VICTORIA Transport Policy INSTITUTE
EFFICIENCY • EQUITY • CLARITY

www.vtpi.org
Info@vtpi.org
250-360-1560

Recommendations for Improving LEED Transportation and Parking Credits

27 January 2015

Todd Litman
Victoria Transport Policy Institute

Buildings can be located, designed and managed to optimize transportation and parking efficiency.

Abstract

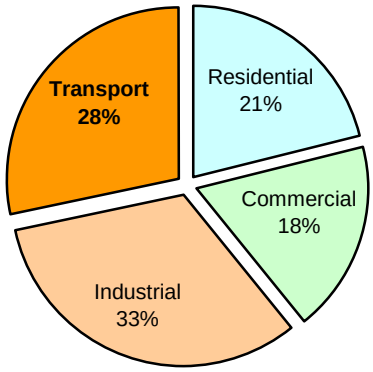
This paper describes ways to improve LEED (Leadership in Energy and Environmental Design) transportation and parking credits. Typical LEED programs reduce building energy consumption 20-60%. Cost effective mobility and parking management programs can provide similar motor vehicle trip and parking generation reductions, resulting in large economic, social and environmental benefits. However, the current LEED rating system overlooks some of the most effective mobility and parking management strategies and encourages practitioners to choose strategies based on ease of implementation rather than effectiveness. As a result, the current LEED rating system is unlikely to implement mobility and parking management to the degree optimal.

This paper recommends a different approach which defines performance targets needed to achieve LEED categories (silver, gold, platinum). Developers would establish mobility and parking management plans that indicate how targets will be met, how performance will be evaluated, and what additional strategies will be deployed if needed to achieve targets. This optimizes mobility and parking management programs, and responds to changing demands. However, it is unnecessary to wait for a major reform to improve and expand LEED transportation credits; new credits proposed in this paper could be quickly incorporated into the existing LEED rating system.

Introduction: Transport and Parking Impacts

Transportation and parking policies have very large economic, social and environmental impacts. Transport represents about 28% of total energy consumed in the U.S. (of which about 2/3 consists of personal travel), compared with 18% for commercial and 21% for residential, as illustrated in Figure 1.

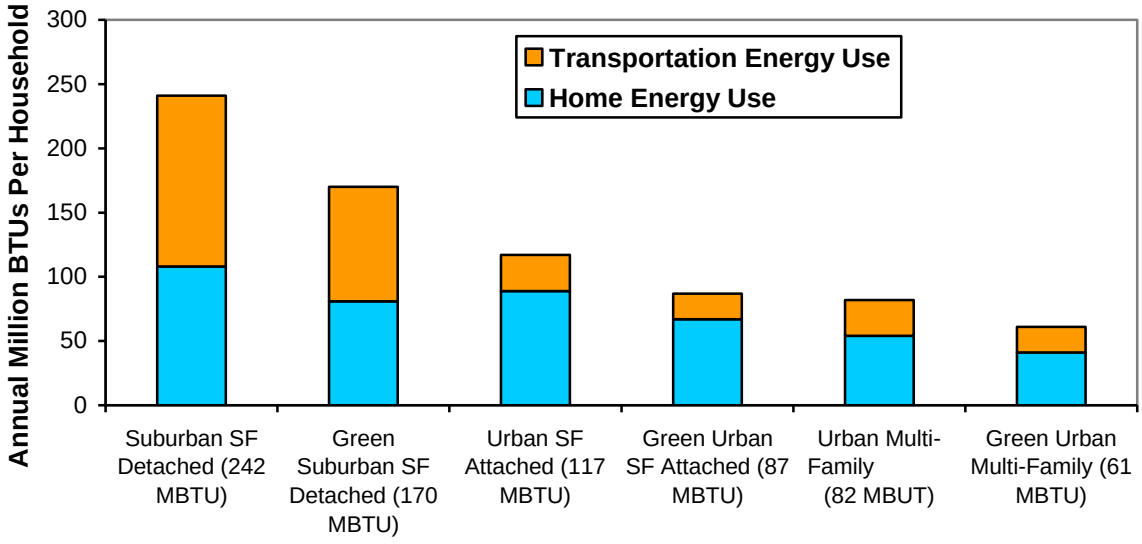
Figure 1 **Energy Consumption by Sector, 2006** (EIA 2008)



About 28% of total U.S. energy consumption is devoted to transportation.

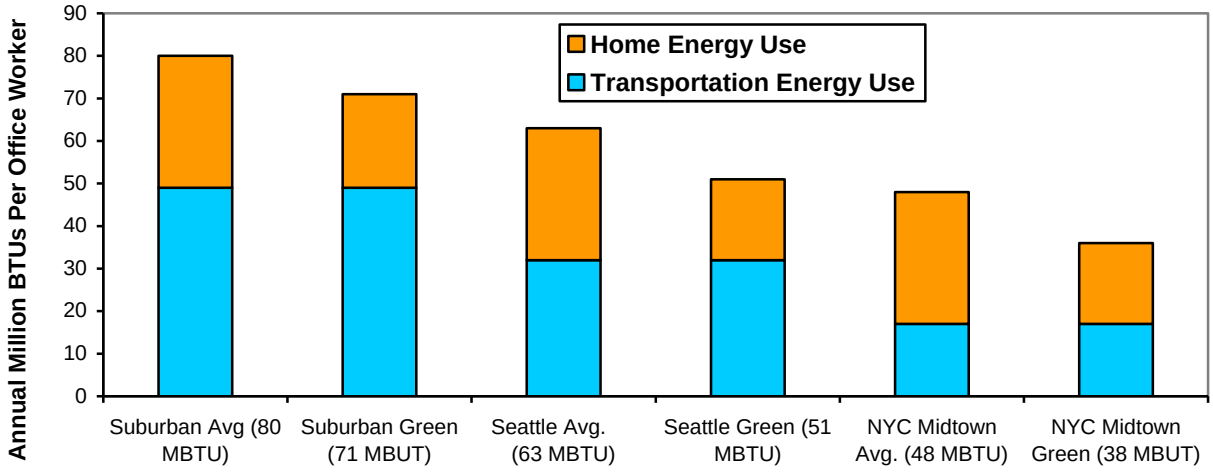
The portion of energy consumed by transport is increasing as other sectors became relatively more efficient (EIA 2008). As much energy is often used to travel to a building as is consumed in the building (Norman, MacLean and Kennedy 2006; Wilson 2007), as indicated in figures 2-4.

Figure 2 **Residents Transport and Home Energy Consumption** (JRC 2009)



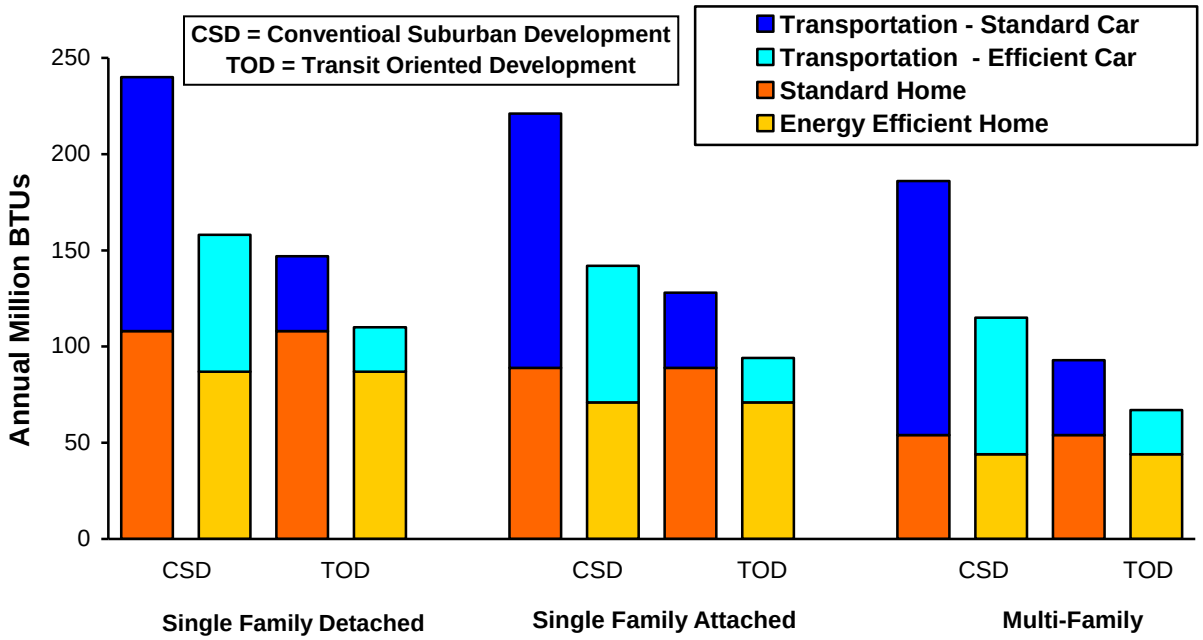
According to this analysis, compared with a typical detached single-family house in an auto-dependent suburb, an attached green (energy efficient) home in an urban location reduces energy consumption 64%, and a multifamily home reduces energy consumption 75%.

Figure 3 **Transport and Building Energy Consumption** (JRC 2009)



According to this analysis, compared with an average efficiency office building in an auto-dependent suburban location, a green building in a central location reduces energy consumption 36% in typical North American city such as Seattle, and as much as 55% in a city with excellent public transit service such as New York.

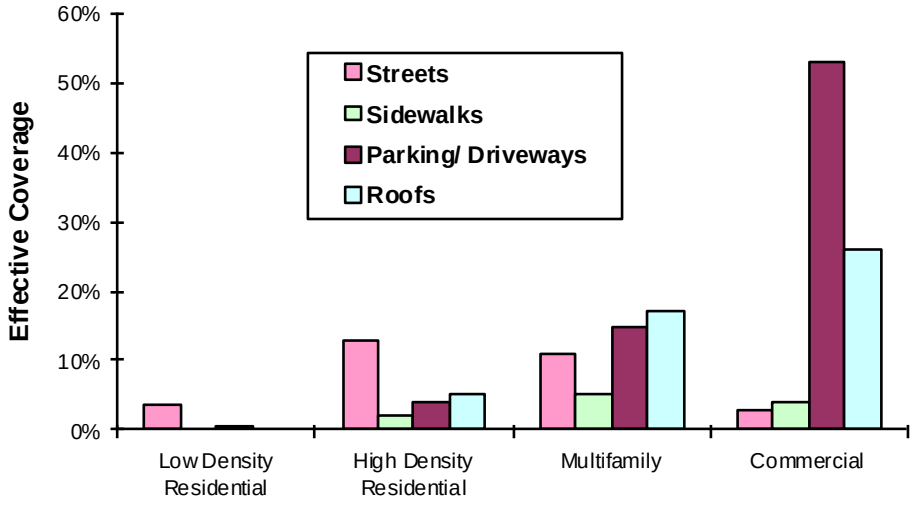
Figure 4 **Household Transportation Energy Use By Location** (JRC 2011)



Housing location and type have greater impacts on total household energy use than vehicle or home energy efficiency.

Driveways and parking facilities have other large economic cost and environmental costs. A typical urban parking space has an annualized value between $500 and $1,500, and even more for structured or underground parking facilities (Litman, 2007). Conventional standards often result in more land being devoted to driveways and parking facilities than to the buildings they serve, as illustrated in Figure 5.

Figure 5 **Impervious Surface Coverage** (Arnold and Gibbons 1996)



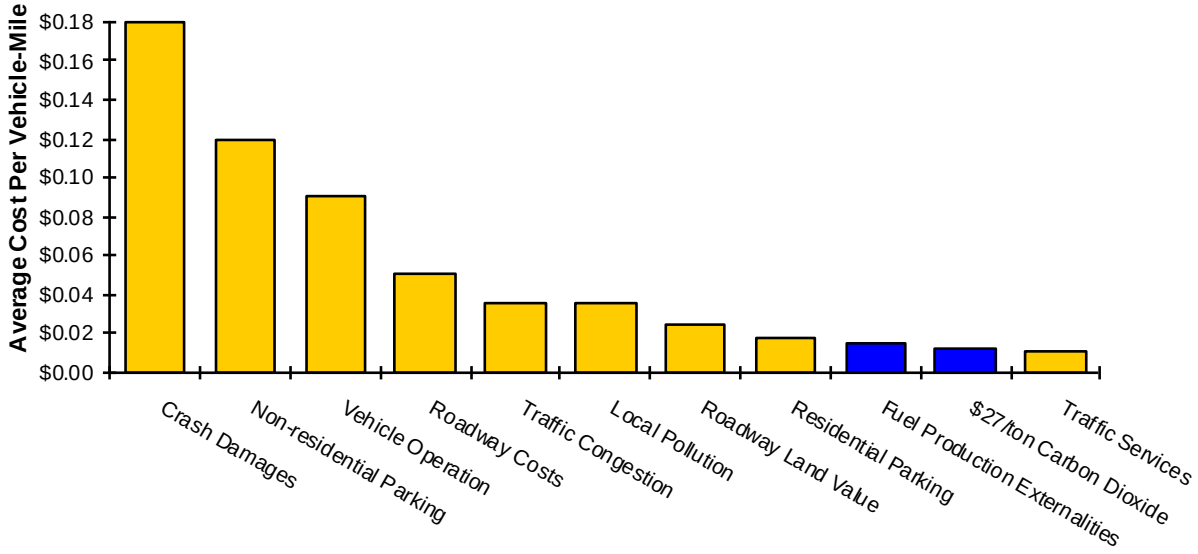
Roads, parking facilities and sidewalks represent a major portion of urban land area.

Some transport and land use management strategies provide more total benefits than others. For example, increasing vehicle fuel efficiency reduces energy consumption and pollution emissions but provides few other benefits. Similarly, structured parking reduces impervious surface area but increases development costs. However, transport and land use management strategies that improve mobility options (walking, cycling, ridesharing, public transit and telecommuting), reduce total motor vehicle traffic, and create more accessible land use patterns tend to provide multiple benefits (Litman 2007):

- Energy conservation and emission reductions.
- Reduced traffic congestion, and barrier effect (traffic delay to pedestrians and cyclists).
- Reduced parking problems and parking facility cost savings, which reduces development costs and increases housing affordability.
- Reduced costs to build, maintain and operate roadways.
- Consumer transportation cost savings.
- Improved mobility options, particularly for non-drivers.
- Reduced traffic accidents.
- Reduced land consumption, reducing stormwater costs, heat island effects, and habitat loss.
- Supports strategic planning objectives, such as urban redevelopment and reduced sprawl.
- Increased physical activity and associated health benefits.

These benefits tend to be greater in value than energy conservation and emission reduction benefits (USF 2006). For example, $27 per ton of CO_2 equals about 1.2¢ per vehicle-mile, which is smaller than other vehicle costs such as fuel, road and parking facilities, crash damages, and even local pollution costs, as illustrated in Figure 6.

Figure 6 **Estimated Automobile Costs** ("Transportation Costs," VTPI 2008)



This figure illustrates monetized (measured in monetary values) estimates of various vehicle costs. Climate change emissions are a relatively small cost.

As a result, a unit of energy conserved by reducing vehicle travel provides far greater total benefits than the same energy saved through increasing building energy efficiency or shifting to alternative fuels, due to co-benefits such as congestion reduction, consumer savings, reduced traffic accidents and improved public health, as illustrated in Table 1. Described differently, true sustainability requires more than just reducing energy consumption and pollution emissions: it balances economic, social and environmental goals. Improving transportation and land use efficiency, which reduces the amount of vehicle travel needed to access destinations, reflects true sustainability.

Table 1 **Comparing Strategies** (Litman 2007)

Planning Objective	Energy Efficient Buildings	Fuel Efficient Vehicles	Reduced Vehicle Travel
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			✓

Strategies that reduce vehicle travel by improving travel options and encouraging use of efficient modes help achieve multiple objectives and so represent true sustainability.

For these reasons, the LEED rating system should encourage development that:

- Is located in accessible, multi-modal locations (with common destinations are close together, has good walking and cycling conditions, and high quality public transit services).
- Includes programs and financial incentives that encourage use of efficient travel modes.
- Has reduced parking supply and efficient parking management.

Although existing transport and parking planning practices are well entrenched, they are ripe for change. A number of demographic, economic and market trends (aging population, rising fuel prices, increasing urbanization, growing environmental and health concerns, shifting consumer preferences) and increasing the value of more accessible locations and alternative modes. New planning practices that result in more efficient transport and parking management are often cost effective and provide significant benefits. The major barriers are ignorance and inertia.

As with other LEEDs strategies, many transport and parking management strategies are overall cost effective because incremental costs are ultimately repaid with infrastructure cost savings, energy savings, and other benefits to developers, building occupants, and their communities. The next section of this paper describes these strategies.

Transport and Parking Management Strategies

Various location and building design and management factors can significantly reduce vehicle ownership and use (Ewing, et al. 2007; Litman 2005; USEPA 2006; BA Consulting 2008; Daisa and Parker 2010). Table 2 summarizes travel impacts of various location factors. Table 3 summarizes the travel impacts of various building design and management factors.

Table 2 **Building Location and Design Factor Impacts on Travel** (Litman 2005)

Factor	Definition	Travel Impacts
Density	People or jobs per unit of land area (acre or hectare).	Increased density tends to reduce vehicle travel. Each 10% density increase typically reduces per capita VMT 1-3%.
Mix	Degree that related land uses (housing, commercial, institutional) are located close together.	Increased land use mix tends to reduce per capita vehicle travel, and increase 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 urban fringe residents.
Centeredness	Portion of commercial, employment, and other activities in major activity centers.	Centeredness increases use of alternative modes. Typically 30-60% of commuters to major centers use alternative modes, compared with 5-15% at dispersed locations.
Network Connectivity	Degree that walkways and roads are connected to 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 can help reduce motor vehicle traffic and increase walking and cycling activity.
Walking and cycling conditions	Quantity, quality and security of sidewalks, crosswalks, paths, and bike lanes.	Residents of more walkable communities typically walk 2-4 times as much and drive 5-15% less than if they lived in more automobile-dependent communities.
Transit quality and accessibility	Quality of transit service and degree to which destinations are transit accessible.	Residents of transit oriented areas tend to own 10-50% fewer vehicles, drive 10-50% fewer miles, and use alternative modes 2-10 times more than in automobile-oriented areas.

This table describes various neighborhood factors that can affect travel behavior.

Actual travel impacts vary depending on various factors. Models are available that can predict the travel demand in a particularly situation, and the travel impacts of various transportation and parking management strategies (SUMMA 2003). For example, the USEPA *Smart Growth Index (SGI) Model* predicts the travel reduction impacts of various land use factors, the *TRIMMS* (Trip Reduction Impacts of Mobility Management Strategies) *Model* predicts the travel reduction impacts of commute trip reduction programs, and Krizek, et al. (2006) describe ways to quantify the travel impacts of bicycle facility improvements. These can be used to predict how various building location, design and management factors will affect trip and parking generation, and therefore help create mobility and parking management plans that achieve specific targets.

Table 3 **Transport Management Strategies** (based on Litman 2006)

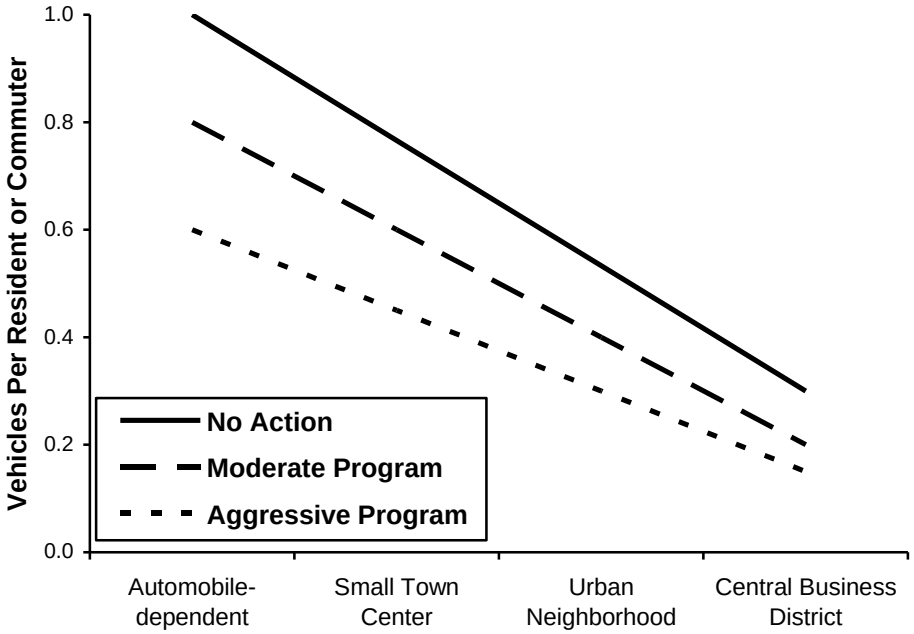
Strategy	Description	Typical Reduction
New urbanist design	Compact, mixed, multi-modal development.	10-30%
Mobility management	Policies and programs that encourage more efficient travel patterns.	10-30%
Parking supply and management	Number of parking spaces per building unit or acre, and how parking is regulated and priced.	10-30%.
Carsharing & public bikes	Availability of automobiles and bicycles for hourly rental or loan.	2-10%.
Site design	The layout and design of buildings and parking facilities.	2-10%.
Walking and cycling Improvements	Improve walking and cycling conditions to increase travel options and improve public transit accessibility.	5-15%
Commute trip reduction programs	Employers actively encourage more efficient commute patterns.	10-30%
Financial incentives	Provide financial incentives to shift mode such as parking cash out.	10-30%
Parking pricing	Charge motorists directly and efficiently for using parking facilities.	10-30%
Unbundle parking	Rent or sell parking facilities separately from building space.	10-30%
Carshare services	Provide hourly vehicle rental services within or near buildings.	5-15%
Bicycle facilities	Provide bicycle storage and changing facilities.	5-15%
Improve user information and marketing	Provide convenient and accurate information on travel options using maps, signs, websites and direct marketing programs.	5-15%

This table summarizes various building design and management strategies and indicates the typical reductions in affected travel they can provide. Actual impacts vary depending on specific circumstances.

These strategies can have large total impacts. For example, if a building is located in an isolated, automobile-dependent area, designed to emphasize automobile access with abundant parking supply, and has minimal mobility management effort, virtually every adult will own an automobile and virtually every trip will be made by motor vehicle Although even in such locations a small portion of adults are unable to drive, this is offset by drivers who own multiple vehicles, so buildings will be designed to accommodate one vehicle per person.

As building locations become more urbanized, building designs becomes more multi-modal, and mobility management programs are implemented, per capita vehicle ownership and use will decline. In more accessible, multi-modal locations typically 60-80% of commuters drive alone if parking is subsidized, 40-60% if parking is priced or cashed out (employees can choose cash or transit subsidies instead of a parking subsidy), and only 20-40% with comprehensive mobility management programs. Similarly, residents of apartments and condominiums located in urban areas with high quality transit services, unbundled parking (occupants pay separately for parking spaces), and onsite carsharing services, tend to own 15-30% fewer vehicles and drive 20-40% less than in automobile dependent locations with bundled parking.

Figure 7 **Vehicles Ownership and Use** (Litman, 2005; VTPI, 2008)



In isolated, automobile-dependent locations nearly every adult owns an automobile and nearly all travel is by motor vehicle, but vehicle ownership and use decline with increased urbanization and mobility management programs that improve and encourage use of alternative modes.

A typical LEED program reduces building resource consumption 20-60% in ways that are cost effective, that is, incremental costs are offset by future energy savings and improved building livability. Similarly, a mobility management program can typically reduce motor vehicle trip and parking generation to a building by 20-60% in cost effective ways, with incremental costs offset by parking and roadway facility cost savings, and other savings and benefits to users and the community.

Although they are often cost effective overall, transportation and parking management strategies face various obstacles, such as inflexible zoning requirements which require generous parking supply (once this amount of parking is built there is little incentive for building operators to encourage efficient transport or parking because the expensive parking spaces would be unoccupied), and transport planning practices that under-invest in alternative modes and mobility management programs. The LEED rating system can therefore be most effective if it encourages policy changes, such as reduced and more flexible parking requirements, and application of least-cost planning ("Least-Cost Planning," VTPI, 2008), which allows alternative modes and mobility management programs are supported to the degree that is economically justified. By stimulating such policy reforms, the LEED rating system can provide much greater total benefits.

Evaluating Current LEED Transportation and Parking Credits

Current LEED (Leadership in Energy and Environmental Design) rating systems, and similar systems by LEED Canada and ASHRAE, include a few credits to encourage more efficient transportation, as summarized below.[1] The estimated vehicle travel reductions are somewhat arbitrary because they are based on assumptions of what conditions and services would exist without the incentive of LEED credits.

Development Density

Channel development to achieve at least 60,000 sq. ft per acre (about two stories)
This reflects one important smart growth attribute but ignores others, such as land use mix, walkability or street connectivity. Alone, this strategy is likely to reduce vehicle trips to the site by 5-15% compared with medium density development (SFLCV 2003).

Public Transportation Access

Locate building with 0.5 miles of a rail transit station or 0.25 miles of two bus lines.
This reflects just one transit accessibility factor and ignores other important factors, such the quality of walking and cycling conditions, quality, transit service (such as frequency) or affordability, and there are no other policies to encourage shifts from driving to public transit. A half-mile is an excessive walking distance from a rail station to many destinations. Alone, this is likely to reduce vehicle trips to the site 5-15% compared with urban locations with poor transit access (USEPA 2002).

Bicycle storage and change facilities

Provide bicycle storage and changing facilities that accommodate 5% of building occupants.
This gives no consideration to other factors that affect cycling activity, such as the quality of cycling facilities and roadway conditions in the area. There is no consideration of policies and programs that encourage shifts from driving to cycling or discourage automobile travel. Alone, this is likely to reduce motor vehicle trips to the site by 1-3% (Krizek, et al. 2006).

Parking Capacity

Size parking capacity to meet, but not exceed, minimum parking requirement, and dedicate 10% of parking to ridesharing and carsharing vehicles
Parking supply reductions and management programs can significantly reduce automobile travel, but as currently worded this credit would probably do little to reduce parking supply or create incentives to implement other parking management strategies. Alone, this is likely to reduce vehicle travel by 2-10% compared with conventional parking planning (Litman, 2006).

Hybrid and Alternative Fuel Vehicles

Provide high efficiency hybrid or alternative fuel vehicles for 3% of building occupants.
Hybrid and alternative fueled vehicles provide, at best, only modest benefits. A portion of their energy savings are usually offset by rebound effects (as vehicles become more fuel efficient motorists tend to drive more annual miles, typically offsetting 20-30% of energy savings), and the additional annual vehicle travel exacerbates other transportation problems such as traffic congestion and accidents. Some alternative fuels provide few benefits and create other problems, such as the increase in food prices caused by ethanol production.

[1] These definitions have been simplified. Some alternative strategies can be applied.

The current LEED rating system is unlikely to significantly increase transport or parking system efficiency because it excludes some of the most effective strategies, and is not performance based. It encourages developers to choose strategies considered most convenient to implement rather than most effective at achieving desired outcomes.

Table 4 lists various mobility management strategies. Those with LEED credits are bold, representing about 10% of all strategies. To be fair, LEED allows innovation credits for additional vehicle travel reduction strategies, but these usually provide only modest incentives to reduce driving. They fail to encourage all cost-effective mobility management and parking management strategies.

Table 4 **Mobility Management Strategies** (VTPI, 2008)

Improved Transport Options	Incentives	Land Use Management	Implementation Programs
Bike parking and changing facilities Nonmotorized facilities Public bikes Transit service improvements Transit station improvements Rideshare (car- and vanpool) programs Shuttle bus services **Priority rideshare parking** Flextime Telework Carsharing Taxi service improvements Guaranteed ride home	Parking regulations Parking pricing Commuter financial incentives (parking cash out and transit subsidies) Parking unbundling (parking rented separately from building space) Transit fare discounts and passes (for example, included with building rents).	**Increased density** **Transit proximity** Increased land use mix Improved roadway connectivity Reduced and more accurate parking supply Parking management Carfree planning Traffic calming Streetscape improvements	Transportation management associations Commute trip reduction programs School and campus transport management Access management Tourist transport management Mobility management marketing Transport planning reforms (least-cost financing and multi-modal planning) Multi-modal access guides

This table is a list of mobility management strategies suitable for implementation at a particular building, campus or activity center. LEED currently offers credits to those in bold.

The LEED rating system currently lacks credits for financial incentives such as parking pricing (including cash out and unbundling) and public transit subsidies, although these are among the most effective transport and parking management strategies. They often double or triple mode shifting impacts. For example, if an office building is located near high quality transit service, typically about 10% of employees will commute by transit if parking is abundant and free, but 20-30% will commute by transit if parking is priced or cashed out, or if employees receive subsidized transit passes. Walking and cycling also increase if parking is priced or cashed out. Such incentives are therefore important to make other strategies successful.

Many LEED transport and parking management credits are poorly defined. For example, the transit accessibility credit only considers the distance between a building and a transit stop or station (it is unclear whether this is "as the crow flies" or a more realistic walking distance). It fails to incorporate other important factors, such as the quality of walking conditions, train service frequency, station quality or vehicle comfort. A better approach can be developed based on level-of-service (LOS) standards, which rate service quality using grades from A (best) to F (worst). Such ratings are available for evaluating walking and cycling conditions, and transit service quality (FDOT 2002; VTPI, 2008). For example, one LEED credit could be offered if a building is located a transit station if transit service LOS averages C, two credits if it averages B, and three credits if it averages A; with adjustments to reflect walking distance and conditions.

Parking management deserves special consideration in this analysis because conventional practices are very inefficient and improved practices can significantly help achieve LEED objectives. Conventional parking standards are intended to insure that parking is abundant and cheap; reflecting a subsidy of driving and a stimulation of sprawl. Conventional standards are often based on the 85th percentile (85 out of 100 parking facilities will never fill even during peak periods), and lack adjustments to reflect geographic, demographic or management factors that reduce parking demand (Litman, 2006). For example, few building codes reduce parking requirements at locations with good walkability and transit accessibility, where residents have lower than average incomes, or where parking is priced, although these factors reduce parking demand.

These practices tend to stimulate automobile ownership and use (by subsidizing automobile travel), and sprawl (by increasing the amount of land required for parking facilities). These impacts are large. Free parking tends to increase automobile traffic and associated costs (traffic congestion, accidents, energy consumption, pollution emissions, etc.) by about 20% compared with charging motorists directly for the parking facilities they use. Put differently, more efficient parking management can significantly reduce parking requirements, vehicle travel and sprawl, and the various associated costs, providing significant sustainability benefits.

Reduced and more flexible parking requirements are generally cost effective, since current standards are very generous, parking facilities are increasingly costly to build and operate, many management strategies are available, and the resulting reduction in vehicle trips and pavement area provides so many benefits. For example, it is often more cost effective to build only half the amount of parking required by conventional standards, and use a portion of the savings to implement various mobility and parking management strategies such as parking cash out, sharing parking with other nearby businesses (for example, an office can usually share parking facilities with restaurants and churches since their peak demands occur at different times of the week). This reduces development costs while increasing transportation system efficiency, and thereby achieving sustainability objectives.

It is therefore important that LEED ratings support reduced and more flexible parking requirements and encourage more parking management. It is necessary to communicate to transportation engineers, local officials, land use planners, developers, designers and the general public that buildings with generous parking supply generally cannot meet LEED standards (except perhaps the lowest standard) because they generate excessive vehicle traffic and land use impacts. Parking supply reductions should receive stormwater management and heat island reduction credits. These changes will not only help reduce parking supply at specific buildings, they will also help change planning practices toward more efficient parking management, providing potentially large additional benefits.

That LEED offers a relatively limited set of transportation and parking credits is unsurprising because many mobility and parking management strategies are literally outside the scope of conventional building design: most of their impact occurs off-site. Incorporating these factors into the LEED standards requires partnerships with other professions and agencies, such as transport and land use planners, traffic modelers and parking operators. In addition, some mobility management strategies may seem difficult to measure and their effects difficult to predict. For example, it may be difficult to predict how a particular public transit improvement or price incentive will affect travel behavior in a particular location.

Another obstacle to developing more LEED standards for transport and parking management is that transport and parking demands vary depending on a variety of geographic and demographic factors, and these factors may change over time. For example, in a downtown area, transportation management may focus on encouraging walking and public transit travel, but in suburban areas it may be more appropriate to encourage cycling and ridesharing (carpooling and vanpooling). Similarly, at one time a building may be occupied by a prestigious law firm with a small number of high-income employees who live in distant suburbs, then a call center that has a large number of lower-income employees who live scattered around the region, and later house a retail business with fewer employees but many customers. Each of these would require a different set of mobility and parking management strategies.

As a result, achieving mobility and parking reduction targets requires a flexible, on-going program that responds to future changes. There is noting particularly difficult about establishing such programs (there are now transportation management professional organizations, such as the *Association for Commuter Transportation*), and they can provide many benefits (for example, may employees value incentives such as parking cash out and bicycle parking facilities). Legal instruments exist that allow such strategies to be incorporated into development plans and enforced, including legal contracts, bonds, and special property assessments that are reduced if a building meets certain performance standards. However, such programs are fundamentally different from most LEED standards that are based on initial designs and require little or no on-going administration.

The following section describes an approach that can be used to establish LEED standards for transportation and parking management.

LEED Transport and Parking Management Framework

As described above, transport and parking management require a somewhat different approach than other LEED standards. Rather than assigning credits to individual strategies, with the assumption that their cumulative impacts will achieve a desired outcome (such as reduced energy consumption or stormwater generation), mobility and parking management should begin by establishing a desired outcome, and developing a flexible program to achieve this target.

For example, the standard could define the traffic and parking generation reduction required relative to a baseline that must be achieved to quality for a particular LEED category. Thus, if the *ITE Trip Generation* report predicts that a particular building is expected to generate 100 daily trips, the developers would need to show how they would reduce this to 80 daily trips for basic (Bronze) LEED certification, 60 daily trips for silver, 40 daily trips for gold, or 20 daily trips for platinum ratings.

Table 5 **Example of LEED Certification Trip Reduction Targets**

LEED Category	Reduction Relative to Baseline	Typical Actions Required
Bronze	20%	Urban location or modest mobility management program.
Silver	40%	Urban location and modest mobility management.
Gold	60%	Transit oriented location and modest mobility management.
Platinum	70%	Transit oriented location and aggressive mobility management.

This table indicates an example of the trip and parking generation reductions that would be needed to achieve various LEED certifications. This may be adjusted based on expert consultation.

Achieving such targets is not necessarily difficult, since baseline values (minimum parking requirements in zoning codes) are relatively high (Shoup, 1999). Most urban sites would probably qualify for basic LEED certification with minimal effort, and suburban sites could qualify with relatively modest mobility management programs, such as a commute trip reduction program with small rideshare and transit subsidies. LEED silver would typically require an urban location with modest mobility management programs, or a suburban area with aggressive programs (such as rideshare services, and parking pricing or generous transit subsidies). LEED gold would require a transit oriented location (location close to a rail station or frequent bus service) and moderate mobility management programs. LEED platinum would typically require a central business district or transit-oriented location, and aggressive mobility management programs.

These trip and parking reduction plans would need to be approved by a certified transportation engineer, using appropriate guidelines and models, such as tables 2 and 3 in this paper, the *Smart Growth Index* (USEPA 2002), and the *TRIMMS* model (USF 2006). The plan would include monitoring and enforcement measures and contingency actions, which would track actual trip and parking generation over time, identify any problems that develop (such as excessive automobile commute mode split or automobile trip generation, or parking congestion and spillover parking problems), and deploy additional mobility and parking management strategies if necessary.

This approach is a significant improvement over the current LEED system because it establishes explicit performance targets, greatly expands the menu of potential strategies that can be used, and encourages the development of the most efficient, integrated, program to achieve these targets, with the flexibility to change over time in response to changing demands. This should be more effective and beneficial than the current system.

This approach will require the following actions:

- Establish reasonable trip and parking generation reduction targets for various LEED categories. The targets in Table 5 can be reviewed by appropriate experts (transport engineers, land use modelers, parking planners, commute trip reduction program managers, etc.) and modified to reflect various building types and geographic conditions.
- Establish a process for developing and certifying mobility and parking management plans that can reduce trip and parking generation to meet targets. This will require developing appropriate modeling tools that can help practitioners predict the travel and parking generation impacts of various factors and strategies.
- Develop monitoring and enforcement mechanisms, including legal instruments that require building operators to update mobility and parking management plans and implement additional strategies if needed in future years to meet stated targets.

Short-term Improvements

The approach described above may require considerable time to be approved and implemented. Some short-term adjustments to the current LEED rating system can support mobility and parking management. Recommendations for this are described below. These can apply to both individual buildings and LEED-ND (neighborhood scale) applications.

- Identify a broader range of potential mobility management strategies that can qualify for LEED credits, such as those listed in Table 6. The *Online TDM Encyclopedia* (VTPI, 2008), Cairns, et al (2004) and CCAP (2005) provide additional information on these strategies and guidance on their effectiveness and implementation requirements.
- Develop more detailed credit definitions based on level-of-service (LOS) ratings. A certain type of LEED building could be required to meet certain minimal level-of-service ratings (for example, walkability LOS must be at least C), and additional credits provided as LOS ratings increase.
- Identify suitable guidelines, models and evaluation methods that can be used to predict the vehicle travel reductions and benefits that can be achieved by specific mobility management strategies in a particular situation. Tables 2 and 3 in this report, the *Online TDM Encyclopedia* (VTPI, 2008), the *Smart Growth Index* (USEPA 2002), the *TRIMMS* model (USF 2006), and Pratt (2007) are examples of such resources. Transportation engineers and experts in related fields (such as commute trip reduction program coordinators) are most qualified for evaluating such impacts and benefits.
- Allow additional mobility management strategies to receive LEED credits if they are likely to reduce vehicle travel comparable to existing Alternative Transportation strategies. For example, a commute trip reduction program with rideshare matching and parking cash out incentives should qualify for the same credits as transit accessibility if careful analysis indicates that it would provide a comparable reduction in vehicle trips.

To achieve transportation and parking goals the LEED credit system must include far more mobility and parking management strategies and give more emphasis to incentives that discourage driving, such as parking pricing and commuter financial incentives. The checklist below can help identify such strategies.

Table 6 **LEED Transportation and Parking Management Checklist**

Strategy	Description	Magnitude
Density	High levels of residential or commercial density	Large
Land use mix	High levels of residential, commercial and institutional mix	Medium
Transit proximity	Within 0.5 miles of a rail station or 0.25 miles of frequent bus service	Medium
Transit service quality	High transit service frequency, convenience, comfort and security	Medium
HOV travel speed	Rideshare and transit travel that is comparable to driving travel times	Medium
Transit station quality	Transit stations amenities such as coffee shops, washrooms and rider information	Medium
Transit affordability	Low transit fares (less than 20-minutes labor at minimum wage)	Medium
Road connectivity	Well connected street system	Small
Streetscape	Quality of street design to encourage use of alternative modes	Small
Walkability	Improved quality of walking conditions in an area	Medium
Reduce parking supply	20-80% reduction in parking supply relative to ITE standards	Large
Transportation management association	A local organization that provides transportation and parking management services.	Varies
Parking pricing	Parking pricing (including unbundling), at least for facility cost recovery	Large
Commute trip reduction	Programs by employers	
Commuter financial incentives	Parking cash out, transit and rideshare subsidies, at least to 80% of a monthly transit pass.	Large
Transit passes	Free or 80% discounted transit passes provided to residents	Medium
Rideshare services	Rideshare promotion, matching, and vanpool organizing services	Medium
Carsharing services	Automobiles conveniently available to rent for short trips.	Medium
Bike paths and lanes	High quality bike paths serving area	Medium
Bicycle facilities	On-site bicycle parking and changing facilities	Small
Public bikes	Bicycles conveniently available to borrow or rent for short trips.	Small
Telework	Businesses encourage use of telecommunications to substitute for physical travel by employees and customers	Medium
Flextime	Employers allow employees some flexibility in their work schedule	Small
Guaranteed ride home	Employers provide support to employees who need a ride home when they use alternative commute modes	Small
Mobility management marketing	Programs that encourage use of alternative modes using sophisticated marketing techniques	Medium
Multi-modal access guides	Guides, maps, websites and other information that provide directions on how to reach a particular destination by various modes of transport	Small
Address security concerns	Programs that address security concerns by users of alternative mode (walking, cycling, ridesharing and public transit)	Medium

This checklist indicates various strategies that should receive LEED credits, and the relative magnitude of their impacts and benefits. ***Small*** *generally means less than 5% reduction in affected trip or parking demand.* ***Medium*** *generally means 5-10% reduction.* ***Large*** *generally means that reductions often exceed 10%. These ratings are general and should be adjusted to reflect specific circumstances. In some cases a particular strategy may have greater impacts than indicated. This information can be used to establish LEED credits.*

Conclusions

The LEED rating system's transportation and parking credits can significantly improve. This could approximately double energy conservation and emission reduction impacts, and provide other important economic, social and environmental benefits. LEED credits should encourage development in accessible, multi-modal locations (where there are good walking and cycling conditions, good public transit services, and public services nearby); use of alternative modes and reduced vehicle trip generation; and more efficient parking management.

The current LEED rating system fails to support mobility and parking management strategies as much as justified. It includes few mobility and parking credits. It excludes some of the most effective and beneficial strategies, particularly those that reward significant reductions in parking supply or motor vehicle use. It encourages practitioners to select strategies that seem easy to implement rather than those that provide the greatest total benefits. These problems can be overcome.

Parking policy reforms are particularly important for achieving LEED objectives. Conventional planning practices are intended to make parking abundant and cheap at every destination. This represents a subsidy for automobile travel and stimulates sprawl. It eliminates the incentive for building operators and local communities to encourage use of alternative modes, since expensive parking spaces would sit unoccupied. Reduced and more flexible parking standards is a critical first step in increasing transport and parking system efficiency.

There are many reasons to support these changes. Various demographic, economic and market trends (aging population, rising fuel prices, urbanization, growing environmental and health concerns, shifting consumer preferences) are increasing the value of more accessible locations and alternative modes. New planning practices that result in more efficient transport and parking management are often cost effective and provide significant benefits. The major barriers are ignorance and inertia.

This paper proposes setting specific performance targets needed to achieve specific LEED categories. For example, LEED Silver would require a 40% reduction from the baseline, and Gold would require a 60%. Developers would establish mobility and parking management plans which indicate how these targets will be met, how performance will be evaluated, and what additional strategies will be deployed if targets are not met. Such plans would be integrated and flexible, including various complementary strategies, including many that would only be deployed if needed.

However, it is not necessary to wait for a major reform to improve and expand LEED transportation credits. A variety of new credits proposed in this paper could be incorporated into the existing LEED rating system.

Example

GreenTRIP (www.transformca.org/GreenTRIP)

GreenTRIP is a Traffic Reduction + Innovative Parking certification program for new residential and mixed use developments. It rewards projects that reduce traffic and greenhouse gas emissions. GreenTRIP expands the definition of green building to include robust transportation standards for how people get to and from green buildings. Each certified project receives a *Project Evaluation Report* which describes the project location, details and inventories how the project meets GreenTRIP standards. This typically includes features such as an accessible and multi-modal location (near shops and other services, good neighborhood walkability, near public transit), unbundled parking (parking spaces rented separately from building space), carshare services, discounted public transit passes, and affordable housing.

The GreenTRIP program provides the following support:

- *Tailored Traffic Reduction Strategies* – Experts work with developers, designers and operators to identify the most appropriate transportation and parking management strategies in a particular situation.
- *Public Hearing Testimony* - GreenTRIP staff will explain the traffic and greenhouse gas reducing benefits achieved by GreenTRIP Certified projects to decision-makers and the public.
- *Market Differentiation* - Use of the GreenTRIP name and logo in promotional materials, and a plaque to mount on the project when built.

As of March 2010 the following projects were certified:
The Crossings (www.transformca.org/files/SLCrossingsProjEvalRpt.pdf)
Parker Place (www.transformca.org/files/ParkerPlace_ProjEvalRpt.pdf)
Station Park Green (www.transformca.org/files/StationParkGreenProjEvalRpt.pdf)
The Ohlone (www.transformca.org/files/OhloneProjEvalRpt.pdf)

Right Size Parking (http://metro.kingcounty.gov/up/projects/right-size-parking)

King County's *Right Size Parking Project* is developing practical tools for more accurately calculating parking demand, taking into account geographic and economic factors. The study found that parking demand per unit declines with increased transit proximity, local population and employment density, and parking price (the amount that residents must pay extra, if any, for a parking space), and increases with rents, unit size and number of bedrooms. The resulting model can be used to determine the parking supply needed in a particular development.

References

APA (2006), *Smart Codes*, American Planning Association (www.planning.org/smartgrowthcodes). These model ordinances and regulations reflect Smart Growth principles and planning objectives.

Chester Arnold and James Gibbons (1996), "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator," *American Planning Association Journal*, Vol. 62, No. 2, Spring pp. 243-258.

ASHRAE and USGBC (2007), *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*, Standard l89P, American Society of Heating, Refrigerating and Air-Conditioning Engineers (www.ashrae.org) and U.S. Green Buildings Council (www.usgbc.org); at www.greenbuildingsnyc.com/2007/06/29/proposed-standard-189p-design-of-high-performance-green-buildings.

BA Consulting (2008), *TDM Supportive Guidelines For Development Approvals: A Handbook For Practitioners*, Association for Commuter Transportation of Canada (www.actcanada.com); at www.actcanada.com/actcanada/en/tdmsupportiveguidlines1.aspx.

Bicyclepedia (www.bicyclinginfo.org/bikecost) provides tools for predicting bicycle facility travel impacts, benefits and costs.

Cherise Burda and Geoffrey Singer (2015), *Location Matters: Factoring Location Costs into Home-buying Decisions*, Pembina Institute (www.pembina.org); at (www.pembina.org/pub/location-matters).

CALTRANS (2004), *California Transit-Oriented Development (TOD) Searchable Database*, California Department of Transportation (http://transitorienteddevelopment.dot.ca.gov).

Sally Cairns, et al (2004), *Smarter Choices - Changing the Way We Travel*, UK Department for Transport (www.dft.gov.uk); at www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt.

CGBC (2004), *LEED Canada-NC 1.0 Reference Package*, Canadian Green Building Council (www.cagbc.org).

CCAP (2005), *Transportation Emissions Guidebook: Land Use, Transit & Transportation Demand Management*, Center of Clean Air Policy (www.ccap.org/guidebook) provides rules-of-thumb estimates of VMT reductions of smart growth and mobility management strategies.

CITE (2004), *Canadian Guide to Promoting Sustainable Transportation Through Site Design*, Canadian Institute of Transportation Engineers (www.cite7.org); at www.cite7.org/Technical_Projects/sitedesignreview.htm.

James M. Daisa and Terry Parker (2010), "Trip Generation Rates for Urban Infill Uses In California," *ITE Journal* (www.ite.org), Vol. 79, No. 6, June, pp. 30-39.

DCE, et al (2006), *Understanding The Relationship Between Public Health And The Built Environment: A Report Prepared For The LEED-ND Core Committee*, U.S. Green Building Council (USGBC) (www.usgbc.org/ShowFile.aspx?DocumentID=1480).

EIA (2007), *Energy Consumption by Sector*, Energy Information Administration (www.eia.doe.gov); at www.eia.doe.gov/emeu/aer/consump.html.

ETAAC (2008), *Recommendation of the Economic and Technology Advancement and Advisory Committee (ETAAC)*, Economic and Technology Advancement Advisory Committee, California Air Resources Board (www.arb.ca.gov); at www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf.

Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters and Don Chen (2007), *Growing Cooler: The Evidence on Urban Development and Climate Change*, Urban Land Institute and Smart Growth America (www.smartgrowthamerica.org/gcindex.html).

FDOT (2002), *Quality/Level of Service Handbook*, Florida Department of Transportation (www.dot.state.fl.us/Planning/systems/sm/los/default.htm).

Lawrence Frank, Sarah Kavage and Todd Litman (2006), *Promoting Public Health Through Smart Growth: Building Healthier Communities Through Transportation And Land Use Policies*, Smart Growth BC (www.smartgrowth.bc.ca); at www.vtpi.org/sgbc_health.pdf.

Green Trip Program (http://transformca.org/GreenTRIP) is a certification program that rewards projects that apply strategies to reduce traffic and greenhouse gas emissions.

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

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

King County (2011), *Right Size Parking Project* (http://metro.kingcounty.gov/up/projects/right-size-parking).

Kevin J. Krizek, et al. (2006), *Guidelines for Analysis of Investments in Bicycle Facilities*, NCHRP Report 552, TRB (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_552.pdf.

LGC (2004), *Creating Great Neighborhoods: Density in Your Community*, Local Government Commission (www.lgc.org); at www.lgc.org/freepub/PDF/Land_Use/reports/density_manual.pdf.

LCC (2008), *Smart Growth Scorecard*, Livable Communities Coalition (www.livablecommunitiescoalition.org); at www.livablecommunitiescoalition.org/uploads/100012_bodycontentfiles/100636.pdf.

Todd Litman (2005), *Land Use Impacts on Transport*, VTPI (www.vtpi.org); at www.vtpi.org/landtravel.pdf.

Todd Litman (2006), *Parking Management: Strategies, Evaluation and Planning*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/park_man.pdf.

Todd Litman (2007), *Guide to Calculating Mobility Management Benefits*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tdmben.pdf.

Todd Litman (2008), *Transportation Elasticities: How Prices and Other Factors Affect Travel Behavior*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/elasticities.pdf.

Todd Litman (2008), *Land Use Impacts On Transport: How Land Use Factors Affect Travel Behavior*, VTPI (www.vtpi.org); at www.vtpi.org/landtravel.pdf.

Todd Litman (2008), *Smart Emission Reduction Strategies*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/sers.pdf.

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

Todd Litman (2010), *Affordable-Accessible Housing In A Dynamic City: Why and How To Support Development of More Affordable Housing In Accessible Locations*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/aff_acc_hou.pdf.

Todd Litman (2011), *Affordable-Accessible Housing Photo Essay*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/aff_acc_photo.pdf.

Todd Litman (2011b), "Can Smart Growth Policies Conserve Energy and Reduce Emissions?" Portland State University's *Center for Real Estate Quarterly* (www.pdx.edu/realestate/research_quarterly.html), Vol. 5, No. 2, Spring, pp. 21-30; at www.vtpi.org/REQJ.pdf.

Todd Litman (2012), *Critique of the National Association of Home Builders' Research On Land Use Emission Reduction Impacts*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/NAHBcritique.pdf.

Todd Litman (2013), "Comprehensive Evaluation Of Energy Conservation And Emission Reduction Policies," *Transportation Research A*, Vol. 47, January, pp. 153-166 (http://dx.doi.org/10.1016/j.tra.2012.10.022); at www.vtpi.org/comp_em_eval.pdf.

James McWilliams (2010), "Green Building: LEEDing Us Where?," Freakonomics, *New York Times* (http://freakonomics.blogs.nytimes.com/2010/03/19/green-building-leeding-us-where)

Anne Vernez Moudon, et al (2003), *Strategies and Tools to Implement Transportation-Efficient Development: A Reference Manual*, Washington State Department of Transportation (www.wsdot.wa.gov), WA-RD 574.1; at www.wsdot.wa.gov/Research/Reports/500/574.1.htm.

Jonathan Norman, Heather L. MacLean, and Christopher A. Kennedy (2006), "Comparing High and Low Residential Density: Life-Cycle Analysis of Energy Use and Greenhouse Gas Emissions," *Journal of Urban Planning and Development*, Vol. 132, No. 1, pp. 10–21.

NYSDOT (2010), *Growing GreenLITES*, New York State Department of Transportation (www.nysdot.gov); at www.nysdot.gov/programs/greenlites.

Richard H. Pratt (2007), *Traveler Response to Transportation System Changes*, TCRP Report 95, TRB (www.trb.org); at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034.

RMLUI (2008), *Sustainable Community Development Code*, Rocky Mountain Land Use Institute, Strum College of Law (http://law.du.edu); at www.law.du.edu/index.php/rmlui/sustainable-community-development-code-main.

Karen E. Seggerman, Sara J. Hendricks and E. Spencer Fleury (2005), *Incorporating TDM into the Land Development Process*, National Center for Transportation Research, Center for Urban Transportation Research (www.nctr.usf.edu/pdf/576-11.pdf).

SFLCV (2003), *This View of Density Calculator*, San Francisco League of Conservation Voters (www.sflcv.org/density). This website illustrates various land use patterns, predicts their effects on travel behavior, and discusses various issues related to New Urbanist development.

SGN (2002 and 2004), *Getting To Smart Growth: 100 Policies for Implementation*, and *Getting to Smart Growth II: 100 More Policies for Implementation*, Smart Growth Network (www.smartgrowth.org) and International City/County Management Assoc. (www.icma.org).

Donald Shoup (1999), "The Trouble With Minimum Parking Requirements," *Transportation Research A*, Vol. 33, No. 7/8, Sept./Nov., pp. 549-574; at www.vtpi.org/shoup.pdf.

SUMMA (2003), *Fast Simple Model*, SUMMA (Sustainable Mobility, Policy Measures and Assessment) (www.summa-eu.org). This is a model for operationalizing the concept of sustainable transportation by predicting the impacts of various policies and programs.

USGBC (2008), *LEED Rating System*, U.S. Green Building Council (www.usgbc.org); at www.usgbc.org/LEED/LEEDDrafts/RatingSystemVersions.aspx?CMSPageID=1458.

USEPA (2002), *Smart Growth Index (SGI) Model*, U.S. Environmental Protection Agency (www.epa.gov/livablecommunities/topics/sg_index.htm).

USEPA (2006), *Smart Growth Scorecards*, U.S. Environmental Protection Agency (www.epa.gov/smartgrowth/scorecards/component.htm). This website provides information on various scorecards for evaluating communities and projects in terms of Smart Growth objectives.

USF (2006), *TRIMMS* (Trip Reduction Impacts of Mobility Management Strategies) *Model*, University of South Florida (www.nctr.usf.edu); at www.nctr.usf.edu/abstracts/abs77704.htm.

USEPA (2007), *Measuring the Air Quality and Transportation Impacts of Infill Development*, USEPA (www.epa.gov); at www.epa.gov/dced/pdf/transp_impacts_infill.pdf.

VTPI (2008), *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org/tdm).

Alex Wilson (2007), "Driving to Green Buildings: The Transportation Energy Intensity of Building," *Environmental Building News* (www.buildinggreen.com), Vol. 16, No. 9, Sept. 2007; at www.buildinggreen.com/auth/article.cfm?fileName=160901a.xml.