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Driving to Green Buildings: The Transportation Energy Intensity of Buildings

As the world's first LEED Platinum building, the Chesapeake Bay Foundation's Philip Merrill Environmental Center is loaded with green features: photovoltaic panels, rainwater harvesting, composting toilets, and bamboo flooring, to mention just a few. However, moving the organization's staff of around 100 into the new building meant that many employees who had been able to walk to work in the older downtown facility now have to drive roughly ten miles (16 km) to get there. To their credit, the organization spent two years looking for a downtown building to house their growing staff, and they tried to mitigate the increased use of cars in the new building with bicycle and kayak racks, showers, and loaner vehicles for non-automobile commuters, among other strategies. The fact remains, however, that the additional energy use from more employees driving to work may well exceed the energy savings realized by the green building.

Since the late 1990s, Portland's Pearl District has been transformed from a largely abandoned industrial area into a bustling mixed-use neighborhood. Local developers actively promote alternative forms of transportation, evident in the giant neon "Go By Streetcar" sign atop this multi-use complex.

Designers and builders expend significant effort to ensure that our buildings use as little energy as possible. This is a good thing—and very obvious to anyone who has been involved with green building for any length of time. What is not so obvious is that many buildings are responsible for much more energy use getting people to and from those buildings. That's right—for an average office building in the United States, calculations done by *Environmental Building News (EBN)* show that commuting by office workers accounts for 30% more energy than the building itself uses. For an average *new* office building built to code, transportation accounts for more than *twice* as much energy use as building operation.

This article takes a look at the "transportation energy intensity" of buildings and the influence of location and various land-use features on this measure of energy use. While the focus will be primarily on energy (and the associated environmental impacts of energy use, such as pollution), we will see that measures to reduce transportation energy use can have very significant ancillary benefits relating to water runoff, urban heat island mitigation, and habitat protection, while creating more vibrant, livable communities.

Transportation Energy Intensity as a Building Performance Metric

"Transportation energy intensity" is a metric that has long been used to measure such things as how efficiently freight is transported. We're proposing it here as a metric of *building* performance. The transportation energy intensity of a building is the amount of energy associated with getting people to and from that building, whether they are commuters, shoppers, vendors, or homeowners. The transportation energy intensity of buildings has a lot to do with location. An urban office building that workers can reach by public transit or a hardware store in a dense town center will likely have a significantly lower transportation energy intensity than a suburban office park or a retail establishment in a suburban strip mall.

Comparing Transportation and Operating Energy Use for an Office Building

	U.S. UNITS	METRIC UNITS
Average U.S. commute distance – one way[1]	12.2 mi	19.6 km
U.S. average vehicle fuel economy – 2006[2]	21.0 mi/gal	8.9 km/liter
Work days	235 days/yr	
Annual fuel consumption	273 gal/year	1,030 liters/yr
Annual fuel consumption per automobile commuter[3]	33,900 kBtu/yr	9,890 kWh/yr
Transportation energy use per employee[4]	27,700 kBtu/yr	8,100 kWh/yr
Average office building occupancy[5]	230 ft^2/person	21.3 m^2/person
Transportation energy use for average office building	121 $kBtu/ft^2$	381 kWh/m^2
Operating energy use for average office building[6]	92.9 $kBtu/ft^2$-yr	293 kWh/m^2-yr
Operating energy use for code-compliant office building[7]	51.0 $kBtu/ft^2$-yr	161 kWh/m^2-yr
Percent transportation energy use exceeds operation energy use for an average office building	30.2%	
Percent transportation energy use exceeds operation energy use for an office building built to ASHRAE 90.1-2004 code	137%	

In the table, we compare the transportation energy intensity of an average commercial office building with the building operation energy intensity of such a building. We use average figures for commute distance, fuel economy, work days per year, gross square footage per employee, and commuting transportation mode to calculate the average transportation energy use per square foot of building floor area. For that average building, the transportation energy use exceeds the building energy use by 30%. When compared with a new, more energy-efficient building built to ASHRAE 90.1-2004 energy code, the transportation energy use exceeds the building energy use by nearly 140%. (Note that this analysis examines only *site energy*; if it compared *primary energy or source energy*, the differences would be smaller—largely due to the significant electricity use in commercial buildings and the inefficiency of electricity generation.)

We will see in this article that about eight factors, largely controlled by planners, designers, developers, and regulators, dramatically affect the transportation energy intensity of buildings. While far from a comprehensive treatise on the topic, this article introduces these issues and makes the case that, first, we need to pay far more attention to location and land-use planning as a part of green development, and, second, that this is an area deserving a great deal more research attention.

Environmental Impacts of Automobile Travel

Transportation Share of U.S. Criteria Air Pollutant Emissions (2002)

Criteria air pollutant	Transportation share	Highway vehicle share
Carbon monoxide (CO)	77.3%	55.5%
Nitrous oxide (NOx)	54.3%	34.9%
Volatile organic compounds (VOCs)	43.7%	27.5%
Particulates – 10 micron (PM-10)	2.3%	0.9%
Particulates – 2.5 micron (PM-2.5)	6.5%	2.2%
Sulfur dioxide (SO_2)	4.5%	1.8%
Ammonia (NH_3)	8.8%	8.0%

Transportation energy use and the environmental impacts associated with that energy use are huge. In 2006, transportation in the U.S. consumed 28.5 quads of energy (84 trillion kWh), or 28.5% of total national energy use, according to the Energy Information Administration of the U.S. Department of Energy. Both the total energy and the percentage of transportation energy use have been rising in recent years, while industrial energy use (currently the largest share at 32.1%) has been dropping. The transportation share of carbon dioxide emissions is slightly greater at 32.9% (2005 data) and higher than that of industrial, commercial, and residential sectors, with the share rising slightly since 1990.

Environmental impacts of transportation are not limited to energy and greenhouse gas emissions. The table below shows transportation's share of certain criteria pollutants.

In addition to these direct emissions from transportation, there are many other environmental impacts associated with the infrastructure needed to support transportation and with development patterns. Our roadways create impervious surfaces that result in significant pollutant runoff into waterways—in fact, non-point source water pollution from stormwater runoff is now the nation's leading source of water pollution to estuaries and the third largest to lakes. Highways fragment ecosystems and wildlife habitat. Paved areas, including roadways and parking lots, absorb solar energy, contributing to localized heat islands that exacerbate smog and increase air-conditioning requirements in urbanized areas. And stormwater runoff from these surfaces creates thermal pollution that makes many waterways unsuitable for trout and other cold-water fish.

Land development is occurring at a far higher rate than population growth, resulting in sprawl. In the nation's 34 metropolitan areas with populations greater than one million people, between 1950 and 1990 the population increased 92.4%, according to the U.S. Environmental Protection Agency (EPA) report *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality*, while the urbanized land area grew by 245%, or 2.65 times the population growth rate. In Atlanta, the developed land area grew almost tenfold during this period, while the population grew a little over threefold.

As our urban and suburban areas spread out, vehicle travel increases. Transportation planners use *vehicle miles traveled* (VMT) to measure automobile use. In the U.S., VMT per household has increased from 12,400 miles (20,000 km) per year in 1969 to 21,200 miles (34,000 km) per year in 2001, a 70% increase. During the same period, VMT for commuting to work increased from 4,180 miles to 5,720 miles (6,730 km to 9,200 km), or 37%.

Reducing the Transportation Energy Intensity of Buildings

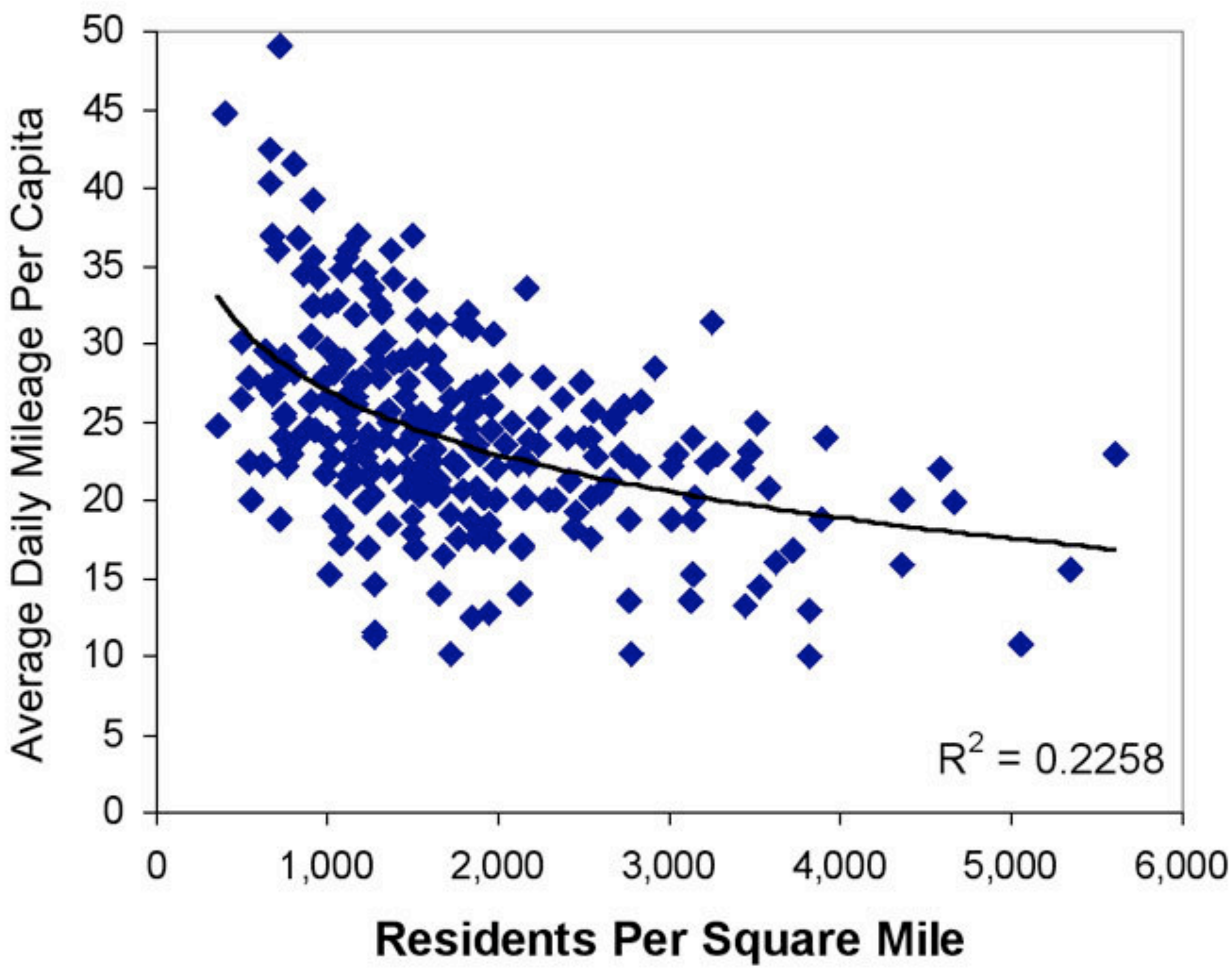
While most measures to reduce building energy use relate just to that particular building, most measures to reduce the *transportation* energy use of buildings relate to the broader land-use context. They help to achieve what is often called transit-oriented development (TOD) or smart growth. (The terms new urbanism and neo-traditional development are also used, though with slightly different connotations.) Among the goals of these development paradigms are communities, towns, or urban areas that are pedestrian-friendly and accessible with minimal use of the automobile.

Features used to achieve this sort of development are typically beyond the control of building designers and, to some extent, even building owners. Location is critical. "The transportation performance of buildings is all about location," says Doug Farr, AIA, of Chicago, author of the forthcoming book *Sustainable Urbanism: Urban Design With Nature* (John Wiley & Sons, 2008).

We'll now explore eight key factors that can reduce the transportation energy intensity of buildings, primarily by reducing VMT. Transportation and land-use planners often talk about the "D-factors," including density, distance to transit, diversity of uses, and design of streetscapes; we'll look at these and others.

Density

Density vs. Vehicle Travel for U.S.



Per capita vehicle travel tends to decrease with increases in density.

Most experts put density at or near the top of the list of measures for reducing vehicle use. Hank Dittmar, executive director of the Prince's Foundation for the Built Environment and chair of the Congress for the New Urbanism, points to density as the first priority in achieving location efficiency. Research he conducted with the Natural Resources Defense Council (NRDC) and the Center for Neighborhood Technology (CNT) in the 1990s "showed a fairly dramatic reduction in VMT as you moved from seven to 10–12 units to the acre," he told *EBN*. The reduction curve begins to flatten out at 40–50 units per acre; the benefits of mixed use remain, Dittmar explains, but the residents of those units may still have to travel for work and other trips throughout the region, which density does not affect. This correlation between density and VMT is shown in the graph above.

Reid Ewing, Ph.D, a widely published author on transportation planning and traffic calming and director of the National Center for Smart Growth Research at the University of Maryland, says that in the most compact, densely populated places like Chicago, VMT can be as much as 90% less than in sprawling suburbs. Among the innovative strategies for encouraging density are density transfer mechanisms, which enable planners to manage development rights by trading them from environmentally sensitive areas to areas that can be developed. This mechanism is being used in Montgomery County, Maryland; Sarasota, Florida; and Chapel Hill, North Carolina.

Transit availability and access

Everyone agrees that the availability of rail and bus transit is a key requirement for getting people out of cars. Distance to transit addresses how far someone must walk to get to a bus stop, light rail or trolley stop, or train station. "The first problem is that it isn't there for most people," says Dittmar. When public transit isn't available, or convenient, or comfortable enough to be used, some companies are taking it upon themselves to satisfy the need. Information technology giant Google maintains a fleet of alternative-fuel buses that it uses to shuttle employees from many locations throughout the San Francisco Bay area to its office park; the company encourages ridership by offering such amenities as comfortable seats and wireless access.

To be effective, transit stops have to be close to where people live. "Generally speaking," according to John Thomas, Ph.D., of the Development, Community & Environment Division at EPA, "one-quarter to one-half-mile range is the distance people will walk to transit." People can be expected to walk further to reach rail transit stops compared with bus stops, but rarely will people walk more than a half-mile.

While transit is the key word in transit-oriented development, it's really more about walking. "I think of transit as connecting walkable districts," says Ellen Greenberg, a coauthor of *The New Transit Town* (Island Press, 2004) and the past director of policy and research at the Congress for the New Urbanism. "Everyone winds up being a pedestrian somewhere in the travel day," she told *EBN*. Even people who commute by car walk to and from their cars, she points out, "but transit riders are on foot a bigger part of their day, so transit-oriented developments have, by their very nature, a bigger component of the walking trips than conventional development."

In a discussion of transit, it's worth noting that some forms of transit are no more energy efficient than private automobile commuting (see chart below). On a Btu per passenger-mile basis, buses actually use more energy per passenger mile than cars, assuming average occupancy of both, while all forms of rail use less and vanpools use a lot less. The number of passengers makes a huge difference in the energy intensity (Btu per passenger mile). For example, by increasing the assumed ridership of a transit bus to 40 people, the energy intensity drops to less than 1,000 Btu per passenger mile. Note that even though buses with average ridership may use more energy per passenger mile than cars, bus transit is still beneficial as a public service, because it can make urban areas more walkable.

Mixed uses and access to services

The Energy Intensity of Different Forms of Travel

Vehicle Type	Load Factor (persons/vehicle)	Energy Use (Btu/vehicle-mile)	Energy Intensity (Btu/pass-mile)
Cars	1.6	5,489	3,496
Personal trucks	1.7	7,447	4,329
Taxi & van (demand response)	1.0	14,952	14,301
Vanpool	6.4	8,226	1,294
Bus – Transit	8.7	38,275	4,318
Airline	90.4	358,000	3,959
Rail – Intercity (Amtrak)	17.9	51,948	2,760
Rail – light & heavy	22.4	70,170	2,750
Rail – commuter	32.9	91,525	2,569

Diversity has to do with the mix of residential, commercial, and retail land uses and whether key services can be met within easy walking distance of residences and workplaces. In the LEED for New Construction rating system, one of the considerations for awarding a credit is whether a residential area is within a half-mile of at least ten out of 22 listed services, including banks, convenience grocery stores, daycare, restaurants, pharmacies, laundry, schools, libraries, and parks. Farr calls this area a "pedestrian shed"—a play on the term "watershed"—referring to a surrounding area in which everyday needs can be met on foot.

This diversity also affects the success of transit. "It's very important for people who ride transit to be able to accomplish multiple things on foot once they arrive at their destination," notes Greenberg. "You need to have a mix of uses to satisfy people's needs," she told *EBN*.

In addition to having a diversity of services and land-use types in a community, it is beneficial to have a diversity of housing to serve all socioeconomic groups. According to Ewing's book Best Development Practices (American Planning Association, 1996), "promoting affordable housing serves transportation as well as social purposes." He notes that low-skill-level workers tend to be concentrated in cities, while low-skill-level jobs are concentrated in wealthier suburbs. This mismatch results in a lot of commuting by those who have the hardest time affording it.

Parking management

For transit-oriented development to succeed, many experts call for good parking management. Todd Litman, executive director of the Victoria Transport Policy Institute, calls parking management the top priority in reducing VMT. "Once you build generous parking," Litman told *EBN*, "you have very little incentive to provide alternatives." Brett Van Akkeren, a smart growth analyst at EPA, told *EBN* that in suburbs there are nine parking spots for every car.

Greenberg agrees, saying that the first priority "is definitely constrained or expensive parking supply. It has been shown that expensive parking acts as a deterrent to commuters." In the book *Parking Management Best Practices* (Planners Press, 2006) and in a summary paper, "Parking Management: Strategies, Evaluation and Planning" (Victoria Transport Policy Institute), Litman lays out more than 20 strategies that can be used alone or in combination to reduce parking by 20% to 40%.

As with many of these strategies for encouraging transit-oriented development, parking affects more than just VMT. "Not only will more parking encourage more driving," says John Holtzclaw, a widely published transportation researcher in San Francisco and chair of the transportation committee for the Sierra Club, "but curb cuts along sidewalks make walking less interesting and less safe and make buildings less interesting." Surface parking also takes up a lot of space, forcing pedestrians to walk further to get where they want to go. Where you do have parking, suggests Holtzclaw, "have it underground. Don't take up the first two floors with parking; that just deadens the neighborhood."

Walkability, traffic calming, and site design

As noted earlier, walkability is key to the success of transit-oriented development. "Walkability and public transit go hand-in-hand," argues Holtzclaw. He suggests that planners place themselves as pedestrians: "Think about how it feels to walk. Are there places to walk to? How are the streets laid out? Are there sidewalks on both sides of the street? Is the traffic calmed? Are the buildings close to the sidewalk, or do you have to walk through a parking lot to get inside?"

Hank Dittmar notes that while transit is a key aspect of smart growth and transit-oriented development, not all communities are there yet. For communities without transit, measures can be taken to prepare for a transit future. "They ought to be getting those neighborhoods ready," he said. "At the core must be a connected, strong network that works for pedestrians."

Traffic calming is another aspect of walkable communities. "By slowing traffic, you create a nicer pedestrian environment," notes Reid Ewing, whose book *Traffic Calming: State of the Practice* (Institute of Traffic Engineers, 1999) remains the authority on the topic. "Also, when you slow down traffic, you make trips shorter, which reduces VMT," he told *EBN*. (For more on traffic calming, see *EBN* Vol. 12, No. 3.)

Along with traffic calming, it helps to create streetscapes that are comfortable, safe, relaxing, and enjoyable to spend time in. Good lighting, park benches, outdoor tables at cafés, shade tree plantings, pedestrian courts that are closed off to automobiles, and public wireless access can all help to create vibrant, pedestrian-friendly outdoor spaces where people will be glad to walk a few blocks from a transit stop to get to their workplaces, and glad to walk to a restaurant for lunch, thus helping to reduce VMT.

Connectivity

Connectivity is about designing—or redesigning—communities so that pedestrian connections are better. It can mean breaking up "super-blocks" into smaller, more walkable blocks, and replacing connector streets and cul-de-sacs with a network of interconnected streets that spread out traffic flow, slow down vehicles, and make walking more pleasant.

"The smaller the block dimension, the more people will walk," notes Farr. Ewing agrees that limiting block size favors pedestrians. "You ever walk on a super block? They're endless," he says. "With small blocks, it's much easier to walk." To evaluate the connectivity of a community, Ewing created a "connectivity index," which is determined by dividing the number of roadway links (street segments between intersections) by the number of roadway nodes (intersections). The higher the connectivity index, the greater the route choices and the better the pedestrian access. Using this formula, a minimum connectivity index of 1.4 is considered necessary for a walkable community.

Connectivity can also be achieved for pedestrians by creating pathways that cut between cul-de-sacs or that bisect long blocks.

Such connections don't spread out vehicle traffic, but they improve walkability. Providing appropriate lighting and attractive landscaping along those pathways can increase usage.

Bicycle accessibility

In Copenhagen, Denmark, more than 30% of workers commute by bicycle. Since the 1970s, planners, traffic engineers, and politicians have worked hard to keep road infrastructures from growing, which has reduced VMT by 10%.

While a much smaller percentage of Americans bicycle than walk, bicycle access is an important strategy in achieving the kind of communities envisioned with transit-oriented development. While walking is limited to sidewalks and pedestrian pathways, a significant portion of bicycling occurs on roadways, where it competes with motor vehicles.

There are areas in Europe, particularly The Netherlands, Denmark, and Sweden, where bicycling accounts for up to 40% of all trips, and in the U.S., bicycling is widely used on many campuses and in a some urban areas. A big limitation to greater bicycle usage in the U.S. appears to be that our streets and communities are not bicycle friendly. According to the 2004 publication *Getting to Smart Growth II* by the Smart Growth Network, a 2003 poll by the American League of Bicyclists found that over half of the respondents would like to bike more often, and three-quarters of them would increase their biking with safer bike paths and other amenities.

The most important strategies for increasing bicycle use relate to where people bike: bicycling lanes and designated bicycle paths and trails. But some bicycle-access measures relate more to buildings. Covered bicycle storage allows people to bike to work and not worry about their bicycles getting wet. Changing and shower facilities at workplaces are essential for bicycling to be realistic as a commuting option.

Improved efficiency of transportation options

The strategies addressed here focus primarily on land-use and transportation planning issues. The transportation energy intensity of buildings can also be reduced by making our motorized means of transportation more energy efficient. Natural-gas-fueled and hybrid diesel-electric buses are increasingly appearing in cities around North America, offering both improvements in fuel economy and reductions in pollution emissions. New, more efficient light-rail and heavy-rail train cars are improving the energy efficiency of rail travel; most of those serving as commuter transit are now electric, so they have very low emissions (at the place of use).

With both bus and rail transit, the best way to improve the energy efficiency of operation is to increase ridership. While a packed train, subway, or bus may be somewhat less pleasant for riders, it's far better from the standpoint of energy use and pollution emissions per passenger-mile.

With private automobiles, the same arguments apply—for both energy efficiency and ridership. Hybrids and biodiesel-burning cars are generally better than conventional gasoline-powered cars, but even the lowest fuel-economy SUV carrying four carpool riders to work will use less energy and emit less pollution per passenger-mile than a hybrid Prius carrying only a driver.

Developing Building-Specific Metrics for Transportation Efficiency

One reason that location efficiency or transit-oriented development isn't more front-and-center in the design community is that it's too easy to consider it someone else's problem. The common sentiment is that it's a land-use issue that's beyond the scope of a particular building project. Specific metrics that measure the transportation energy intensity of a building would help change that perception. "What's needed is to develop a set of adjustment factors that a planner or designer could apply that indicate the reduction of vehicle travel," Litman told *EBN*. From these, one could calculate the reduction in energy consumption associated with those factors, he suggests.

For example, if one could define the baseline transportation energy intensity for a building type and attach a number to that, it should be possible to modify that value by a series of adjustment factors—much as is done with energy performance ratings of buildings. These adjustment factors would be based on the measures covered in this article: distance to transit, presence of bicycle pathways, traffic calming, etc. In such adjustment factors would be implicit weightings: distance to transit might be worth more than existence of bicycle racks, but both could be applied numerically.

Portland planners predicted in 2001 that the new streetcars would serve about 3,500 riders a week, but 9,000 people now ride them daily. Over half of the city's development in the last decade has occurred within one block of the streetcar route, and property values within a block of the route are 35–40% higher than those just two blocks away.

One could argue that the transportation energy use of a building is too dependent on occupant behavior to warrant this sort of treatment (that even if the building is located right next to a light-rail station, there is nothing to stop workers from driving to work anyway). This is a reasonable concern that needs to be addressed, but the same concern exists with building energy use—albeit to a lesser degree. We are learning that the modeled energy use of buildings often varies considerably from the actual energy use—because doors are left open, workers use electric resistance heaters at their workstations and leave their computers on 24/7, or the facility managers use more air conditioning than predicted. Despite the reality that user behavior influences the actual transportation energy intensity of a building, such modeled transportation energy intensity would provide a good means of comparing one building to another in terms of expected performance.

Such metrics could be used in energy and environmental rating approaches for buildings, from Energy Star to LEED—permitting such certification programs to become more performance-based. Clearly, there would be a lot of details to work out, but the opportunities for providing metrics that help us reduce the environmental impacts of buildings are huge.

Final Thoughts

The green building movement is making tremendous strides at improving the environmental performance of buildings. Pushed by building codes and pulled by voluntary programs like LEED, buildings are getting better and better. But, as this article shows, if we want to continue reducing the ecological footprint of buildings, we need to focus much more actively on the transportation impacts that are associated with our buildings. With average new code-compliant office buildings "using" twice as much energy getting occupants to and from the buildings as the buildings themselves use for heating, cooling, lighting, and other energy needs, the green building community needs to focus greater

Conventional wisdom has it that the U.S. population is expected to increase by forty million people over the next two decades, 80% of whom will settle in developments like this car-dependant Denver suburb. More and more communities are recognizing that transit-oriented development offers a better option, particularly among an aging population.

attention on the transportation dependency of our buildings.

Farr takes these ideas one step further: “It’s unconscionable to do any new development that’s auto-dependent,” he told EBN, suggesting that the architects’ oath should address these location issues in some way. “I think you should lose your license for laying out sprawl,” he said, only half in jest.

Increasingly, a key driver of such changes is likely to be demographics. According to Sam Zimmerman-Bergman at Reconnecting America, a national organization providing resources on transit-oriented development, by 2030 there will be “demand for 10 million more housing units for people who want to live near transit.” When you add in such factors as a possible increase in transportation fuel cost, demand could be even greater.

“What we’re talking about is a fundamental paradigm shift,” according to Todd Litman of the Victoria Transport Policy Institute. The benefits of reduced VMT would extend well beyond energy savings. “If we get people to drive less through building location and building management strategies,” says Litman, “there’s a huge range of benefits beyond energy conservation and pollution reduction. Until we develop a more holistic model that takes [these added benefits] into account, we’ll undervalue transit demand management.”

It’s time for the green building community to embrace the transportation energy intensity of our buildings much more directly. Where we build should be given greater attention, and our tools for evaluating building performance should include metrics that relate to transportation.

– Alex Wilson with Rachel Navaro

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Checklist: Select Strategies for Achieving Transportation-Efficient Communities

Municipal Planning

Support transit-oriented development (TOD).

Develop in clusters with highest density near transit stations, commercial centers, and parks; direct development toward existing communities; develop TOD features in building design; create walkable communities; incorporate density transfer mechanisms when managing development rights.

Encourage mixed use.

Redevelop single-use areas into mixed use; place services and stores in residential neighborhoods; combine ground-floor retail with upper-floor residential whenever possible; accommodate adaptive reuse of obsolete buildings.

Encourage alternative means of transportation.

Provide a variety of high-quality transportation options; provide right-of-way to rapid buses; develop bicycle and pedestrian networks that are as good as (or better than) those for motorists; liberally employ traffic calming methods; keep streets narrow (no more than four lanes wide); keep speeds as low as 20 mph on local streets and 35 mph on arterials and collectors; create comprehensive transit-rider programs; provide preferential parking for car-share vehicles; refrain from expanding roadway capacity, which has been shown to induce traffic.

Municipal Zoning

Increase Density.

Mandate density minimums and eliminate lot-size minimums; density near transit should meet or exceed density in surrounding areas; consider a “density average” for an area combined with a “density gradient” that adjusts depending on site’s distance to transit station; develop density requirements in conjunction with open space requirements and urban growth boundaries.

Eliminate parking minimums.

stablish maximum rather than minimum parking requirements, particularly in areas with high-quality transit, or establish parking requirements that suit each site's actual needs rather than relying on "one size fits all" standards; allow building owners to assign "parking share zones" rather than individual spaces for multifamily housing; allow businesses the flexibility to trade or share parking capacity.

Change height and floor area ratio (FAR) limits.

More compact development can occur as height and FAR limits increase; this is especially important near transit stations.

Public Incentives

Municipal

Charge motorists for street parking costs to reduce demand for parking; provide property tax exemptions and revolving loan funds for TOD features; institute road pricing strategies such as road tolls, congestion pricing using fixed or dynamic schedules, and area tolls in places like city centers.

State

Change state insurance policies to encourage pay-as-you-drive insurance; institute road pricing strategies such as HOT (high-occupancy toll) lanes for which low-occupancy vehicles pay to use, distance-based charges such as mileage fees (in addition to, or in place of, vehicle registration fees and fuel taxes), and provide funding for bicycle and pedestrian access.

Federal

Increase transit's share of overall federal funding to at least $1 for every $3 currently spent on highways; make location-efficient mortgages more available to buyers of transportation-efficient housing; develop stronger tax incentive programs for adaptive reuse, mixed-use and TOD projects; remove tax loopholes that allow drivers to use pre-tax wages to pay for parking at work.

Private Incentives

Building Designers and Developers

Provide all the necessary amenities (e.g., showers/lockers) to accommodate pedestrians and cyclists; create clear pedestrian connections between buildings and sidewalks; ensure that primary entrances face street; place windows at ground level; avoid blank walls on pedestrian streets.

Employers and Commercial Building Owners

Locate business near transit, preferably in mixed-use areas; unbundle parking from employment contracts and sell or rent parking to employees instead; in places where free parking acts as a subsidy for motorists, provide equivalent cash-outs to non-motorists; provide free transit passes; provide loaner vehicles to transit commuters for daytime business; provide preferential parking for carpool vehicles.

Landlords and Residential Building Owners

Locate residential buildings in mixed-use areas, preferably near transit; assign parking zones to groups of residents rather than individual parking spaces to individuals; provide preferential parking for car-share vehicles.

Community Groups

Encourage community members to participate in planning charrettes early in the development of transit policy; they can help advance transit alternatives by demanding relief from automobile pollution, etc.

Todd Litman, Victoria Transport Policy Institute, provided input for this checklist.

IMAGE CREDITS:
1. Photo: Reconnecting America
2. 1. U.S. Department of Transportation, Transportation Energy Data Book 26th Edition, 2007, Table 8.6
3. Source: U.S. Department of Transportation,
4. Source: Todd Litman, VTPI
5. Source: U.S. Department of Transportation – Transportation Energy Data Book, 26th Edition, 2007, Table 2.12 (data from 2004)
6. Photo: Dan Burden, Walkable Communities, Inc.
7. Photo: Reconnecting America
8. Photo: Airphoto-Jim Wark