www.vtpi.org
Info@vtpi.org
250-508-5150

Win-Win Transportation Emission Reduction Strategies

Smart Transportation Strategies Can Reduce Pollution and Provide Other Important Economic, Social and Environmental Benefits

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Todd Litman
Victoria Transport Policy Institute

The Earth's surface is covered by a thin and precious atmosphere. There are many ways to protect it, some of which provide significant co-benefits. (Photo, NASA)

Summary

There are many possible ways to reduce pollution emissions, but some provide more total benefits than others. *Win-Win transportation strategies* are cost-effective policy reforms that solve transportation problems by improving resource-efficient mobility options and removing market distortions that cause excessive motor vehicle travel. They provide many economic, social and environmental co-benefits, in addition to reducing emissions. If implemented to the degree that is economically justified, Win-Win solutions can reduce transport emissions 30-60% while helping to achieve other community goals. A useful rule of thumb is that at least half of transportation emission reduction targets should be achieved with Win-Win strategies. This report discusses the Win-Win concept, describes Win-Win strategies, and provides guidance for their optimal implementation.

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Introduction to Win-Win Strategies

There are many possible ways to reduce transportation pollution emissions. Which are best? That often depends on how they are analyzed. Some strategies impose indirect costs or provide co-benefit in addition to their emission reductions. Good planning accounts for all significant impacts when selecting emission reduction strategies.

Win-Win solutions are Transportation Demand Management (TDM) strategies that improve and encourage resource-efficient travel (walking, bicycling, ridesharing and public transit), and create more compact, multimodal neighborhoods where residents tend to own fewer vehicles, drive less, rely more on resource-efficient modes, and spend less money on transportation. These changes provide many benefits in addition to emission reductions including congestion reductions, road and parking facility cost savings, consumer savings and affordability, more independent mobility for non-drivers, improved public health and safety, and reduced sprawl-related costs, to name a few.

Cost effective TDM programs typically reduce affected automobile travel by 10-30%, and more if integrated with supportive policies such as fuel price reforms and Smart Growth development policis (Litman and Pan 2024). An integrated set of cost-effective Win-Win strategies can typically reduce affected vehicle travel and emissions by 30-60% compared with what would otherwise occur, while providing substantial co-benefits.

These are, admittedly, big claims. To understand why such large benefits are possible it is useful to consider some basic economic principles. To be efficient and equitable a transportation system must be diverse and favor affordable, inclusive and resource-efficient options. Many current transport policies contradict these objectives: they favor automobile travel over more affordable and efficient modes, and sprawl over more compact, accessible development. Although few motorists want to give up automobile travel altogether, surveys indicate that many would prefer to drive less, rely more on efficient modes, and live in more walkable neighborhoods, provided they are convenient, comfortable and affordable. Win-Win solutions respond to these demands.

This is timely issue. There is growing agreement on the need to reduce emissions but disagreement concerning how. When evaluating options it is important to apply comprehensive analysis that considers all impacts including rebound effects, co-benefits and social equity goals. More comprehensive evaluation tends to support Win-Win solutions, alone and in conjunction with “clean vehicle” strategies such as fuel switching, to maximize their benefits.

This report examines these issues. It describes basic economic principles required for an efficient and equitable transportation system, identifies current policy distortions that violate these principles, describes various Win-Win transportation emission reduction strategies, and evaluates their benefits. This should be of interest to anybody involved in transportation or emission reduction planning.

Types of Emission Reduction Strategies

There are two general ways to reduce transportation emissions: *cleaner vehicles* strategies that reduce per mile emission rates, and *vehicle travel reduction* strategies that reduce total vehicle travel. Table 1 lists examples.

Table 1 **Examples of Emission Reduction Strategies** (EU 2021; IEA 2021; ITF 2020; LSE & OECD 2021; OECD 2021; SUM4All 2020; TFA and SGA 2020; TUMI 2020; VTPI 2020)

Cleaner Vehicles	Motor Vehicle Travel Reductions
Technologies and policies that reduce emission rates per vehicle-mile	*TDM and Smart Growth policies that reduce total vehicle travel*
• Shifts to more efficient and alternative fuel vehicles (e.g., hybrid, electric and hydrogen). • High emitting vehicle scrapage programs. • Efficient driving and anti-idling campaigns. • Switching to lower carbon and cleaner fuels. • Inspection and maintenance programs. • Resurface highways. • Roadside "high emitter" identification	• Multimodal planning (improve walking, bicycling, public transit, ridesharing, etc.) • Smart Growth policies that create more compact and multimodal communities. • Transportation Demand Management programs (commute trip reduction, freight transport management, etc.) • More efficient road, parking and vehicle pricing. • Vehicle parking policy reforms.
• Increase fuel prices by reducing subsidies and increasing taxes (encourages both types of strategies)	

"Cleaner vehicles" reduce emission rates. Vehicle travel reductions reduce total motor vehicle mileage.

All of these strategies reduce emissions but they vary in other effects. Because cleaner vehicles generally cost less to operate than current vehicles they tend to increase total vehicle travel and associated costs. For example, electric vehicles cost about half as much to operate than comparable fossil fuel vehicles, which typically increases vehicle travel 10-30%. This is called a *rebound effect*, and the additional vehicle-miles are called *induced vehicle travel* (Byun, Park and Jang 2017). Although there are still net emission reductions – a 10-30% rebound effect still leaves 70-90% net energy savings – it reduces emission reduction benefits and the induced vehicle travel increases external costs including congestion, crashes, non-tailpipe vehicle emissions and sprawl-related costs such as habitat loss. The additional vehicle travel benefits users, but these tend to be modest since the additional vehicle travel consists of marginal value vehicle-miles that users are most willing to forego if their costs increase.

Conversely, vehicle travel reduction strategies usually provide *co-benefits* in addition to emission reductions (Fang and Volker 2017; IGES 2011; ITF 2021). These tend to be large and numerous, so vehicle travel reduction strategies often provide much larger total benefits than clean vehicle strategies, as discussed later in this report. In recognition of these co-benefits, many experts recommend that vehicle travel reduction strategies receive at least as much consideration as clean vehicle programs (Litman 2022; Milovanoff, Posen and MacLean 2020; Small 2019; Vaughan 2019).

Some jurisdictions have established vehicle travel reduction targets (ACEEE 2019; Litman 2020; Thorwaldson 2020). For example, California state law requires that capita vehicle travel be reduced 15% by 2050 (GOPR 2018); Washington State requires 30% reductions by 2035 (WSL 2008); and the United Kingdom has a goal that half of urban journeys will be by bicycle or walking by 2030 (DfT 2020). This reduces emissions and helps achieve other goals including congestion reduction, infrastructure savings, affordability, public health and safety, and social equity. Travel reduction targets can also be justified as a way to correct past policies that resulted in automobile dependency, and respond to changing travel demands (Boarnet 2013; STTI 2018). Guides and tools are available for designing vehicle travel reduction plans (Byars, Wei and Handy 2017).

Table 2 illustrates a basic framework for comparing the objectives achieved by various strategies. Although all reduce emissions, cleaner vehicles tend to increase total vehicle travel and encourage sprawl development, which reduces their net benefits and increases their external costs. Conversely, vehicle travel reduction strategies help achieve numerous economic, social and environmental goals.

Table 2 **Comparing Impacts**

Planning Objectives	TDM and Smart Growth	Clean Vehicles
Vehicle Travel Impacts	*Reduced*	*Increased*
Congestion reduction	✓	×
Roadway cost savings	✓	×
Parking cost savings	✓	×
Consumer savings and affordability	✓	Higher purchase, lower operating
Traffic safety	✓	×
Improved mobility for non-drivers	✓	×
Fossil fuel conservation	✓	✓
Pollution reduction	✓	✓
Physical fitness and health	✓	×
Strategic development objectives (reduced sprawl)	✓	×

(✓= Achieve objectives. ×= Contradicts objective.) Vehicle travel reductions and more compact development help achieve a wide range of planning objectives. Cleaner vehicles help conserve fossil fuel and reduce pollution but provide few other benefits and, by inducing more vehicle travel, contradict many objectives.

This is not to suggest that clean vehicle strategies are bad and should never be implemented, but it demonstrates the importance of applying comprehensive analysis when evaluating emission reduction options. It asks, for example, to achieve a 30% emission reduction target, would you prefer to subsidize electric cars for 40% of your neighbors, or instead to convince your neighbors to reduce their vehicle travel by 30%?

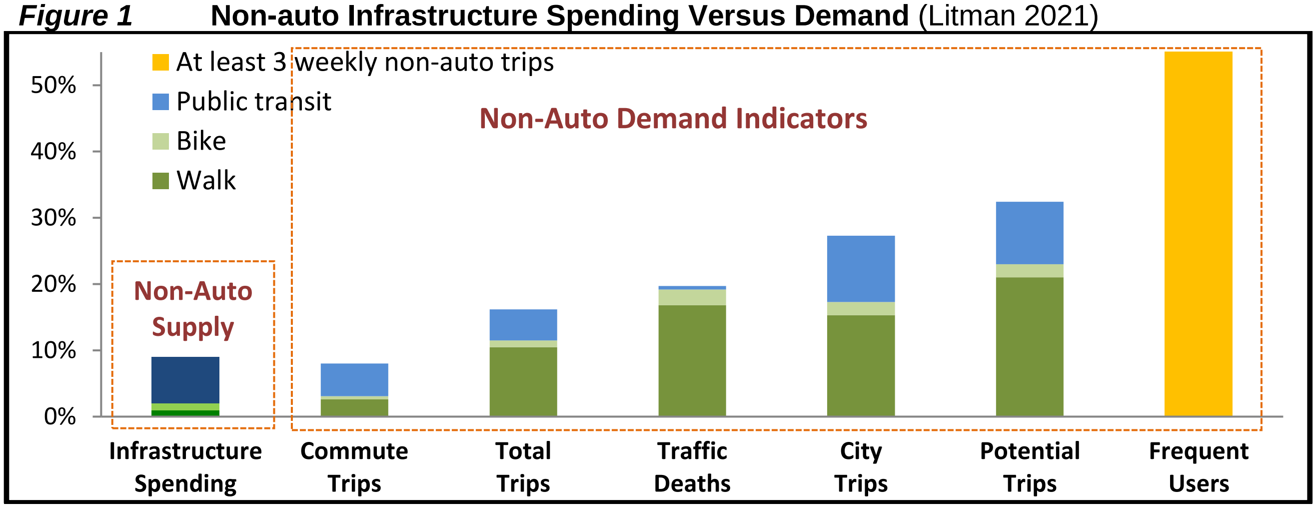
A Dozen Excellent Win-Win Strategies

This section describes twelve Win-Win strategies. For more information see Brown, et al. 2021; EU 2021; ICAT 2020; IEA 2021; ITF 2020; LSE & OECD 2021; OECD 2021; PPMC 2016; Stechemesser et al. 2024; SUM4All 2020; TFA and SGA 2020; TUMI 2020; and VTPI 2020.

Transportation Planning Reforms

Conventional transportation planning practices tend to favor automobile travel over slower but more resource-efficient modes (STTI 2018; Grant, et al. 2013), which creates automobile-dependent transportation systems and sprawled development patterns (Shill 2018). As a result, the majority of transportation infrastructure spending is currently allocated to automobile improvements, as illustrated below. This is inefficient and unfair; it forces people to drive for trips that could be made by more efficient modes, if they received greater investments, and is particularly harmful to people who for any reason cannot, should not, or prefer not to drive for most trips.

Figure 1 **Non-auto Infrastructure Spending Versus Demand** (Litman 2021)



Non-auto modes receive less than 10% of transportation infrastructure spending, which is less than their share of total trips, traffic deaths, potential trips, and users.

More comprehensive and multimodal planning, sometimes called *least-cost planning*, tends to create more diverse and efficient transportation systems (Lindquist and Wendt 2012). Transport model improvements provide better information on the impacts and benefits of vehicle travel reductions (CalSTA 2020). People who live or work in multimodal communities typically drive 10-30% less, and rely much more on non-auto modes, compared with conventional, automobile-oriented areas (LSE & OECD 2021).

Active and Micro Mode Improvements

Active modes include walking, bicycling, and variants such as wheelchairs and scooters. Micromodes, such as e-bikes and e-scooters, can travel faster, farther, in more conditions and with heavier loads than human powered equivalents (ITDP 2019). Improving and encouraging these modes can provide many direct and indirect benefits. Approximately 12% of U.S. personal trips are by active modes, and their potential is much greater: A quarter of current vehicle trips are less than one mile, a walkable distance; half are less than three miles, a bikeable distance; and most are less than five miles, a distance suitable for e-biking (Bhattacharya, Mills, and Mulally 2019; Litman 2023).

There are many ways to improve active travel including better facilities (sidewalks, crosswalks, paths and bike parking), lower traffic speeds, and more compact development (AARP and CNU 2021). Electric vehicle subsidies can be expanded to include micromodes. Significantly improving these modes can substitute for 5-15% vehicle trips (CARB 2010-2015), and can leverage additional vehicle travel reductions as descrive in Box 1. A major academic study, *A Global High Shift Cycling Scenario*, estimated that improving bicycling conditions could increase urban bicycle and micro mode shares from the current 6% up to 17-22% (Mason, Fulton and McDonald 2015). Another study estimated that in typical urban areas micro mode could serve 10-15% of trips and reduce emissions 12% (McQueen, MacArthur and Cherry 2020). Maizlish, Rudolph and Jiang (2022) conclude that active mode improvements could reduce transportation emissions 24%, and by improving public health and safety, avoid 167,000 deaths with $1.6 trillion monetized benefits.

Box 1 Leverage Effects (Litman 2023; McGraw 2021)

Non-auto improvements often leverage additional vehicle travel reductions in these ways:

- *Shorter trips.* A shorter active trip often substitutes for longer motorized trips, such as when people choose a local store rather than driving to more distant shops.
- *Vehicle ownership reductions*. Improving alternative modes allows some households to reduce their vehicle ownership, for example, from two to one car, or to become car-free. When households no longer have a vehicle available at any time, they tend to significantly reduce their total vehicle travel.
- *Complementary.* Most public transit trips include walking and bicycling links, so improving walking and bicycling conditions around transit stops and stations increases both active and public transport travel.
- *Reduced chauffeuring*. Poor walking and bicycling conditions often cause motorists to chauffeur non-drivers which generates empty backhauls (trips with no passenger). For such trips, a mile of walking often reduces two vehicle-miles of travel.
- *Lower traffic speeds.* Active travel improvements often involve reducing urban traffic speeds. This makes non-auto travel safer, more pleasant and more time-competitive with driving.
- *More compact development with reduced parking subsidies*. Reduced vehicle ownership and use reduces the amount of land required for roads and parking facilities, reducing subsidized parking and allowing more compact development, which further reduces vehicle trips and travel distances.
- *Social norms.* As non-auto travel becomes more common it becomes more socially acceptable.

Non-auto mode (walking, bicycling, micromodes and public transit) improvements can leverage additional vehicle travel reductions so an additional non-auto travel-mile reduces more than one vehicle-mile.

Public Transit Improvements

Although public transit only serves a minor portion of travel in most North American communities, high quality public transit can leverage large reductions in vehicle travel by helping to stimulate more compact, multimodal communities where residents own fewer vehicles, drive less and rely more on non-auto modes (Arrington and Sloop 2010). There are many ways to improve public transit including increasing service coverage, frequency and speed, improving vehicle and station comfort, and more convenient user information and payment systems. Transit Oriented Development (TOD) uses transit stations as a catalyst to create compact, walkable neighborhoods (World Bank 2018). Commuters on corridors with high quality transit typically drive 10-30% less, and TOD residents typically drive 20-60%, less than in automobile-oriented areas (Salon 2014).

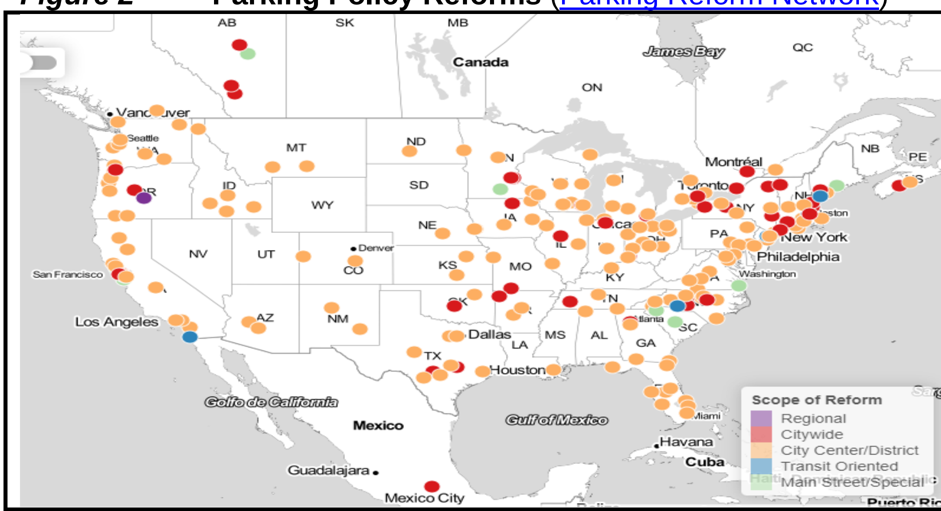
Vehicle Sharing

Vehicle sharing refers to car and rental services designed to provide a convenient alternative to private vehicle ownership. This allows households to own fewer vehicles and rely more on alternative modes. Motorists who shift from owning an automobile to carsharing typically reduce their vehicle travel 30-60%. Bike- and scooter-sharing can substitute for automobile trips and facilitate public transit travel, particularly in denser urban areas (CARB 2010-2015; Clewlow 2015).

Reduce Parking Mandates and Manage Parking Efficiently

Most North American jurisdictions impose minimum parking mandates. This subsidizes and encourages automobile travel, and by increasing the land required for a given amount of development, increases sprawl. Mandates reduce property owners' incentive to encourage non-auto travel. For example, an employer with one parking space per employee has little incentive to encourage non-auto commuting since that would result in valuable parking spaces sitting unoccupied. Eliminating parking minimums allows property owners to reduce their parking supply and invest the savings in commute trip reduction programs. Many jurisdictions are reducing parking mandates in order to reduce traffic problems and sprawl, as illustrated below.

Figure 2 **Parking Policy Reforms** (Parking Reform Network)



This dynamic map produced by the Parking Reform Network identifies North American jurisdictions that are reforming their parking policies for efficiency and fairness.

Some jurisdictions reduce parking minimums and instead require property owners to impelement TDM programs. These typically reduce traffic and parking demands by 40-60% compared with conventional development (Galdes and Schor 2022; Spack and Finkelstein 2014).

Efficient Parking Pricing

Efficient parking pricing means that motorists pay cost-recovery prices for the parking facilities they use, with higher rates under congested conditions (ICAT 2020). It can also include *parking cash out*, which means that non-drivers receive the cash equivalent of parking subsidies offered to motorists, and parking *unbundling*, which means that parking is rented separately from building space, so occupants are no longer required to pay for costly parking spaces they don't need. Including land, construction and operating expenses, a typical urban parking space has $500-3,000 annual costs, so efficient prices are typically $2-15 per day, and more during peak periods (Litman 2019). This typically reduces affected vehicle travel 10-30% (CARB 2010-2015).

Efficient Road Pricing

Road Pricing means that motorists pay directly for driving on a particular roadway or in a particular area. *Decongestion Pricing* (also called *Value Pricing*) refers to road pricing with higher fees during peak periods to reduce congestion. VMT fees charge developres based on a project's vehicle trip generation, providing a financial incentive to locate and design development to minimize driving (Bowen 2021). Economists have long advocated road pricing as an efficient and equitable way to fund transport facilities and reduce external costs including congestion and emissions (Veitch and Rhodes 2024). It typically reduces affected vehicle traffic 10-30%, with larger reductions if implemented with improvements to other modes (CARB 2010-2015). New payment technologies can reduce the costs and inconvenience of road and parking pricing, making it cost effective in most locations.

Pay-As-You-Drive (PAYD) Pricing

Pay-As-You-Drive (also called *Distance-Based* and *Mileage-Based*) pricing means that vehicle insurance, registration fees, and taxes are based directly on the vehicle's annual mileage (Bordoff and Noel 2008; Litman 2011). For example, for a vehicle in a class that averages 12,000 annual miles, a $600 annual premium becomes 5¢ per mile and a $1,800 annual premium becomes 15¢ per mile. A typical U.S. motorist would pay about 10¢ per mile for insurance, plus 3¢ for fees and taxes. This is more equitable and affordable, and with fully marginalized rates (total premiums are distance-based) would reduce affected vehicles' annual mileage by 10-15% (Greenberg and Evans 2017).

Reduce Fuel Subsidies and Increase Fuel Taxes

Motor vehicle fuel is subsidized in various ways (IMF 2015). Eliminating subsidies and increasing fuel taxes are efficient ways to reduce energy consumption and pollution emissions, finance roadways, and internalize petroleum external costs such as environmental damages and explosion risks (ExternE 2015). Eliminating fuel subsidies is predicted to reduce global GHG emissions 11-18% (IMF 2015; Merrill, et al. 2015). Fuel taxes would need to approximately double to cover all roadway costs (FHWA 2018), and more to internalize other costs. *Carbon taxes* reflect a fuel's carbon content. A $50 per metric ton carbon tax would be 44₵ per gallon of gasoline, increasing current retail prices about 25% (Hafstead and Picciano 2018). The price elasticity of vehicle travel with respect to fuel price is typically about -0.3 in the short run and -0.7 in the long run, so a 25% price increase would reduce consumption about 7% within two years and 18% within ten years (CARB 2014; Litman 2015).

Transportation Demand Management (TDM) Programs

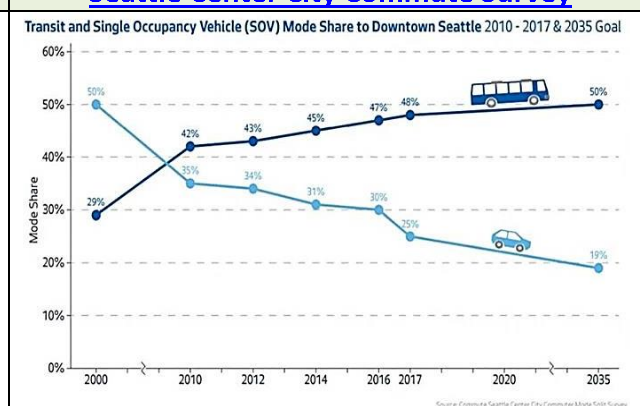
TDM programs encourage resource-efficient travel (Litman and Pan 2024; SANDAG 2015; WSDOT 2017). *Commute Trip Reduction* programs target employee travel. *School* and *Campus Trip Management* programs target students and staff. *Transportation Management Associations* target a particular area, such as a commercial or industrial center. Although most TDM strategies individually only affect a small portion of total travel, an integrated program can typically reduce affected vehicle travel 5-15% if it only provides information and encouragement, and 10-30% if it has financial incentives such as efficient road or parking pricing (CARB 2010-2015). For example, the article, *Don't Underestimate Your Property: Forecasting Trips and Managing Density Over the Long Term in Fairfax County, Virginia* (Galdes and Schor 2022), found that residential and commercial developments that had comprehensive but cost-effective TDM programs actually generated 30-60% fewer trips and require significantly less parking than ITE trip and parking generation values. Similarly, Spack and Finkelstein (2014) found that office buildings that implemented TDM Plans generate, on average, 34% to 37% less traffic and need 17% to 24% fewer on-site parking spaces. Cities such as Portland, Seattle and Vancouver demonstrate TDM program effectiveness, as illustrated below.

Figure 3 **Examples of Successful Vehicle Travel Reduction Programs**

Vancouver 2018 Transport Panel Survey

Between 2013 and 2018, Vancouver citywide walking, bicycling and transit mode shares increased from 48% to 53%, through a combination of multimodal planning and TDM incentives.

Seattle Center City Commute Survey



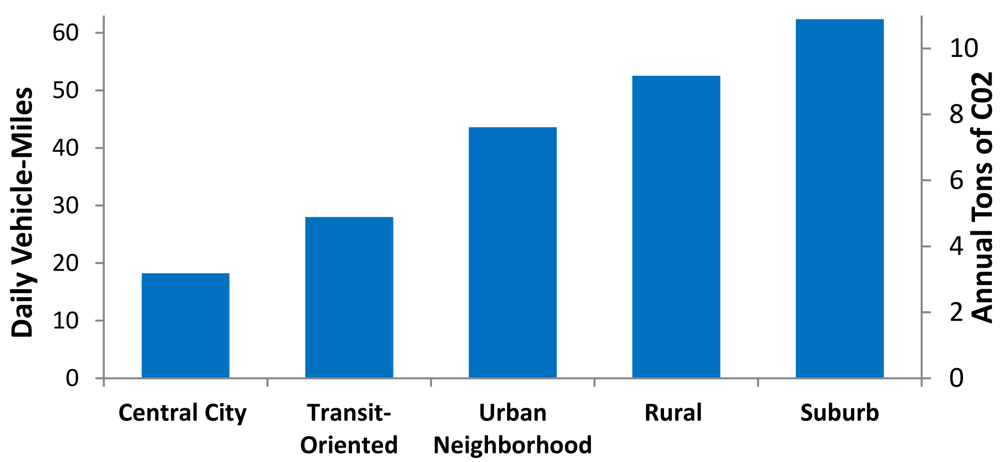
Between 2000 and 2017, downtown Seattle's transit mode share increased from 29% to 48%, and auto mode share declined from 50% to 25%, due to transit improvements and TDM incentives.

Smart Growth Development Policies

Smart Growth refers to development practices that result in more compact, multimodal communities where travel distances are shorter and people have more travel options. This is sometimes called a *15-minute neighborhood*, where common services are accessible within a 15 minute walk or bike ride (AARP and CNU 2021; TfA and SGA 2020). Surveys indicate that many families want to live in such neighborhoods but cannot due to inadequate supply; Smart Growth policies respond to these demands by allowing more infill development (NAR 2020). Smart Growth policies typically reduce per capita vehicle travel and emissions 10-30%, and more if implemented with complementary strategies such as efficient road and parking pricing (Holland, et al. 2023; Kimball, et al. 2013; Subin, et al. 2024).

The report, *Quantifying the Effect of Local Government Actions on VMT* (Salon 2014), used sophisticated analysis to measure how local transportation and land use policies affect work and non-work travel. It found that households located in automobile-dependent, urban fringe areas drive about three times more miles and produce about three times the carbon emissions as otherwise comparable households located in compact, multimodal neighborhoods (Figure 2). Smart Growth policies would allow most households and businesses to locate in compact, multimodal neighborhoods.

Figure 2 **Household VMT by Neighborhood Type** (Salon 2014)



Freight Transport Management

Freight Transport Management includes various strategies to increase freight and commercial transport efficiency (CIVITAS 2015). This includes improving distribution practices to reduce vehicle trips, shifting freight to more resource efficient modes (such as from air and truck to rail and marine), and better siting of industrial locations to improve distribution efficiency. Freight vehicle represent less than 10% of total vehicle travel but about 30% of vehicle emissions. More efficient management typically reduces freight vehicle travel 5-20% (Goetz and Alexander 2019).

Win-Win Solutions Summary

Table 2 summarizes these Win-Win strategies.

Table 2 **Win-Win Emission Reduction Strategies**

Name	Description	Typical Travel Impacts
Planning Reforms	More comprehensive planning and investment practices.	People who live or work in multimodal communities typically drive 10-30% less than in automobile-dependent areas.
Active and Micromode Improvements	Improve walking and cycling conditions, and support micro modes.	People who live or work in very walkable and bikeable communities typically drive 10-30% less than in auto-dependent areas.
Transit Improvements	Significantly improve public transit services and support transit oriented development (TOD).	Commuters with high quality transit typically drive to work 10-30% less, and TOD residents typically drive 20-60% less than they otherwise would.
Vehicle Sharing	Convenient vehicle rental services.	Households that shift from owning a vehicle to carsharing typically drive 20-40% fewer annual miles.
Parking Management	Reduce parking mandates and manage parking efficiently.	Efficient parking management reduces automobile ownership and use and encourages more compact development. People who live or work in areas with efficient parking management tend to drive 10-30% less than with over-abundant parking.
Parking Pricing	Charge users cost-recovery parking fees, and cash out free parking.	Typically reduces affected vehicle ownership by 5-15%, and vehicle trips by 10-30%.
Road Pricing	Charges users cost-recovery road tolls, with higher rates under congested conditions.	Typically reduces affected vehicle travel by 10-30%, and is particularly effective on major urban corridors.
Pay-As-You-Drive Pricing	Converts fixed vehicle charges into mileage-based fees.	Fully marginalized incsurance and registration fees reduce affected vehicle travel 10-15%.
Higher Fuel Taxes	Reduce fuel subsidies, increase fuel taxes, and apply carbon taxes.	Cost recovery fuel taxes would increase fuel prices about 40₵ per gallon, or about 10%. This would reduce vehicle travel about 3% and fuel consumption about 7% over the long run.
TDM Programs	Transportation demand management (TDM) programs that encourage non-auto travel and reduce automobile travel.	TDM programs implemented at a worksite or development typically reduce affected trips by 30-60%. More comprehensive TDM programs can have additional impacts.
Smart Growth Policies	More accessible, multi-modal land use development patterns.	Residents of compact, multimodal neighborhoods typically drive 30-60% less than in automobile-dependent areas.
Freight Transport Management	Encourage shippers to use more efficient transportation options.	More efficient management typically reduces freight vehicle travel 5-20%, representing 0.5-2% of vehicle travel but 1.5-6% of transport emissions.

This table summarizes the impacts of various Win-Win strategies.

Many of these strategies overlap or have synergistic effects, so it would not be appropriate to simply add their travel imapcts. For example, transportation planning reforms often result in more active and public transport improvements, plus more TDM programs, and public transit improvements tend to become more effective if implemented with efficient parking management, road pricing, TDM programs and Smart Growth development policies. By itself, a public transit improvement may only attract 10% of commuters, but 30% if implemented with efficient road and parking pricing, plus walking and bicycling improvements around transit stops.

These strategies also vary in the scope of travel they affect. In the past, transportation planning was primarily concerned with reducing traffic congestion problems, so TDM programs focused on reducing urban-peak travel, for example, with urban rail services and congestion pricing. However, urban-peak travel only represents about 10% of total vehicle travel. Reducing consumer costs, crashes, fuel consumption and emissions requires reducing total vehicle travel, including off-peak and rural travel.

Table 3 indicates the scope of win-win strategies and their typical travel impacts. Although it is difficult to predict the total impacts of comprehensive Win-Win programs due to their overlapping and synergistic effects, if implemented to the degree economically justified, considering all benefits and cost, an integrated program is likely to reduce total vehicle travel 30-60% compared with current practices (IEA 2021; Litman 2017). This would provide substantial emission reductions and help achieve other economic, social and environmental benefits.

Table 3 **Travel Impacts** (Win-Win Evaluation Spreadsheet, www.vtpi.org/Win-Win.xls)

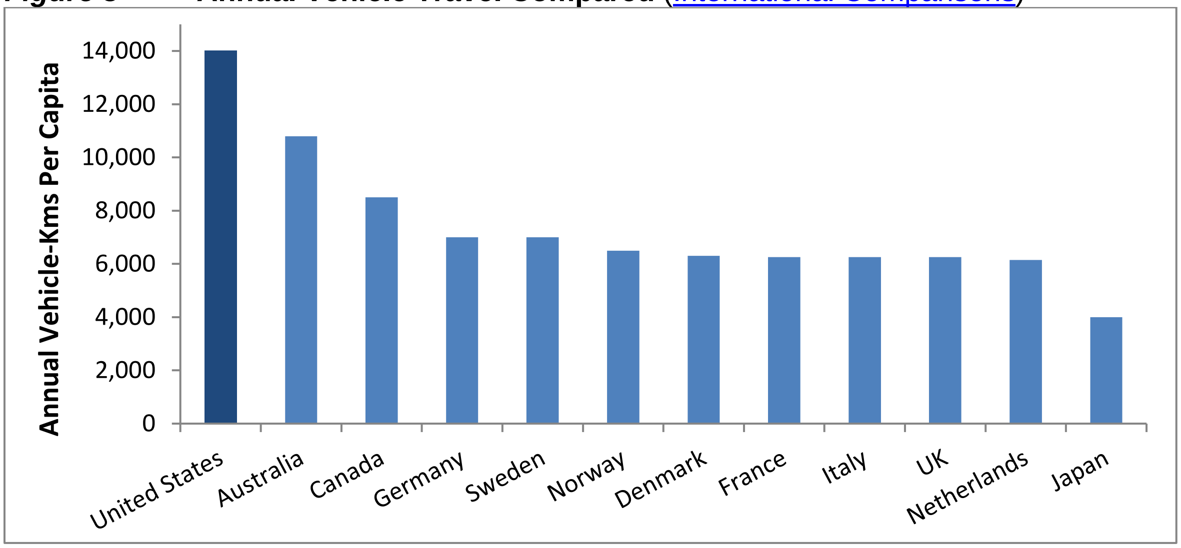
Name	Portion of Vehicle Travel Affected	Typical Reductions Of Affected Travel	Total Reductions
Planning reforms	100%	10-30%	10-20%
Active and micromodes	20%. Shorter-distance trips	10-30%	4-12%
Transit & TOD	30%. Mainly urban travel	10-30%	3-9%
Vehicle sharing	5%. Suitable households	20-40%	1-2%
Parking management	60%. Most urban travel	10-30%	6-18%
Parking Pricing	40%. Mainly urban travel	10-20%	4-8%
Road pricing	30%. On new or congested roads	10-20%	3-6%
Pay-As-You-Drive pricing	80%. Private automobile travel	10-12%	8-10%
Fuel taxes	100%	5-15%	5-15%
TDM programs	40%. Travel affected by programs	10-30%	4-12%
Smart Growth reforms	50%. Mainly urban travel	20-50%	10-25%
Freight Transport Man.	10%. Freight and commercial travel	5-20%	0.5-2%

This table indicates the magnitude of reductions that can be achieved by various Win-Win strategies.

Some strategies provide particularly large benefits because they reduce high-cost travel. For example, a 10% reduction in urban-peak driving or freight vehicle mileage can reduce congestion, parking, and pollution costs by 10-30%. Some strategies can be implemented quickly and provide significant emission reductions in just a few years.

International comparisons support these estimates. Residents of wealthy countries with more multimodal transport systems and efficient pricing drive 30-60% less than in the U.S. (Figure 3), although none has implemented all cost-effective Win-Win strategies. Similarly, recent experience during the Covid-19 pandemic indicates that, given incentives, many people can significantly reduce their vehicle travel by using telework and delivery services, and relying on local services. Replogle and Fulton (2014) and Wheeler and Kammen (2018) also conclude that TDM and Smart Growth policies can provide large cost effective emission reductions.

Figure 3 **Annual Vehicle Travel Compared** (International Comparisons)



Residents of wealthy countries such as Germany, Norway and France drive less than half as many kilometers as in the U.S. due to policies and planning practices that encourage transport efficiency.

Comparing Costs and Benefits

This section compares the costs and benefits of electric vehicle incentives with a vehicle travel reduction program.

Electric Vehicle Costs

Most current transportation emission reduction plans invest primarily in clean vehicle (mostly electric, but sometimes hydrogen or low-carbon fuel) subsidies (Litman 2022). These are costly. For example, electric vehicles currently receive CAFE credits averaging $3,000-6,000 per vehicle, purchase subsidies averaging about $5,000 per vehicle, public investments in recharging stations, plus road user fuel tax exemptions averaging about $310 per vehicle-year, as summarized below.

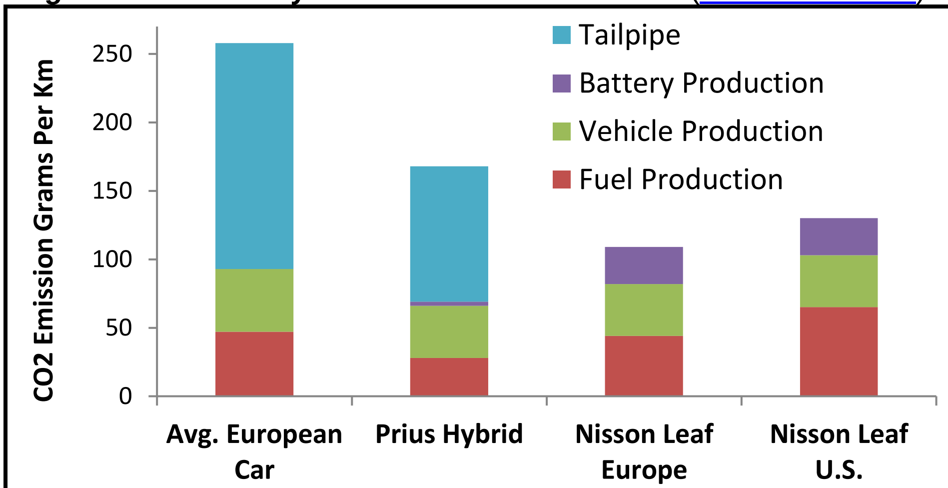
Table 4 **Typical Electric Vehicle Subsidies** (www.fueleconomy.gov)

Subsidy	Annual Value
Corporate Average Fuel Economy (CAFE) credits ($4,700 over 15 years)	$313
Purchase subsidy ($5,000 over a 15-year vehicle life)	$333
Electric vehicle recharging stations	$125
Road user fee exemption (12,500 annual miles, 20 mpg, 50₵ tax per gallon)	$310
Total Annual Subsidy	*$1,081*

Electric vehicles currently receive more than $1,000 annual subsidies and reduce approximately five metric tons of carbon-equivalent per year, averaging $200 cost per ton reduced.

This indicates that for the foreseeable future, electric vehicle subsidies total $500-1,500 per vehicle-year. Figure 4 compares lifecycle emissions of various cars. Hybrids typically produce a third less, and electric cars two-thirds lower emissions than comparable fossil fuel cars (Bieker 2021). A typical gasoline car produces approximately seven annual tonnes of carbon, compared with five for a hybrid and two for an electric car, indicating that shifting to electric reduces about five tons, at a cost of $100-300 per ton.

Figure 4 **Life-cycle Greenhouse Emissions** (Hausfather 2020)



Electric vehicles typically reduce emissions 50-70% compared with a comparable fossil-fuel vehicle.

Also see Bieker (2021)

The need for subsidies may decline somewhat as electric vehicle technology improves, but until a vehicle-miles tax is applied, electric vehicles will continue to receive more than $300 annual subsidy in avoided road user taxes, representing approximately $60 cost per ton of emissions reduced. Other studies find similar costs (Gillingham and Stock 2018; Litman 2022).

Vehicle Travel Reduction Program Costs

An integrated vehicle travel reduction program typically includes increased investments in active and public transport, efficient parking pricing, commute trip reduction programs, and Smart Growth development policies that allow more compact infill in walkable urban neighborhoods.

In 2018, U.S. transit expenditures totaled $49 billion, of which $33 billion is public subsidies that average about $100 per capita (APTA 2020). Doubling or tripling transit service is therefore estimated to cost an additional $100-200 subsidy per capita. The Federal Highway Administration's *Nonmotorized Transportation Pilot Program*, which invested about $100 per capita in active travel improvements in four typical communities, increased walking 23% and bicycling 48%, and reduced driving about 3% (FHWA 2014). Road and parking pricing generate revenues. TDM programs typically cost $50-150 annually per effected commuter, but those costs are often offset by parking cost savings. Smart Growth policies increase planning costs but tend to provide significant consumer and infrastructure cost savings (Gordon 2012; Litman 2018).

This suggests that an integrated vehicle travel reduction program is likely to cost an additional $200-500 annual per capita for active and public transport improvements, TDM programs, and Smart Growth policy development, but these costs are generally repaid through infrastructure and consumer savings.

Additional Considerations

These additional factors should be considered when comparing clean vehicle and Win-Win solutions (Creutzig, et al. 2018).

Implementation Speed

Many vehicle travel reduction strategies can be implemented more quickly than clean vehicles. Electric vehicle technology is relatively new, with high prices, few models (particularly for SUVs, light trucks and vans), and face operational obstacles such as limited recharging stations. Less than 5% of 2020 North American vehicle sales were electric. By 2030, up to half of new vehicles may be electric, but because only about 5% of the vehicle fleet is replaced each year, new technologies take two or three decades to penetrate the fleet, so it will probably be the 2040s before most vehicle travel will be electric. Many Win-Win strategies can be implemented much more quickly. These include fuel and carbon tax increases, efficient transport pricing, active and micro mode improvements, transit service improvements, and TDM programs. Smart Growth policies can allow most future growth to occur in compact, multimodal neighborhoods.

Consumer Impacts

People sometimes assume that, since mobility provides benefits, vehicle travel reductions harms consumers. As evidence they describe examples of trips most efficiently made by automobile, such as commuting to isolated worksites, carrying heavy loads, or transporting people with mobility impairments. But the fact that *some* trips are most efficiently made by automobile does not prove that *all* trips should be by automobile, or that it is infeasible to reduce vehicle travel. Given better options and incentives, many travellers will drive less, rely more on resource-efficient modes, and be better off overall as a result. Vehicle travel reductions that results from positive incentives, such as better travel options or financial rewards from reduced driving directly benefits consumers, and even negative incentives such as new road tolls or parking fees can benefit consumers overall by providing new ways to save money. When roads and parking facilities are financed indirectly through general taxes or rents, people pay regardless of how they travel, but if users pay directly, consumers save money when they reduce peak period driving or use a cheaper parking space.

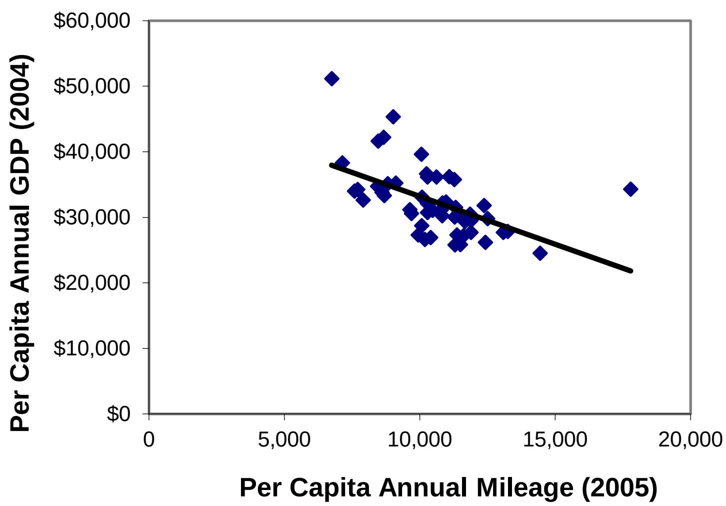
Many Win-Win strategies respond to travel consumer demands and so increase social welfare. Current demographic and economic trends are causing demand for automobile travel to peak, and demand for other modes and for housing in compact neighborhoods to increase (NAR 2020). By increasing transportation system diversity, Win-Win solutions also increase transportation system *resilience*; they allow individuals and communities to respond to physical and economic shocks that constrain automobile travel, for example, if a motorists is suddenly unable to drive, a household's income declines, or if a transportation link fails. TDM and Smart Growth policies can help communities respond to these demand changes.

Equity Impacts
Many vehicle travel reduction strategies help achieve equity goals. Clean vehicle subsidies primarily benefit affluent households that purchase new vehicles. In contrast, many TDM strategies and Smart Growth policies directly benefit disadvantaged groups by improving affordable modes; providing financial benefits such as parking cash out and unbundling, reducing external costs that vehicle traffic imposes on other people, and create more affordable housing in walkable urban neighborhoods.

Strategic Goals
Vehicle travel reduction strategies tend to support strategic goals. During the last century, transportation planning favored automobile travel over other modes, and sprawl over compact infill, creating automobile-dependent communities (Litman 2006; Shill 2020). Many communities now have goals to become more multimodal and compact. Unless implemented with TDM and Smart Growth policies, clean vehicles subsidies tend to increase driving and sprawl. In contrast, vehicle travel reduction strategies help create more diverse and efficient transport systems, and more compact and multimodal communities.

Economic Impacts
Many people assume that since many economic activities depend on vehicle travel, vehicle travel reductions must reduce productivity. But Win-Win strategies can support economic development in various ways. Although a certain amount of vehicle travel supports economic activity, beyond an optimal level, additional mobility is economically harmful (marginal costs exceed marginal benefits). Many Win-Win strategies correct current market distortions that result in economically inefficient vehicle travel. This increases overall economic efficiency and equity, and reduce problems such as traffic congestion, crash risk and pollution damages. Win-Win strategies are a type of preventive medicine, equivalent to putting a transport system on a healthier diet.

Figure 11 **Per Capita GDP and VMT for U.S. States** (Litman 2014)



Per capita economic productivity increases as vehicle travel declines. (Each dot is a U.S. state.)

Integrated Emission Reduction Planning

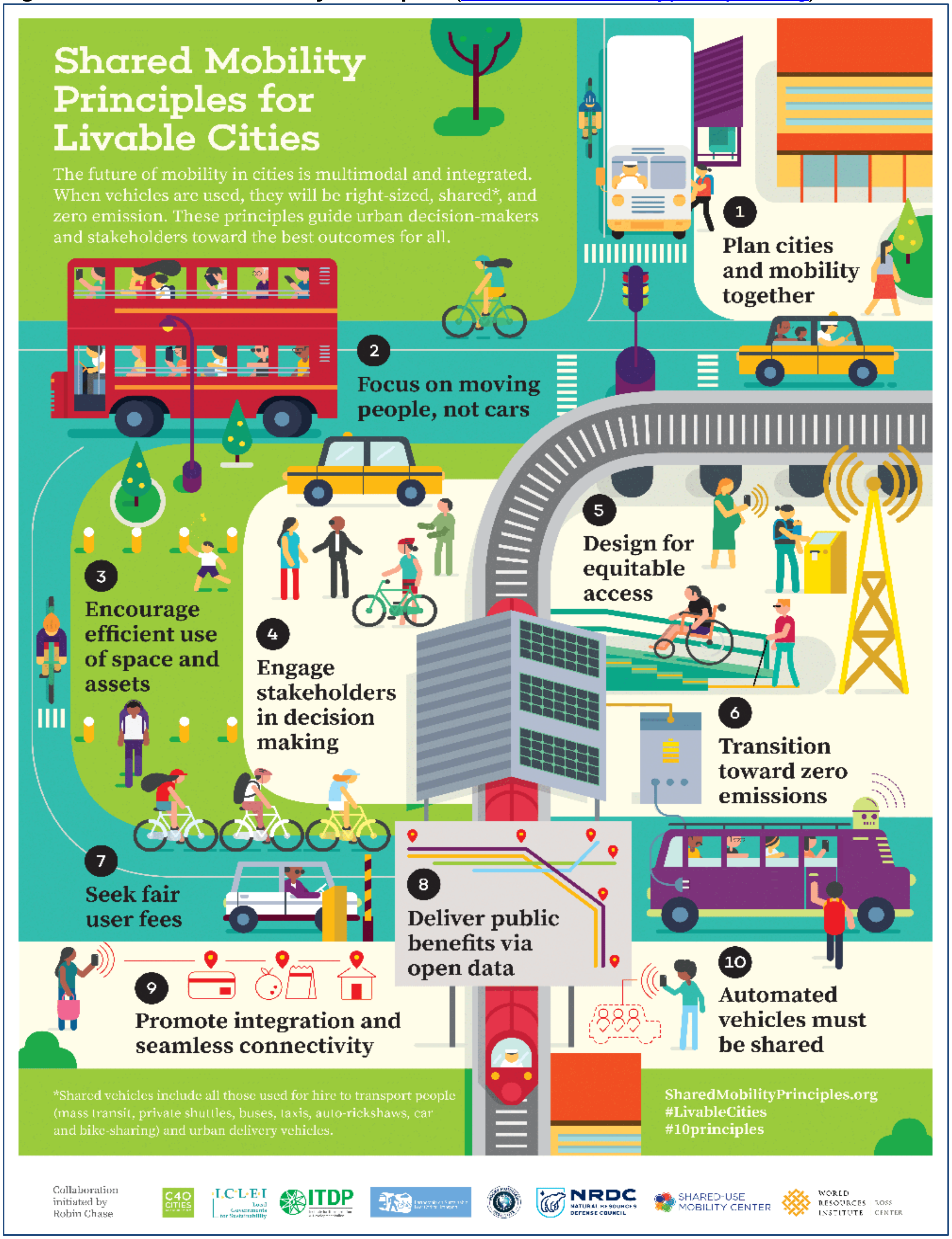
Most older transportation emission reduction plans ignored rebound effects and co-benefits (Litman 2022). This tends to favor clean vehicle strategies. A recent review of National Determined Contributions (NDC), which identify the actions that each country plans to take to achieve Paris Agreement emission reduction targets, found that most plans emphasize clean vehicle implementation, with only 6% rely vehicle travel reduction strategies (Taeger 2021). This indicates that current emission plans do not support TDM and Smart Growth to an optimal degree.

However, newer plans are more comprehensive and integrated. For example, New Zealand's independent Climate Change Commission, *He Pou a Rangi* (Maori for "A Pillar of the Sky") incorporates broad social goals into emission reduction planning, and so recommends integrated solutions (He Pou a Rangi 2021). Similarly, many strategic transportation plans incorporate emission reduction goals and so will favor traffic or parking congestion reduction strategies that also help reduce emissions, and avoid those that may induce more vehicle travel and pollution (CalSTA 2020; STTI 2018; Volker, Lee, and Handy 2020; STTI 2018).

Many jurisdictions are implementing vehicle travel reduction policies to achieve various goals (ACEEE 2019; Litman 2020; Pollution Probe 2020). For example, California and Washington state have VMT reduction targets to reduce congestion and consumer costs as well as emissions (CalSTA 2020; GOPR 2018; WSL 2008). The City of Vancouver's *Climate Emergency Action Plan*, includes goals that by 2030, two-thirds of trips within the city will be by active and public transport modes, and 90% of residents will live in compact, multimodal neighborhoods where most services and activities are easy to access by walking and bicycling. Experts increasingly recommend that vehicle travel reduction strategies receive at least as much priority as clean vehicle programs (Milovanoff, Posen and MacLean 2020; Manjoo 2021; Nadel and Ungar 2019; Reid 2021; Small 2019; Vaughan 2019; Wilson 2021). A comprehensive analysis of transport policies in 120 cities found that a combination of policies including fuel taxes, public transport improvement and more compact development could reduce transport emissions 22-30% without reducing residents' quality of life (Liotta,Viguié and Creutzig 2023).

Many clean vehicle advocates now recognize the negative impacts of rebound effects, and so recommend integrated programs that include travel reduction strategies. For example, Daniel Sperling's book, *Three Revolutions*, highlights the potential benefits of automated, electric and shared vehicles, but recognizes potential problems if they increase vehicle travel and sprawl (Sperling 2018). Similarly, the Greenline Institute's report, *Autonomous Vehicle Heaven or Hell? Creating a Transportation Revolution that Benefits All*, recommends policies that favor *Fleets o*f "Autonomous Vehicles that are Electric and Shared" (FAVES) to avoid transportation hell (Creger, Espino and Sanchez 2019). The *Shared Mobility Principles for Livable Cities* supports resource-efficient transportation (Figure 6). This integrates TDM incentives and Smart Growth policies to maximize the benefits of new technologies.

Figure 6 **Shared Mobility Principles** (www.sharedmobilityprinciples.org)



The Shared Mobility Principles for Livable Cities emphasizes the importance of favoring resource-efficient over resource-intensive travel options. TDM and Smart Growth policies make this happen.

Conclusions

There are many possible ways to conserve resources and reduce pollution emissions. Some are more efficient and equitable than others. Clean vehicle strategies reduce per-mile emission rates but tend to induce more vehicle travel that increases external costs and contradicts strategic goals. In contrast, Win-Win strategies that improve resource-efficient travel options, encourage travellers to use the most efficient mode for each trip, and create more accessible communities, can provide large and diverse co-benefits. Most people benefit more overall if their community's emission reduction programs convince their neighbors to drive less, and therefore reduces traffic problems, than if the program simply subsidizes the purchase of more electric cars.

Conventional planning tends to overlook and undervalue many of these impacts, and so tends to undervalue Win-Win solutions. When evaluating and comparing potential emission reduction strategies it is important to use a comprehensive analysis framework that accounts for:

- *Lifecycle emission impacts*, including embodied and upstream emissions.
- *Rebound effects*, including the additional external costs of increased vehicle travel.
- *Co-benefits* of vehicle travel reduction strategies.
- *Social equity impacts*, including the benefits of improvements to affordable travel modes.

Most Win-Win strategies affect a small portion of total vehicle travel, so their benefits seem modest, but their impacts tend to be cumulative and synergistic; they become more effective and beneficial if implemented as a coordinated package. An integrated Win-Win program can reduce affected people's vehicle travel by 30-60% while achieving other economic, social and environmental goals.

Win-Win strategies have other advantages over clean vehicle incentives. They tend to be more cost effective overall, considering all impacts. Many can be implemented quickly. They respond to unmet consumer demands, which increases social welfare and transport system resilience. They tend to be more equitable, providing substantial benefits to physically, economically and socially disadvantaged people. Win-Win solutions support strategic goals to create more diverse and efficient transportation systems, and more compact and affordable neighborhoods. In contrast, clean vehicle strategies tend to increase automobile dependency and sprawl.

A comprehensive emission reduction program should include both clean vehicle and Win-Win strategies. It is particularly important to use clean vehicles for public transit and other public fleets, and clean-vehicles should be implemented with vehicle travel reduction strategies to avoid rebound effects and achieve a wider range of benefits. A useful rule of thumb is that at least half of transportation emission reduction targets should be achieved with Win-Win strategies.

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