air Resources Board; at http://arb.ca.gov/cc/sb375/policies/policies.htm.

[34] Ewing and Cervero, 2010.

The development and real estate industries can benefit financially overall from smart growth. Households often make tradeoffs between housing and transportation expenditures, so policies that create more accessible development, where consumer transportation costs are lower, can increase total real estate investments.[35] For example, real estate in transit oriented areas are typically worth 10-20% more than they would be in more automobile-oriented locations, reflecting transportation cost savings capitalized into property values.[36] Real estate foreclosure rates tend to be lower in smart growth locations.[37]

Pisarski claims that, “most people, excepting a small but often very loud minority, opt for lower density living,” implying that smart growth policies harm consumers.[38] Yet, the market research discussed previously in this article indicates growing demand for more compact development, particularly if public policies provide support and incentives, such as more flexible zoning regulations, increased investment in alternative modes, and financial rewards for more compact infill development that reflect public service cost savings.[39]

CONCLUSIONS

Land use policies can significantly affect transportation options and costs, and therefore travel activity. People who live and work in automobile-dependent locations tend to drive more annual miles, consume more fuel and produce more pollution than they would in more accessible, multi-modal communities. As a result, smart growth reforms can provide various economic, social and environmental benefits.

Some critics claim that these impacts are small and not cost effective but their analysis tends to misrepresent key issues. The only consider land use density, ignoring the effects of other land use factors such as regional accessibility, land use mix, road and path connectivity, transport system diversity, and parking management. They overlook additional benefits, and growing consumer demand for more accessible, multi-modal home locations. As a result, they underestimate smart growth impacts and benefits.

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[35] CTOD and CNT (2006). *The affordability index: a new tool for measuring the true affordability of a housing choice*. Center for Transit-Oriented Development and the Center for Neighborhood Technology, Brookings Institute, at http://htaindex.cnt.org and www.brookings.edu/metro/umi/20060127_affindex.pdf.

[36] Smith, J.J. and Gihring, T.A. (2004). “Financing transit systems through value capture: an annotated bibliography.” American Journal of Economics and Sociology, Volume 65, Issue 3, July 2006; at www.vtpi.org/smith.pdf.

[37] NRDC (2010). Reducing foreclosures and environmental impacts through location-efficient neighborhood design. Natural Resources Defense Council; at www.nrdc.org/energy/files/LocationEfficiency4pgr.pdf.

[38] Pisarski (2009).

[39] Blais (2010).

This is important because existing land use development policies and planning practices tend to favor sprawl and automobile dependency. Smart growth requires policy reforms that allow more compact and mixed development, support alternative modes, and reduce existing subsidies to automobile such as generous minimum parking requirements. These reforms tend to face institutional inertia and political opposition. It is therefore important to have accurate information on the full potential impacts and benefits of smart growth policy reforms. When all impacts are considered, smart growth policies are often a cost effective way to achieve planning objectives. ■

Todd Litman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transport problems. His research is used worldwide in transport planning and policy analysis. Mr. Litman authored the *Online TDM Encyclopedia*, a comprehensive Internet resource for identifying and evaluating mobility management strategies, and *Parking Management Best Practices*, the most comprehensive book available on management solutions to parking problems.

www.vtpi.org/REQJ.pdf