GrowSmartPlanet

Sustainable 21st Century Plans

June 2017

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We share the concern of millions that we may be unable to reduce emissions of greenhouse gases fast enough to stop global warming, despite worldwide efforts to reduce the use of fossil fuels, encourage renewable energy, design energy-efficient buildings, and slow population growth.

We believe it is feasible to cut use of energy and greenhouse gas emissions in half by 2030 by complementing these efforts with a worldwide movement to encourage higher-density "Smart Growth" in cities and suburbs. This would make it easier for people to walk, bike, or use "low carbon" electric transportation powered mostly by renewable energy to get around. We support ***sustainable*** growth that ***preserves environmental and fiscal resources for future generations.***

In the United States, most urban regions can finance the capital costs of new multi-billion-dollar regional transportation systems or new lines ***locally*** to get them built faster ***– without increasing taxes*** – using revenues from Transit-Oriented-Development (TOD) near the lines to pay off bonds quickly. We have estimated 30 years of tax revenues from ***new*** development near ***each mile*** of transit line – at 2017 tax rates - in two regions with income taxes (Cincinnati and Northern Virginia) and one region with no income taxes (San Antonio). The results:

Location	TOD Per Mile	30 Years of Tax Revenues from TOD Per Mile: Office/Commercial Areas	Residential Areas
Cincinnati	$1 billion	$ 2.20 billion	$ 1.08 billion
Northern VA	$2 billion	$ 7.66 billion	$ 2.50 billion
San Antonio	$1 billion	$ 636 million	$ 773 million

In Cincinnati, 30 years of tax revenues would be almost ***9 to 18 times*** the capital cost of new light rail transit lines. Modern streetcar lines would cost less. In San Antonio, tax revenues would be ***5 to 6 times*** the cost of light rail transit lines. In Northern Virginia, tax revenues would be about ***7 to 22 times*** the cost of elevated rapid transit lines; ***10 to 30 times*** the cost of on-grade rapid transit lines; and ***20 to 60 times*** the cost of on-grade light rail transit lines. The spreadsheets in the Appendix explain how these revenues and costs were estimated.

These revenues from ***new*** jobs, businesses, and taxpayers are "the gift that keeps on giving" after bonds are paid. They do not include revenues from new construction jobs created to build the new transit lines and new buildings where these new taxpayers would work and live.

Compact growth also helps create lively outdoor spaces while ***saving billions more in each region*** for land, construction, schools, commuting, and public services. These new revenues and savings combine to help regions ***balance budgets while reducing tax rates.***

The role we plan to play is to spread these ideas to as many regions as possible.

Why Federal Funding of New Transit Lines No Longer Makes Sense

Cities often spend years and millions of dollars developing detailed plans to seek scarce federal transit funds that rarely pay more than 25% of capital costs. While they do, costs keep rising.

- Cities that did not seek federal transit funds when costs were low and the federal share of capital costs was 50-80% now face much higher capital costs.
- On-grade light rail lines that cost only $7-10 million per mile in the early 1980s would now cost about $125 million per mile - if they can be designed and bid by 2020.
- With 5% annual inflation, ***a five-year delay to obtain funds adds 25% to capital costs.***

It makes more sense for regions to fund the ***entire cost*** of new lines or even complete regional transit systems ***locally*** **–** especially when inflation rates are higher than interest rates and the federal planning process requires time-consuming detailed plans and environmental studies**.**

Planners and public officials familiar with capital and operating costs for new transportation systems cannot easily imagine how they could finance them ***without increasing taxes or seeking federal funds.*** Cincinnati could not get voters to support a small tax increase for regional rail lines in 2002 and took another decade to fund a short $148 million streetcar line. How could similar or smaller regions locally fund regional multi-mode systems that would cost billions? **Our answer:** ***use some of the tax revenues from TOD at existing tax rates.***

Here are several reasons to avoid using funds from federal fuel taxes to fund transit lines:

- Revenues from fuel taxes are not high enough to keep roads and bridges in good repair.
- The 2013 funding shortfall: $87 billion ($79 billion roads, $8 billion bridges).
- A fuel tax increase of 58 cents per gallon would have eliminated the 2013 funding shortfall**.**
- In 2012, federal fuel taxes were 18.4 cents per gallon (and fuel costs $3-4 per gallon).
- With fuel prices in 2017 much lower, this would be a good time for Congress to act.
- ***Many people think fuel taxes should only be used for highways and bridges.*** We do too.
- Congress is more likely to increase fuel taxes if those funds are only used for highways.
- ***Why should people in one region pay for transit systems elsewhere they will never use?***
- It is inefficient to send dollars to Washington and wait years to get only some of them back.
- A much simpler transportation planning process is feasible for locally-funded transit lines.
- Tax revenues from TOD are usually much higher than tax revenues from fuel taxes.
- We can get more transit lines funded sooner if we use tax revenues from TOD.

Some regions may want to use local highway funds to fund closely-related items like dedicated bikeway lanes on bridges or major arterials because they are a small percentage of total costs.

When the proposed new regional Bay Area Rapid Transit (BART) system needed ***$180 million*** in 1967 for the tunnel connecting Oakland to San Francisco, the Comptroller for California's highways asked me if he should support the use of toll revenues from the Oakland Bay Bridge to help pay for it. I answered, "Dad, that's a no brainer. If you do, you will never have to widen the bridge or build another one." He convinced Governor Ronald Reagan to approve this controversial funding source. By 1974, 71 miles of BART's regional rail transit system were in operation. When an earthquake damaged Bay Bridge approaches in 1989, ridership on BART doubled and the region's economy stayed afloat. ***A very good use of local highway funds!***

Live Close to Work, School, Shops and Fun

We do not always have to spend billions to encourage people to reduce their carbon footprints by living close to work, school, shops, and fun. All over the world, you find cities and towns where people walk, use bikes, and take transit often. Countries like ours invested billions for high-speed highways instead and adopted policies that encouraged people to buy single family homes in outer suburbs. Commutes that once took an hour at speed limits now take far longer. Many Americans now want to live closer to places they go often, including jobs in suburbs.

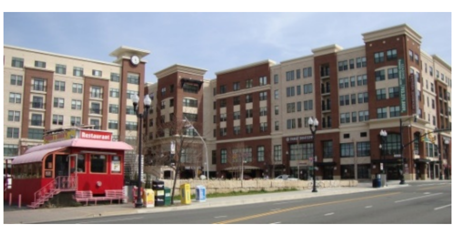
It was and remains possible to live in low-rise housing with short commutes and a low carbon footprint. I walked or rode a bike to excellent schools or work ***almost half of 62 years***. For ten years, my bus rides averaged 30 minutes. My carpools and solo drives to work were 2-10 miles long and averaged 20-22 minutes. I lived happily without a car for two years in a townhouse with only a five-minute walk to shops, food, movies, and buses to the regional DC Metrorail system.

My dad taught me to live close to jobs and schools, even in cities with only bus systems. Cincinnati and San Antonio are the nation's two largest cities without a regional rail transit system. In Cincinnati, we moved from a new home ten miles from work to an older home only 1.7 miles away. ***I rode a bike to work for ten years and cut my driving in half.*** My San Antonio apartment was only ***two miles*** from work, but it was not safe to ride a bike on that route.

Even with a "full court press" to convince more Americans they should simply move closer to their most frequent destinations, we may be unable to reduce emissions of greenhouse gases fast enough to stop global warming. Our political climate does not yet support taxes on fossil fuels or regulations that restrict their use. If worldwide efforts to reduce population growth are unsuccessful, our small planet will need to support ***two billion*** more people by 2050.

Grow Smart Planet's response: ***create strong economic incentives that encourage more people to voluntarily reduce carbon footprints – by saving money, creating millions of jobs, and reducing tax rates.*** We do not need more low-rise housing in suburbs 30+ miles from jobs.

Many regions already have attractive pedestrian and bike-oriented neighborhoods with frequent transit service and great schools – ***in downtowns and suburbs.*** You do not have to build high-rise buildings everywhere to do this. Most recent Transit-Oriented-Development (TOD) includes a mix of 3-5 story office-retail buildings and housing densities averaging 10-20 dwelling units per acre. ***This can generate enough riders to support transit***. In the 1950s, we lived in a single family home three blocks from Arlington's Columbia Pike. Frequent buses to the Pentagon, downtown, and the Metrorail system now serve more bus riders than anywhere else in Virginia.




Mixed-uses and older townhouses near Columbia Pike, Arlington, VA

To achieve these goals, regions must first make an informed choice on transportation modes, reach consensus on routes, and develop plans and incentives to attract TOD near the lines.

Sustainable Driving

Transit advocates must concede that efforts to encourage people to take public transit, ride a bike, or walk often fall on deaf ears. A 2009 Federal Highway Administration survey found that ***70% of the oil consumed in the U. S. was for transportation***, mostly in single-occupant vehicles used for ***82% of all trips.*** More than half of Americans lived in areas with no or very limited transit service. Even in regions with robust, multi-mode regional transit systems, only 10-25% took transit to work. ***To reduce use of fossil fuels, we must make driving more sustainable.*** The strategies below are obvious, but they will all help:

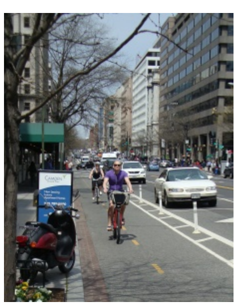
- Increase fuel efficiency
- Increase vehicle occupancy
- Use alternative fuels
- Drive fewer miles
- Design durable vehicles, streets, and highways

The book Sustainable Transportation and Development explores many ways to achieve these goals. It also estimates the full cost of driving to allow readers to compare it to the cost of taking transit. It urges raising fuel taxes at least 60 cents per gallon to eliminate the funding shortfall to keep roads and bridges in good repair and reduce highway congestion. ***If we do this and fund transit systems locally, it would be easier to convince more people to take transit to save thousands of dollars - even if they pay fares high enough to cover all operating costs.***

Walking and Biking

To encourage more people to walk or ride bicycles, we need to redesign suburbs with a compact mix of land uses in close proximity: residential, offices, retail, institutional, sports, recreation, entertainment. Biking is a mainstream mode in many countries and can become one in North America as well. Why? It is low-cost, energy efficient, almost zero pollution – and fun! It attracts people of all ages (I started biking uphill to work at age 50). ***The mode share for biking in five large cities in Europe and Asia is 20-50+%.*** Mode shares in five progressive cities and towns here ranged from only 4% to 15.5%. All of them have college campuses.

We also need to make biking in urban and suburban areas safer. Protected bike lanes cost far less than other transportation upgrades. You should budget about $100,000 per mile for a two-way bike lane with protective barriers like this one on 15th Street in Washington, D.C.



2-way bike lane

Trucks unload and cars park near lane

To encourage biking, more funding for dedicated, protected bike lanes is clearly needed.

Transportation Performance, Costs, Corridor Planning and Mode Selection

Spreadsheets A-5 and A-6 in the Appendix and Tables 3-6 of Sustainable Transportation and Development summarize the performance and costs of more than 600 public transportation lines and define each mode with photos for readers unfamiliar with transit terms and the wide range of mode choices. Most planners and public officials facing today's high capital costs for high-capacity rail transit systems have sticker shock and consider only light-capacity systems with much lower ***capital costs per mile***: buses, Bus Rapid Transit, commuter rail, and modern streetcars. ***This is a big mistake.*** Planners should instead compare ***boardings per mile*** for each mode. If you assume most riders board one direction and return the same day, cut the boardings figure in half to estimate the more useful ***capital costs per rider.*** In 2020 dollars, our results:

Mode	Lines in Operation	Lines in Planning
Bus Rapid Transit	$ 6,706	$ 30,989
Streetcars	$ 18,285	$ 77,026
Monorails	$ 36,808	N/A
Rapid Transit	$ 38,182	$133,534
Commuter Rail	$ 63,158	$185,874
Light Rail	$ 84,550	$115,811
Automated Guideway	$224,887	$341,703

Costs for planned rapid transit lines included high-cost subways in New York; costs for planned light rail lines included lines in two cities with bridges and tunnels. The most surprising result: ***high ridership often made monorails and rapid transit more cost-effective than commuter and light rail lines.*** They were built in corridors with high levels of development.

Planners should also compare ***farebox recovery rates*** (the share of costs paid by transit riders):

Mode	**Range**	**2011 Average**
Bus riders	**8-49%**	**23-36%**
Rapid transit riders	**13-77%**	**66%**
Commuter rail riders	**12-62%**	**52%**
Light rail/streetcar riders	**2-57%**	**30-36%**
Vanpool riders	**53-98%**	**63%**

If public officials want to reduce taxpayer subsidies for riders who do take transit, they should not simply add bus routes on congested city streets. The book describes a few public transit systems that break even or operate at a profit, including 100-year-old inclined planes that provide short trips up very steep hills. ***Riders typically pay a higher share of operating costs on faster regional rail systems, automated systems without drivers, or buses operating in dedicated lanes on city streets or highways.*** Riders paid 90% of operating costs on the San Diego Trolley for ten years and still paid the highest share of operating costs of all light rail systems in 2011. Riders on privately-operated buses and ferries did not receive taxpayer subsidies for operating costs.

The book describes why it has become so difficult to expand transportation choices in the United States. Planners, public officials, and citizens must work together to consider the costs and benefits of competing transit modes, alignments, and complex planning issues for related development. It often now takes decades to study transit choices in several corridors, select transit modes, and get voters and local, state and federal agencies to fund them – before detailed design and construction can begin. ***This process encourages regions to select different modes in each corridor – forcing too many transfers and attracting fewer riders.***

Cincinnati, for example, began in-depth multi-million dollar studies of four corridors in 1993. In 2002, officials asked voters in only ***one*** county to fund most of a ***regional*** light rail and expanded bus system that would serve two million people in seven counties. The referendum failed. It took another decade to obtain $148 million for a short streetcar line. After 24 years of planning, a diesel-powered light rail line estimated at $22 million per mile in 2016 was still unfunded. ***Cincinnati once had 222 miles of streetcar lines that were built much faster with local funds.***

The bold decision to build ***41,000 miles*** of interstate highways with ***90% federal funding*** in the 1950's also transformed American life much faster than the federal transit planning process allows today. ***The mode choice was already made.*** Most people could see the benefits of driving faster on safer highways to new suburbs or across the country. No one had to vote for local taxes to pay for highways in their region. The highway trust fund created from federal and state fuel taxes made it easy to get new highways built once alignments were determined. By 2006, the total cost of the interstate highway system was $425 billion (about $485 billion in 2011 dollars). ***If we had spent a comparable amount on public transportation, we would now have 50 cities with regional rapid transit systems, each with about 100 miles of double track lines.***

Selecting modes for specific corridors or regional systems is no easy task when you consider the wide range of vehicle design and planning concepts. We recommend focusing on the following:

Market Share: What percent of residents are likely to use each mode under consideration?
Miles per Trip: How long are the trips anticipated? What vehicles will offer comfortable rides?
Speed and Frequency: How fast will vehicles go, including stops? How often will they come?
Riders per Mile: How many riders will new lines likely attract? How many per mile?
Capital Costs per Mile and Per Rider*:* How do these costs compare for competing modes?
Farebox Recovery Rates*:* What share of operating costs will riders pay?
TOD: How much development will each mode attract? What tax revenues will result?
Environmental: How do modes compare in use of energy/fossil fuels, noise/air pollution?

The book makes it easier to answer these questions. It describes which modes are most likely to attract TOD. It recommends that time-consuming studies now included in most transportation plans be deferred until after the transportation mode is chosen and funds are approved. Examples: detailed plans for alignments, stations, land uses, architecture and landscaping, and preservation of historic and natural resources. ***The current planning process takes far too long. Funding milestones are missed and costs keep rising.***

The book explains how to improve corridor plans and the design of transit vehicles and facilities to attract more riders, increase farebox recovery rates, and avoid mistakes in selecting transit modes and vehicle designs. ***The most common mistake is to assume riders enjoy standing up or sitting sideways!*** Modern streetcars with only 34 seats that cost $3 million don't make sense - even for short trips downtown. They are fast enough to serve the suburbs on dedicated routes, but ***vehicles must be designed with comfortable seats looking forward for everyone*** - to attract more riders – like those on otherwise similar light rail vehicles designed with more comfortable seats for both suburban and downtown service.

Finance "Low Carbon" Transportation without Increasing Taxes

To help planners make informed mode choices and strengthen the case for funding new transit lines locally, I spent a year documenting how much transit-oriented development (TOD) had been built by 2013 near the more than 600 transit lines studied. Most transit and planning agencies had not taken time to encourage TOD or realize the importance of tracking it. I found incomplete or no reliable information for 90% of the lines studied, even for cities like San Diego or Atlanta where a casual glance reveals many new buildings near their transit lines. The good news: ***65 transit lines attracted more than $100 million per mile in TOD:***

Mode	TOD per Mile
38 Rapid Transit/Subway Lines	$100 million to $5.9 billion
10 Modern Streetcar Lines	$118 million to $1.2 billion
13 Light Rail Lines	$138 million to $850 million
3 Bus Rapid Transit Lines	$457 million to $1.0 billion
1 Commuter Rail Line	$127 million

Most streetcar, light rail, and bus rapid transit lines were opened later than the rapid transit lines. Development near them continues. For example, we counted only $700 million in TOD planned near Cincinnati's short streetcar line five years before it opened**.** It is a loop with 3.6 miles of one-way track in a corridor 1.8 miles long. We used corridor length to facilitate comparison to rail lines with dual tracks and yield a TOD cost of $389 million per mile. We excluded costs for two new stadiums and a new school that would have been built regardless of the streetcar. We also excluded $600 million for other projects in early planning. Once they are completed, there will be ***$722 million per mile in TOD*** near a streetcar loop that began running in late 2016.

When calculating future tax revenues from new transit lines, most consultants consider only higher assessments for existing land and buildings as the new lines make property nearby more desirable. These estimates of "value capture" can yield large increases in tax revenues that should not be ignored, but it would be hard to convince public officials to use them to pay off bonds for new transit lines. For example, our townhouse in Fairfax, VA is four miles from DC Metrorail lines and it more than doubled in value in 25 years. My dad's home in Arlington is three miles from DC Metrorail and is now valued at 24 times what he paid for it in 1954.

Tax revenues from higher assessments are usually offset by lower tax rates to make living in desirable areas more affordable. This is why property ***tax rates*** in the Washington region are about ***half*** those in Cincinnati. Our Fairfax townhouse was assessed at twice the amount of our Cincinnati single-family home in 2016, but annual taxes were $1,000 (19%) lower in Fairfax.

Planners rarely consider tax revenues from new development because they lack information on future plans or consider them too far in the future to count. This is a huge mistake. One example: the MetroWest planned community with 2,250 dwelling units replaced 69 "postwar bungalows" on 56 acres directly south of the Vienna-Fairfax-GMU Metrorail station. The project has 33 times as many units as the original subdivision. My conservative estimate of the increase in property values: ***$1.3 to $1.9 billion.*** With almost ***2,200 new households,*** it also makes sense to consider ***income and sales taxes*** they will pay. A complete analysis would also consider ***savings achieved by compact growth*** from projects like this.

Appendix spreadsheet A-1 makes it easier to estimate tax revenues and savings from TOD in your city. It estimates what could be built ***for every $100 million*** invested. Regardless of building type, $100 million TOD yields ***$1 million*** in annual tax revenues if property is taxed at 1%; it yields ***$2 million*** annually if taxed at 2%. Most regions have property tax rates ranging from 0.5% to 2.5%. If no tax abatements are offered, 30 years of new property tax revenues ***for every $100 million TOD*** would be ***$15 to $75 million.***

The website www.2017Tax-Rates.Org makes it easier for planners to calculate property, income, and sales tax rates, median incomes, and taxable incomes for U.S. cities and counties. We have compared them for most cities with rail transit lines and several other cities large enough to finance new regional systems. We were not surprised to find lower property tax rates in most cities with high property values. Ten cities have no income taxes. One has no sales tax. ***The range of income and sales taxes $100 million in TOD would yield in 30 years:***

Office/Commercial space	***$93 million to $529 million (income taxes)***
Residential Mix	***$27 million to $143 million (income + sales taxes)***

If a new transit line attracts $500 million TOD per mile, tax revenues yielded in 30 years are ***five times*** these amounts; at $1 billion per mile, they are ***ten times*** these amounts; at $2 billion per mile, ***twenty times*** these amounts – ***all far more than new transit line capital costs.***

Appendix spreadsheets A-2 to A-4 illustrate the format we used to estimate tax revenues from TOD for Cincinnati, Northern Virginia, and San Antonio. They will be helpful for planners preparing similar estimates for other regions.

When estimating how much TOD your region will attract for the transportation modes being considered, you must still make judgement calls on the amount of TOD that is realistic.

Cities planning to use some of the tax revenues from TOD must concurrently develop master plans showing higher-density development near the lines and encourage it to happen with zoning changes and much lower parking requirements than most codes require for auto-oriented growth.

TOD areas must be clearly defined to help overcome NIMBY objections from existing residents. This is how Arlington was able to attract 76,500 new jobs and $5.9 billion per mile in TOD to just one corridor three miles long, where 18% of the new residents don't own cars and half walk, bike, or take transit to work. Only ***11% of land in this small county was designated for higher-density development.*** Most housing units in Arlington look just like they did in the 1950s. Residents in them still enjoy great schools, high property values, and also have easy access to lively urban areas all over the region.

Savings from Smart Growth near Public Transportation

Compact medium-density "Smart Growth" near public transportation yields huge savings for families, commuters, public school systems, developers, and public entities responsible for building and maintaining land, infrastructure, and other public services. We have estimated those savings for some big ticket items here, but they are just the tip of the iceberg. Sustainable Transportation and Development also estimates huge savings in energy and greenhouse gas emissions that could help save the planet from global warming - while also saving money. Appendix spreadsheets A-7 to A-9 explains how these savings were calculated.

Commuting and Parking Savings:

Each household would save at least $158,460 in 30 years if they did not have to buy a second car every ten years and costs increased 5% annually. Households would also save money on parking at home, with garage space costing more than space in surface lots. The range of ***capital cost*** savings to households: ***$163,460 to $198,860***.

If employees do not drive to work, employers or public entities do not have to provide parking spaces for them in land wasting surface lots or costly garages. For surface lots this would save about $5,000 per car; for above-ground garages, $33,200 per car; for underground garages, $38,400 per car (2017 dollars). Savings for a garage with 500 cars: ***$16.6 to $19.2 million.*** These savings exclude costs for land, financing, operation and maintenance.

For a 20 mile round trip commute, transit riders would save ***$45,000 in 30 years.*** Commuters close enough to work to walk or take a bike would save ***$102,000 in 30 years.***

Public School Savings:

Appendix spreadsheet A-8 estimates public school savings from Smart Growth for a region with land values of $150,000 per acre, two million people, and about 728,000 housing units. ***These savings occur because the average number of public school children living in townhouses and apartments is much lower than in single-family units.*** The spreadsheet in the appendix compares residential land required and capital and 30 years of education costs at three densities. Savings from medium and higher density residential areas are as follows:

Density Level	Capital Costs	Education Costs in 30 Years
Medium Density	$ 8.7 Billion	$115.1 Billion
Higher Density	$10.2 Billion	$135.4 Billion

Savings in Space, Land, and Costs for Land and Construction:

Appendix spreadsheet A-9 estimates savings from Smart Growth in the same region for space, land, and capital costs for land and construction at comparable density levels:

Density Level	Total Space Million GSF	Acres	Capital Costs (Billion $) Land	Construction
Medium Density	189	175,116	$26.3	$64.3
Higher Density	200	219,770	$33.0	$40.6

In a region with land values of $450,000 per acre, savings for land would triple.

Private-sector developers and residents would save most of this money, but the public sector could have similar savings. Multi-story public buildings and schools designed to serve more students would cost less if designed with fewer parking spaces because they are near public transit. Arlington County's offices are next to a Metro stop (left photo). The University of Cincinnati invested more than $250 million for about 10,000 parking spaces in new garages to transform ugly surface lots into attractive, pedestrian-oriented green spaces (right photos). ***Many of these spaces would not have been needed if the 2001 regional light rail plan with direct service to the campus from several neighborhoods had been funded a year later.***

Spreadsheet A-9 can also be used to estimate savings in energy, operation and maintenance, and public costs for streets, utilities, police and fire protection. Two million people in 728,000 housing units at 10 units per acre would use only ***37% as much land*** as they would at 3.7 units per acre, or only ***21% as much land*** at 17.3 units per acre – ***even with all units the same size.***

Townhouses and apartments save energy because they have less outside wall area than single-family homes. Townhouses usually have less space than single-family homes, and apartments are usually much smaller. The savings in space in our estimate - 189 to 200 million GSF - are due to smaller unit sizes as density increases. This not only reduces construction costs, it also reduces energy used in heating and cooling and related greenhouse gas emissions.

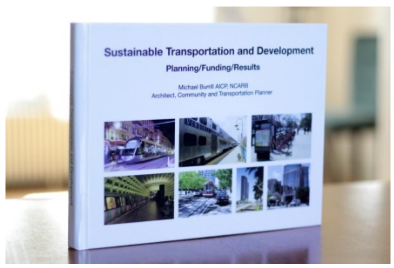
Savings in transportation costs and greenhouse gas emissions from commuting would be huge too. It would be easy for people to live closer to work, schools, shops, fun, and to walk, bike, or take transit (or have much shorter commutes in cars). If two million people would occupy only 37% as much land with medium density growth, ***savings from fuel and greenhouse gas emissions used in transportation would be at least 63% even if most people still drive.*** If they occupy only 21% as much land with higher-density growth, ***savings would be at least 79%.*** If they choose to walk or ride a bike instead of drive, as I did, savings would be even higher.

Of course, it is not feasible to simply tear down existing low-density suburbs and start over. ***But it is feasible to increase density in TOD zones located near new rail and bus rapid transit lines as so many suburbs all over the world have already done.*** Arlington, VA encouraged much higher levels of development near high-speed rapid transit lines to attract more riders, justify frequent service, attract more jobs and gain higher tax revenues. Other regions have encouraged only moderate increases in density in TOD zones – enough to fill modern streetcars and longer light rail transit vehicles or large buses in dedicated lanes that still offer frequent service.

If every low density region does this, the environmental and fiscal benefits will be huge.

Think Globally, Act Locally

Grow Smart Planet has identified 27 regions with a total population of 38.6 million that are large enough to support regional rail transit systems with crosstown feeder bus routes. Most of them have no rail lines or just a short “starter” line now. Many other cities have rail transit lines serving several areas, but are considering extensions or crosstown routes that remain unfunded. We anticipate many regions will be able to take the ball and run with it without spending a fortune on costly planning and engineering consultants. This will be easier if they order a few copies of Sustainable Transportation and Development and get the right people to read it. You can download digital copies for free or order printed copies at www.growsmartplanet.org.



We are a big fan of Chicago architect Daniel Burnham, who said **“Make No Little Plans”** and then helped implement big plans there and in Washington, D.C. His words have inspired us to take on this challenging task because far too many people still do not think global warming is a huge problem for human, animal, and marine life on earth. Many oppose solutions like carbon taxes and birth control that would clearly help, or they think solving it will slow economic growth or cost billions in new taxes (at the expense of other important needs). They do not realize we have already spent billions coping with the impacts of climate change, and we will soon spend trillions more on stop-gap mitigation efforts like flood controls in coastal cities.

It would cost far less to reduce energy demand in buildings and improve public transportation to help solve the core environmental problems caused by our excessive use of fossil fuels.

We are lucky that most countries with rapidly expanding populations use less energy and carbon-based fuel per person than the United States or other countries where auto-oriented “suburban sprawl” accurately describes current development patterns.

Our goal is to encourage Smart Growth with more compact mixed-use areas focused on “low-carbon” transportation corridors designed to attract new businesses and residents at much lower costs. We are confident low-density communities worldwide can follow Arlington’s example and transform themselves into highly-desirable places to live where residents walk, bike, take transit, or have short commutes to jobs only accessible by car. Their residents can work and live in energy-efficient new or renovated buildings and use transportation vehicles powered mostly by renewable energy.

Millions of people prefer to live in small towns or rural areas where cars remain the best way to get around. When our family lived on a 200-acre farm in the 1950s, we had a very low carbon footprint. We drove six miles to town once a week for church, shopping, and to do the laundry.

Let’s simply cut worldwide use of energy and greenhouse gas emissions in half by 2030.

Grow Smart Planet hopes ***you will now take actions*** that will convince public officials, planners, and residents in your city to plan new ***regional*** "low carbon" transportation systems and TOD.

Convince them that:

- Property and other tax revenues from new businesses and residents will be enough to ***pay the full capital cost of the new transportation systems with local funds in just a few years***, and will be the "gift that keeps on giving" for decades to come.

- They do not have to choose between paying for regional transportation systems and budget items they may think are more important. ***They can have their cake and eat it too.*** Why? The revenues from TOD come from taxes on ***new*** property and ***new*** residents (as well as new jobs created during construction). Even if some of the people living and working in the new buildings move from elsewhere in the same region, the homes and buildings they leave will soon be filled by other taxpayers. This is why it would make sense to use tax revenues generated by new buildings and taxpayers ***in TOD zones*** to pay off bonds quickly.

- ***The new tax revenues and huge savings from Smart Growth will allow them to spend more money on worthwhile projects and services and still reduce tax rates in the future***, just as most regions that already have regional transit systems have done.

- It makes more sense to invest billions for a regional rail and high-speed bus transit system than to simply expand bus service ***because riders on faster, region-wide rail systems will pay a much higher share of operating costs.***

- ***It no longer makes sense to compete with other cities seeking scarce federal funds, which requires preparation of costly, complex planning and environmental studies.*** Conceptual plans focused on mode selection and major corridor planning decisions would cost far less.

- ***They do not need to give tax breaks to developers proposing projects located near new transit lines.*** The new lines bring workers and customers to their doors and allow them to build more usable space with fewer high-cost parking spaces. A regional transit system will make projects more desirable and profitable – without tax breaks. Developers will line up to build mixed use projects if they know it will not take years to get projects approved. ***This will require a change in mindset for public officials and developers in many cities.***

- ***Local residents will not be asked to pay for the capital costs of the new transit lines, and higher-density development will only occur within the TOD boundaries.*** Explain that everyone will benefit from higher property values (with lower tax rates), higher tax revenues for schools and other services, and a faster transportation system than buses stuck in traffic.

- ***State lawmakers and bankers should allow cities and suburbs to issue bonds to cover capital costs of multi-billion-dollar regional systems because revenues from TOD near the lines will be more than enough to pay the bonds back in just a few years.***

- They should support plans to replace outmoded trains, buses and shelters; upgrade transit stations and track; improve schedules; and other upgrades ***to attract more riders and improve farebox recovery rates in cities that already have regional rail transit systems.***

Grow smart. Save big. Help save the planet from the adverse impacts of global warming.

Appendix Overview

This Smart Growth Overview is based on the tax revenues, costs, and savings calculated on nine spreadsheets in the Appendix and similar summaries of transit mode performance, costs, and Transit-Oriented-Development (TOD) in the book Sustainable Transportation and Development by Michael Burrill (2014). The book documents sources for all transit modes and more than 600 transit lines studied. The comments that follow should help readers understand the planning assumptions behind the spreadsheet calculations.

A-1 Finance "Low Carbon" Transportation without Increasing Taxes $100 Million TOD per Mile

The first section of the spreadsheet shows the range of TOD documented near 65 rail and bus rapid transit lines. Most of it had been completed by 2013. The second section estimates what could be built ***for every $100 million invested in TOD*** using unit costs for office/commercial space and residential units in the R. S. Means 2017 Square Foot Construction Costs. Unit sizes are close to U. S. national averages for new housing. Common planning factors were used to estimate how many adults and children would be the primary users of this much space. ***Sections one and two are the same for spreadsheets A-1 to A-4.***

The third section estimates ***annual and 30 years of property tax revenues*** at the tax rates shown, regardless of building type. The website cited indicates most regions have property tax rates ranging from 0.5% to 2.5%. Commercial tax rates are often higher than residential rates.

The fourth section estimates income tax revenues from ***1,818 taxpayers*** in office/commercial space and ***400 taxpayers*** in residential space at the taxable incomes and tax rates shown. ***To be conservative, we assumed residential areas were mostly single-family units with only one taxpayer per unit.*** Revenues would be higher if new housing near transit lines averages more than one taxpayer per unit or includes a high percentage of townhouses and apartments.

The fifth section estimates sales tax revenues from ***400 taxpayers*** in residential areas. It assumes that only ***25% of their median taxable incomes*** would be used to buy items subject to sales taxes. Most jurisdictions do not apply sales tax to essential items (groceries, prescription drugs).

A-2 Finance "Low Carbon" Transportation without Increasing Taxes Cincinnati, Ohio Tri-State Region, $1 Billion TOD per Mile

The first two sections on spreadsheet A-2 are identical to those on spreadsheet A-1. Tax revenues in remaining sections are based on rates and median incomes cited on the website www.2017 Tax-Rates.Org for Cincinnati and Hamilton County, Ohio. City residents are paying property taxes closer to 2.5% for five years as a result of a 2016 school bond issue. We estimated taxable incomes are 90% of median incomes reported on the website to allow for deductions/exemptions. Residents in other counties are subject to the 2.1% city earnings tax if they work in Cincinnati.

Tax revenues are estimated based on the assumption that new transit lines would attract ***$1 billion TOD per mile if development is planned and funded at the same time.*** The number of taxpayers used to calculate income and sales taxes is simply ***ten times*** the number of taxpayers estimated for $100 million TOD. Revenues would be higher if new housing near transit lines averages more than one taxpayer per unit or includes a high percentage of townhouses and apartments. The last section of the spreadsheet shows 30 years of revenues from each source for office/commercial space and residential space. To estimate revenues for a specific transit line or regional system, planners must estimate the percentage of TOD for each use. If most new TOD is residential space to balance housing and jobs, commutes would be shorter.

A-3 Finance "Low Carbon" Transportation without Increasing Taxes Northern Virginia, $2 Billion TOD per Mile

The first two sections on spreadsheet A-3 are identical to those on spreadsheet A-1. Tax revenues in remaining sections are based on rates and median incomes cited on the website www.2017 Tax-Rates.Org for Fairfax County, Virginia.

Tax revenues are estimated based on the assumption that new transit lines would attract ***$2 billion TOD per mile if development is planned and funded at the same time.*** This is based on planned TOD near the new Silver rapid transit line, an extension of DC Metrorail to Tysons Corner and Reston. The number of taxpayers used to calculate income and sales taxes is simply ***twenty times*** the number of taxpayers estimated for $100 million TOD. Revenues would be higher if new housing near transit lines has more than one taxpayer per unit or includes a high percentage of townhouses and apartments (likely to be the case in this area). The last section of the spreadsheet shows 30 years of revenues from each source.

A-4 Finance "Low Carbon" Transportation without Increasing Taxes San Antonio, Texas Region, $1 Billion TOD per Mile

The first two sections on spreadsheet A-3 are identical to those on spreadsheet A-1. Tax revenues in remaining sections are based on rates and median incomes cited on the website www.2017 Tax-Rates.Org for San Antonio, Texas. Tax revenues are estimated based on the assumption that new transit lines would attract ***$1 billion TOD per mile if development is planned and funded at the same time.*** The city attracts two million visitors annually, already has many jobs in the suburbs, and the airport is only eight miles from downtown. A fast ***regional*** light rail system would attract more riders and TOD than the 15 mph bus "rapid" transit line recently opened. Revenues would be lower in San Antonio because Texas has no income tax, but construction costs could be lower because crosstown bus routes could use frontage roads parallel to freeways.

A-5 Average Capital Costs of "Low Carbon" Transportation

The average capital costs of transportation systems operating and planned as of 2013 are shown in the first six columns of this spreadsheet. They were first published in Table 3 of the book <u>Sustainable Transportation and Development</u>. Actual costs for lines in operation were adjusted to January 2011 dollars using historical cost indexes. Estimated costs for lines being planned in 2013 came from detailed planning or environmental reports. The book's tables averaged costs for each mode for all of the more than 600 lines studied in 2011 dollars. Those results were then adjusted to 2020 dollars based on 5% annual inflation, as shown here. This approach allows planners to compare "apples to apples" for capital costs for specific lines and average costs for each mode, regardless of when lines were actually bid.

The pre-design budgets for new lines highlighted in yellow in the last three columns of the spreadsheet are Grow Smart Planet's estimates for new lines built on-grade, in elevated sections, and underground ***that can be designed and bid by 2020.*** They clearly illustrate how widely costs vary for each mode, depending on topography and the need for elevated sections, bridges, tunnels. The newest subways in New York cost even more, but they were built far below grade. Underground rapid transit lines built closer to the surface should cost less. The book includes inflation factors that can be used to quickly estimate costs for lines built in future years (at 3% or 5% inflation rates), based either on actual costs for similar lines or average costs for each mode.

A-6 Performance of "Low Carbon" Transportation Modes

This table summarizes key performance indicators for the surface transportation modes studied in the book: market share (% of travel), average miles per trip, speed in miles per hour (including stops), passenger boardings per mile, and farebox recovery rates (the share of operating costs paid by riders in each mode). ***All of these factors should be considered when selecting modes for specific corridors.***

A-7 Savings from Smart Growth near Public Transportation Commuting and Parking

The first section of this spreadsheet estimates capital costs avoided if households have only one car. Each household would save at least $158,460 in 30 years if they did not have to buy a second car every ten years and costs increased 5% annually. The estimate uses $30,000 for a car bought in the first year. Savings would be higher if they avoid buying more expensive cars. Households would also save money on parking at home, with garage space costing more than space in surface lots. The range of ***capital cost*** savings to households: ***$163,460 to $198,860***. The book also describes related savings in fuel, loan payments, insurance, taxes, tolls, and tags.

The second section estimates capital costs avoided if employees do not drive to work and employers or public entities do not provide parking spaces for them in land wasting surface lots or costly garages. For surface lots this would save about $5,000 per car; for above-ground garages, $33,200 per car; for underground garages, $38,400 per car (2017 dollars). Savings for a garage with 500 cars: ***$16.6 to $19.2 million.*** These savings exclude costs for land, financing, operation and maintenance.

The third section estimates commuting costs saved by people who walk, bike, or take transit to work. For a 20 mile round trip commute, transit riders would save $1,500 per year if daily transit fares are close to operating costs (about $8), compared to commuters who drive alone in an energy-efficient car and pay to park. In 30 years, transit riders would save ***$45,000.*** They would save more if they avoid longer commutes by car or transit fares are lower, as they are in most cities. Commuters close enough to work to walk or take a bike would save ***$102,000 in 30 years.***

A-8 Savings from Smart Growth near Public Transportation Public Schools

This spreadsheet estimates public school savings from Smart Growth in a region with land values of $150,000 per acre, two million people, and about 728,000 housing units. ***These savings occur because the average number of public school children living in townhouses and apartments is much lower than in single-family units.*** The $35,000 capital costs for new or fully renovated schools and the $15,500 annual budget per child are based on actual Cincinnati costs.

The first section of the spreadsheet estimates the number of children, capital and education costs if the region is built with low-density residential areas averaging ***3.8 units per acre.*** The region would average about 0.84 public school children per unit with a mix of 75% single-family homes, 10% townhouses, and 15% low-rise apartments. If we assume new single-family units would average one public school child per unit, townhouses 0.6 children per unit, and apartments only 0.2 children per unit, this residential mix would yield 611,520 public school children.

The second section estimates the number of children, capital and education costs if the region is instead built with medium-density residential areas averaging about ***10.5 units per acre.*** The region would average about 0.5 public school children per unit with a mix of 25% single-family homes, 25% townhouses, and 50% low-rise apartments. If we assume the same number of children per housing unit of each type, this residential mix yields 364,000 pubic school children. With 247,520 fewer children, it yields the savings highlighted in green: ***$8.7 billion in capital costs and $115.1 billion in education costs in 30 years.***

The third section estimates the number of children, capital and education costs if the region is instead built with higher density residential areas averaging about ***17.9 units per acre.*** The region would average only 0.44 public school children per unit with a mix of 10% single-family homes, 40% townhouses, and 50% mid-rise apartments. This mix yields only 320,320 public school children. With 291,200 fewer children, it yields the savings highlighted in green: ***$10.2 billion in capital costs and $135.4 billion in education costs in 30 years.*** Savings would be higher in TOD zones with more apartments, fewer townhouses, and no single-family homes.

The fourth section compares the number of public school children per unit and FY 2016-17 education costs per pupil in Cincinnati and three Northern Virginia counties. We were not surprised to find only 0.22 children per unit in Arlington, VA and 0.26 children per unit in Cincinnati; 0.51 children per unit in Fairfax County and the City of Fairfax; and 0.64 children per unit in Prince William County. Arlington and Cincinnati have many older single family homes and apartments with less space for children. Large newer single family homes and townhouses with more children are more common in Fairfax and Prince William Counties.

Arlington could afford to spend $18,957 per child, thanks to revenues from very high levels of TOD ($5-5.9 billion per mile). ***Schools represented only 33-34% of annual budgets in Arlington and Cincinnati.***

We combined budgets for Fairfax County and the City of Fairfax because the county operates city schools. ***The school budget is more than half of the combined annual budget,*** even with a budget of $14,432 per child, 9% lower than Cincinnati and 24% lower than Arlington.

In Prince William County, the school budget was about ***49% of the county operating budget*** despite much lower education costs of $10,981 per child.

These results indicate even moderate increases in density from Smart Growth yield big savings in school costs.

A-9 Savings from Smart Growth near Public Transportation
Region with Two Million People, Land Values $150,000 per Acre

This spreadsheet estimates capital cost savings for land and construction in the same region, based on 910,000 wage earners and 182 million GSF of office/retail space.

The first section of the spreadsheet estimates total GSF, acres, and capital costs for land and construction if this space is built at low densities, with residential areas averaging 3.7 units per acre, 2-4 story office/retail buildings, and surface parking at home and work.

The second section estimates costs for space built at medium densities, with residential areas averaging 10 units per acre, 2-4 story office/retail buildings, and above ground parking garages for half of the spaces serving townhouses, apartments, and office/retail areas.

The third section estimates costs for space built at higher densities, with residential areas averaging 17.3 units per acre, 5-10 story office/retail buildings, and underground garages for 75% of the spaces serving townhouses, apartments, and office/retail areas.

These planning factors yield the following savings from Smart Growth:

Density Level	Total Space Million GSF	Acres	Capital Costs (Billion $) Land	Capital Costs (Billion $) Construction
Medium Density	189	175,116	$26.3	$64.3
Higher Density	200	219,770	$33.0	$40.6

In a region with land values of $450,000 per acre, savings for land would triple.

Finance "Low-Carbon" Transportation Without Increasing Taxes
$100 Million TOD Per Mile

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost Per GSF	Gross Square Feet (GSF) Total	Per Unit	Per Adult	Per Dwelling Unit Adults	Children	Total Users Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $100 Million TOD:

Building Functions	Tax Rate	Property Taxes Per Yr	30 Yrs
All Building Types	0.5%	0.5	$15
All Building Types	1.0%	1.0	$30
All Building Types	1.5%	1.5	$45
All Building Types	2.0%	2.0	$60
All Building Types	2.5%	2.5	$75

Projected Income Tax Revenues in Millions from $100 Million TOD:

Building Functions	Tax Payers	Taxable Income	Income Tax Rates Low	High	Annual Taxes Low	High	30 Years of Taxes Low	High
Offices/Commercial	1,818	$50,000	3.4%	9.7%	$3.1	$8.8	$93	$265
Offices/Commercial	1,818	$60,000	3.4%	9.7%	$3.7	$10.6	$111	$317
Offices/Commercial	1,818	$70,000	3.4%	9.7%	$4.3	$12.3	$130	$370
Offices/Commercial	1,818	$80,000	3.4%	9.7%	$4.9	$14.1	$148	$423
Offices/Commercial	1,818	$100,000	3.4%	9.7%	$6.2	$17.6	$185	$529
Residential Mix	400	$50,000	3.4%	9.7%	$0.7	$1.9	$20	$58
Residential Mix	400	$60,000	3.4%	9.7%	$0.8	$2.3	$24	$70
Residential Mix	400	$70,000	3.4%	9.7%	$1.0	$2.7	$29	$81
Residential Mix	400	$80,000	3.4%	9.7%	$1.1	$3.1	$33	$93
Residential Mix	400	$100,000	3.4%	9.7%	$1.4	$3.9	$41	$116

Projected Sales and Excise Taxes in Millions from $100 Million TOD:

Building Functions	Tax Payers	Taxable Items	Sales Tax Rates Low	High	Annual Taxes Low	High	30 Years of Taxes Low	High
Residential Mix	400	$12,500	4.5%	9.0%	0.2	0.5	7	14
Residential Mix	400	$15,000	4.5%	9.0%	0.3	0.5	8	16
Residential Mix	400	$17,500	4.5%	9.0%	0.3	0.6	9	19
Residential Mix	400	$20,000	4.5%	9.0%	0.4	0.7	11	22
Residential Mix	400	$25,000	4.5%	9.0%	0.5	0.9	14	27

Source of Tax Rates: www. 2017 Tax-Rates.Org

Finance "Low Carbon" Transportation Without Increasing Taxes
Cincinnati Ohio Tri-State Region, $1 Billion TOD Per Mile

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	2.0%	20.0	$600

Projected Income Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	State	City	State	City	State	City
Offices/Commercial	18,180	$62,000	2.64%	2.1%	$29.8	$23.7	$893	$710
Residential Mix	4,000	$62,000	2.64%	2.1%	$6.5	$5.2	$196	$156

Projected Sales and Excise Taxes in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	State	City	State	City	State	City
Residential Mix	4,000	$15,500	5.75%	1.25%	3.6	0.8	$107	$23

30 Years of Tax Revenues in Millions from $1 Billion TOD:

Revenue Sources	Office/Commercial				Residential Mix			
	State	County	City	Totals	State	County	City	Totals
Property Taxes		$600				$600		
Income Taxes	$893		$710		$196		$156	
Sales and Excise Taxes					$107		$23	
Totals	**$893**	**$600**	**$710**	**$2,203**	**$303**	**$600**	**$179**	**$1,082**

Total revenues far exceed the capital cost of "low carbon" public transportation per mile (all modes).

Source of Tax Rates: www. 2017 Tax-Rates.Org

Finance "Low-Carbon" Transportation Without Increasing Taxes
Northern Virginia, $2 Billion TOD Per Mile

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $2 Billion TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	0.89%	17.8	$534

Projected Income Tax Revenues in Millions from $2 Billion TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	State	Local	State	Local	State	Local
Offices/Commercial	36,360	$113,575	5.75%	0.0%	$237.5	$0.0	$7,124	$0
Residential Mix	8,000	$113,575	5.75%	0.0%	$52.2	$0.0	$1,567	$0

Projected Sales and Excise Taxes in Millions from $2 Billion TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	State	Local	State	Local	State	Local
Residential Mix	8,000	$28,394	4.3%	1.7%	9.8	3.9	293	116

30 Years of Tax Revenues in Millions from $2 Billion TOD:

Revenue Sources	Office/Commercial				Residential Mix			
	State	County	City	Totals	State	County	City	Totals
Property Taxes		$534				$534		
Income Taxes	$7,124				$1,567			
Sales and Excise Taxes					$293	$116		
Totals	**$7,124**	**$534**	**$0**	**$7,658**	**$1,860**	**$650**	**$0**	**$2,510**

Total revenues far exceed the capital cost of "low carbon" public transportation per mile (all modes).

Source of Tax Rates: www. 2017 Tax-Rates.Org

Finance "Low-Carbon" Transportation Without Increasing Taxes
San Antonio, Texas Region, $1 Billion TOD Per Mile

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	2.12%	21.2	$636

Projected Income Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	State	Local	State	Local	State	Local
Offices/Commercial	18,180	$55,200	0.0%	0.0%	$0.0	$0.0	$0	$0
Residential Mix	4,000	$55,200	0.0%	0.0%	$0.0	$0.0	$0	$0

Projected Sales and Excise Taxes in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	State	Local	State	Local	State	Local
Residential Mix	4,000	$13,800	6.25%	2.0%	3.5	1.1	104	33

Source of Tax Rates: www. 2017 Tax-Rates.Org

30 Years of Tax Revenues in Millions from $1 Billion TOD:

Revenue Sources	Office/Commercial				Residential Mix			
	State	County	City	Totals	State	County	City	Totals
Property Taxes		$636				$636		
Income Taxes								
Sales and Excise Taxes					$104	$33		
Totals	**$0**	**$636**	**$0**	**$636**	**$104**	**$669**	**$0**	**$773**

Total revenues far exceed the capital cost of "low carbon" public transportation per mile (most modes).

Source of Tax Rates: www. 2017 Tax-Rates.Org

Average Capital Costs of "Low Carbon" Transportation
Million Dollars per Mile in 2020 Dollars

Transportation Modes	Code	Operating as of 2013		Planned as of 2013		Pre-design Budgets for New Lines		
		# of Lines	Million $	# of Lines	Million $	On-Grade	Elevated	Underground
Dedicated bike lanes	BK	1	**$0.1**	N/A	$0	**$0.15**	N/A	N/A
Bus Rapid Transit	BRT	49	**$16**	22	**$26**	**$30**	N/A	N/A
Electric Trolleybus	TB	45	N/A	0	N/A	**$45**	N/A	N/A
Rapid Transit	RT	76	**$279**	7	**$532**	**$250**	**$350**	**$1,700**
Commuter Rail	CR	94	**$12**	11	**$50**	**$50**	**$350**	N/A
Streetcar Rail	SR	33	**$29**	23	**$68**	**$70**	N/A	N/A
Light Rail Transit	LR	62	**$110**	48	**$230**	**$125**	**$350**	**$1,100**
Automated Guideway	AG	6	**$347**	3	**$313**	N/A	**$350**	N/A
Monorail	MR	6	**$155**	0	$0	N/A	**$350**	N/A
Aerial Tramway	AT	2	**$133**	0	$0	N/A	**$150**	N/A
Cable Car	CC	3	**$45**	0	$0	**$100**	N/A	N/A
Inclined Plane	IP	4	N/A	0	$0	**$100**	N/A	N/A
Ferryboat	FB	3	**$51**	0	$0	**$80**	N/A	N/A

NOTES:

1. Source: Sustainable Transportaton and Development, Tables 3-5, Michael Burrill, 2014.

2. Actual costs for most lines were posted on agency websites (Tables 4, 6-9).
Actual costs per mile were adjusted to Jan 2011 dollars using R.S. Means indexes in Table 5.
Future costs per mile were estimated based on 5% annual inflation using factor (1.551) in Table 5.

3. Planned Subways in NYC had very deep tunnels and costs estimated at $1.737 billion per mile (2011 $)
Subways built close to ground level allow "cut and cover" construction at much lower costs.
Elevated RT lines in Honolulu, Vancouver, and Virginia had costs estimated at $219 million per mile (2011 $).
Current technology for RT lines has power near rails, requiring safety barriers that add costs.
Future technology may allow RT lines to get power from overhead lines, reducing costs per mile.

4. Planned light rail lines in two cities included bridges and tunnels, increasing average costs per mile.

5. Higher capital costs for elevated lines and subways can be offset by automated operation, reducing costs.
They also offer the potential of high levels of transit-oriented develoment (TOD) and tax revenues.

Performance of "Low Carbon" Transportation Modes

Transit Lines in Operation in the United States in 2013

Transportation Modes	% Travel	Miles Per Trip	Speed (mph) Range	Speed (mph) Avg	Boardings Per Mile	Farebox Recovery Range	Farebox Recovery 2011 Avg
Bus (MB)	38.9%	4.0	N/A	12.9	72 - 504	8-49%	27.7%
Bus Rapid Transit (BRT)		N/A	8-29	N/A	4,752	16-49%	22.9%
Electric Trolleybus (TB)	0.3%	1.6	7-17	7.1	1,260	18-43%	36.2%
Rapid Transit (RT)	30.4%	4.6	17-41	20.2	14,614	13-77%	66.0%
Commuter Rail (CR)	20.1%	23.4	23-66	32.9	379	12-62%	52.1%
Hybrid Rail (YR)			25-39			3-40%	10.8%
Streetcar Rail (SR)	4.0%	4.8	6-12	15.0	3,196	2-28%	35.6%
Light Rail Transit (LR)			9-38		2,602	12-57%	30.0%
Automated Guideway (AG)	3.5%	N/A	9-20	N/A	3,085	0-8%	10.0%
Monorail (MR)		N/A	16-30	N/A	8,422	114%	
Aerial Tramway (AT)		N/A	12-14	N/A	7,062	N/A	N/A
Cable Car (CC)		N/A	6-7	N/A	4,275	44.7%	44.7%
Inclined Plane (IP)		N/A	4-7	N/A	3,696	29-690%	152.0%
Ferryboat (FB)		6.3	12-16	9.6	3,179	0-143%	23.9%
Vanpool (VP)		34.8	N/A	41.1	N/A	53-98%	63.0%
Demand Response (DR/DT)	2.8%	7.9	N/A	14.9	66	N/A	7.3-10%
Multi-Mode Systems	N/A	N/A	6-55	N/A	N/A	0-102%	26.5%

Comparison to other Countries/Years

Transportation Modes Locations	Years	Miles Per Trip	Speed (mph) Range	Speed (mph) Avg	Boardings Per Mile	Farebox Recovery Range	Farebox Recovery Avg
59 Streetcar/Tram lines, Europe	2013	N/A	8-19	12	7,936	24%	24.0%
430 Lines in 57 US Cities	2010-11	5.3	7-66	25	N/A	0-166%	36.6%
32 Lines in 6 Canadian Cities	2010	N/A	18-35	N/A	N/A		52.7%

NOTES:

1. Source: Sustainable Transportation and Development, Tables 3-4, 10-11, Michael Burrill, 2014.
2. % of Travel, Trip Miles, Average Speeds cited in APTA 2012 Public Transportation Fact Book.
3. Speeds include stops. Range of speeds are for all lines studied in Table 4.
4. Boardings for most systems were cited in APTA Transit Ridership Report, 2nd Qtr 2013.
   Website sources were used for other lines. Boardings are "unlinked trips."
   Riders who transfer from one vehicle to another are counted twice. Total riders is lower.
5. Farebox Recovery rates are the share of operating costs paid by transit riders.
   Systems with high farebox recovery rates reduce operating costs paid by taxpayers.

Savings from Smart Growth near Public Transportation
Commuting and Parking

Capital Costs Avoided if Households Have Only One Car:

Description	GSF Per Car	# of Cars	Unit Cost	Year	Inflation Rate	Inflation Factor	Total $
Energy-efficient Hybrid car		1	$30,000	2011	5%	1.000	$30,000
Energy-efficient Hybrid car		1	$30,000	2021	5%	1.629	$48,870
Energy-efficient Hybrid car		1	$30,000	2031	5%	2.653	$79,590
Savings in 30 Years							**$158,460**
Parking, surface lot at home	400	1	$12.50	2017	5%	1.000	$5,000
Parking, attached garage at home	200	1	$72	2017	5%	1.000	$14,400
Parking, aboveground garage at home	400	1	$83	2017	5%	1.000	$33,200
Parking, underground garage at home	400	1	$96	2017	5%	1.000	$38,400
Savings in 30 Years						**Low**	**$163,460**
Car Plus Parking Costs at Home						**High**	**$196,860**

Capital Costs Avoided if Employees Do Not Drive to Work:

Description	GSF Per Car	# of Cars	Unit Cost	Year	Inflation Rate	Inflation Factor	Total $
Parking, surface lot at work	400	1	$12.50	2017	5%	1.000	**$5,000**
Parking, aboveground garage at work	400	1	$83	2017	5%	1.000	**$33,200**
Parking, underground garage at work	400	1	$96	2017	5%	1.000	**$38,400**
Parking, surface lot at work	400	**500**	$12.50	2017	5%	1.000	**$2,500,000**
Parking, aboveground garage at work	400	**500**	$83	2017	5%	1.000	**$16,600,000**
Parking, underground garage at work	400	**500**	$96	2017	5%	1.000	**$19,200,000**

NOTES:

1. **Table 5, <u>Sustainable Transportation and Development,</u> has inflation factors for 3% & 5% inflation.**
2. **Construction costs per GSF based on <u>2017 R. S. Means Square Foot Construction Costs</u>.**
3. **Garages for 10,000+ cars at the University of Cincinnati average about 400 GSF/car.**
   Surface lots with spaces 9 foot wide and driving lanes 25 feet wide average about 400 GSF/car.

Commuting Costs Saved by Wage Earners who Walk, Bike, or Take Public Transit:

Description	Fuel mpg	Miles Per Yr	Gallons Per Yr	Fuel $/gal	M&R Per Mile	Parking $/Day	Total $
Drive 10 miles to work, 250 days/yr	25	5,000	200	$2.50	$0.10	$10	**$3,500**
Public Transit, $8 per day, 250 days/yr	N/A	5,000	N/A	N/A	N/A	$0	**$2,000**
Annual Savings							**$1,500**
Savings in 30 Years							**$45,000**
Walk/bike 2 miles to work, 250 days	N/A	1,000	0	N/A	0.10	0	**$100**
Savings in 30 Years							**$102,000**

NOTES:

1. **Driving costs above do not include car loan payments, insurance, taxes, tolls, or tags.**
   See Table 2, <u>Sustainable Transportation and Development</u> for all monthly driving costs
2. **Estimated $8 per day for transit fares is for a 20-mile round trip. Many riders pay lower fares.**

Savings from Smart Growth near Public Transportation
Public Schools

Land Values:	$150,000	Per Acre
Population:	2,000,000	Persons
Housing Units:	728,000	Estimated @ 2.75 persons/unit (US/Canada average)
Capital Budget:	$35,000	Cost of new or fully-renovated schools per child
Education budget:	$15,500	Annual operating budget per child

Planning Factors	Land $ Per Acre	Mix %	Per Acre	Total Acres	Total Units	School Children Per Unit	School Children Total	Capital $ Millions	Education (Million $) Annual	Education (Million $) 30 Yrs
Single-Family homes	$150,000	75%	3	182,000	546,000	1.0	546,000	$19,110	$8,463	$253,890
Townhouses	$150,000	10%	10	7,280	72,800	0.6	43,680	$1,529	$677	$20,311
Apartments	$150,000	15%	25	4,368	109,200	0.2	21,840	$764	$339	$10,156
Low-Density Residential			**3.8**	**193,648**	**728,000**	**0.84**	**611,520**	**$21,403**	**$9,479**	**$284,357**
Single-Family homes	$150,000	25%	5	36,400	182,000	1.0	182,000	$6,370	$2,821	$84,630
Townhouses	$150,000	25%	10	18,200	182,000	0.6	109,200	$3,822	$1,693	$50,778
Apartments	$150,000	50%	25	14,560	364,000	0.2	72,800	$2,548	$1,128	$33,852
Medium-Density Residential			**10.5**	**69,160**	**728,000**	**0.50**	**364,000**	**$12,740**	**$5,642**	**$169,260**
Savings							**247,520**	**8,663**	**$3,837**	**$115,097**
Single-Family homes	$150,000	10%	8	9,100	72,800	1.0	72,800	$2,548	$1,128	$33,852
Townhouses	$150,000	40%	12	24,267	291,200	0.6	174,720	$6,115	$2,708	$81,245
Apartments	$150,000	50%	50	7,280	364,000	0.2	72,800	$2,548	$1,128	$33,852
Higher-Density Residential			**17.9**	**40,647**	**728,000**	**0.44**	**320,320**	**$11,211**	**$4,965**	**$148,949**
Savings							**291,200**	**10,192**	**$4,514**	**$135,408**

NOTES:

1. **Land costs widely. We estimated values for 24 locations based on median home values cited in 2017 Tax-Rates.Org. Values ranged from $133,380 per acre in Hamilton County, OH to almost $8 million per acre in Manhattan, NYC.**
2. **Capital costs estimated based on recent major capital investments in Cincinnati, OH. They exclude land costs.**
3. **Number of public school students per unit based on studies for new housing in Montgomery County, PA/Connecticut. Students per unit generated found in most zoning regulations are much higher than real-world numbers.**
4. **Costs per pupil also vary, even with one region. Examples from Cincinnati and Washington Area Board of Education:**

Public School District	Total Cost Per Pupil	Fiscal Year	Total Units	School Children Per Unit	School Children Total	Annual Budgets (Million $) Schools	City/Cty	Total	% Schools
Cincinnati, Ohio (CPS)	$15,503	2016-7	133,420	0.26	35,000	$543	$1,053	$1,596	34.0%
Arlington County, VA	$18,957	2016-7	112,529	0.22	25,302	$463	$943	$1,406	32.9%
Fairfax County & City, VA	$14,432	2016-7	368,091	0.51	185,979	2,684	$2,064	$4,748	56.5%
Prince William County, VA	$10,981	2016-7	137,115	0.64	88,117	526	$544	$1,070	49.2%

In Northern Virginia, the number of students per unit is much higher in outer suburbs with more single family homes.
Arlington County is the suburb closest to Washington with high levels of development near the DC Metro.
Fairfax County is a suburb further away with more than a million residents. Some areas have bus service to the DC Metro.
Prince William County is a low-density outer suburb that also had $140 million in school capital projects in FY 2016-17.

Savings from Smart Growth near Public Transportation
Region with Two Million People, Land Values $150,000 Per Acre

Land Values:	**$150,000**	**Per Acre**
Population:	**2,000,000**	**Persons**
Housing Units:	**728,000**	**Estimated @ 2.75 persons/unit (US/Canada average)**
Wage Earners:	**910,000**	**Estimated @ 1.25 per housing unit**
Office/Retail Space:	**182**	**Million GSF (average 200 GSF/wage earner)**

Planning Factors	**Land $ Per Acre**	**Mix %**	**Per Acre**	**Unit GSF**	**Million GSF**	**Units Spaces**	**Total Acres**	**$ Per GSF**	**Totals (Million $) Land**	**Constr**
Single-family homes	$150,000	**75%**	**3**	2,500	1,365	546,000	182,000	**$200**	$27,300	$273,000
Townhouses	$150,000	**10%**	**10**	2,000	146	72,800	7,280	**$175**	$1,092	$25,480
Apartments	$150,000	**15%**	**25**	1,400	153	109,200	4,368	**$196**	$655	$29,964
Surface parking, TH/APTS	$150,000	**100%**	**109**	400	73	182,000	1,671	**$12**	$251	$874
Residential Areas			**3.7**		**1,736**	**910,000**	**195,319**		**$29,298**	**$329,318**
Office/retail space (2-4 stories)	$150,000		**10,000**		182		18,200	**$202**	$2,730	$36,764
Surface parking, work	$150,000	**100%**	109	400	364	910,000	8,356	**$12**	$1,253	$4,368
Subtotals, Office/Residential					**2,282**	**1,820,000**	**221,876**		**$33,281**	**$370,450**
Streets/utilities (+25%)	$150,000				0		55,469		$8,320	$92,613
Low-Density Growth					**2,282**		**277,344**		**$41,602**	**$463,063**
Single-family homes	$150,000	**25%**	**5**	2,500	455	182,000	36,400	**$200**	$5,460	$91,000
Townhouses	$150,000	**25%**	**10**	2,000	364	182,000	18,200	**$175**	$2,730	$63,700
Apartments	$150,000	**50%**	**25**	1,400	510	364,000	14,560	**$196**	$2,184	$99,882
Surface parking, TH/APTS	$150,000	**50%**	**109**	400	109	273,000	2,507	**$12**	$376	$1,310
Aboveground garages, TH/APTS	$150,000	**50%**	**218**	400	109	273,000	1,253	**$83**	$188	$9,064
Residential Areas			**10.0**		**1,547**	**1,274,000**	**72,920**		**$10,938**	**$264,956**
Office/retail space (2-4 stories)	$150,000		**50,000**		182		3,640	**$202**	$546	$36,764
Surface parking, work	$150,000	**50%**	109	400	182	455,000	4,178	**$12**	$627	$2,184
Aboveground garages, work	$150,000	**50%**	436	400	182	455,000	1,045	**$83**	$157	$15,106
Subtotals, Office/Residential					**2,093**	**2,184,000**	**81,783**		**$12,267**	**$319,010**
Streets/utilities (+25%)	$150,000				0		20,446		$3,067	$79,752
Medium-Density Growth					**2,093**		**102,229**		**$15,334**	**$398,762**
Savings					**189**		**175,116**		**$26,267**	**$64,301**
Single-family homes	$150,000	**10%**	**8**	2,500	182	72,800	9,100	**$200**	$1,365	$36,400
Townhouses	$150,000	**40%**	**12**	2,000	582	291,200	24,267	**$175**	$3,640	$101,920
Apartments	$150,000	**50%**	**50**	1,400	510	364,000	7,280	**$234**	$1,092	$119,246
Surface parking, TH/APTS	$150,000	**25%**	**109**	400	66	163,800	1,504	**$12**	$226	$786
Underground garages, TH/APTS	$150,000	**75%**	**N/A**	400	197	491,400	**0**	**$96**	**$0**	$18,870
Residential Areas			**17.3**		**1,536**	**1,383,200**	**42,151**		**$6,323**	**$277,222**
Office/retail space (5-10 stories)	$150,000		**100,000**		182		1,820	**$184**	$273	$33,488
Surface parking, work	$150,000	**25%**	**109**	400	91	227,500	2,089	**$12**	$313	$1,092
Underground garages, work	$150,000	**75%**	**N/A**	400	273	682,500	**0**	**$96**	**$0**	$26,208
Subtotals, Office/Residential					**2,082**	**2,293,200**	**46,060**		**$6,909**	**$338,010**
Streets/utilities (+25%)	$150,000				0		11,515		$1,727	$84,503
Higher-Density Growth					**2,082**		**57,575**		**$8,636**	**$422,513**
Savings					**200**		**219,770**		**$32,965**	**$40,550**

NOTES:

1. **Land costs per acre vary. See estimates for 24 locations based on median home values cited in 2017 Tax-Rates.Org.**
2. **Construction costs per GSF based on 2017 R.S. Means Square Foot Construction Costs.**
   Costs for single-family homes includes 2-car attached garage. Garage cost: $14,360 per space.
3. **25% allowance for streets and utility lines is based on cost analyses for large subdivisions and planned communities.**