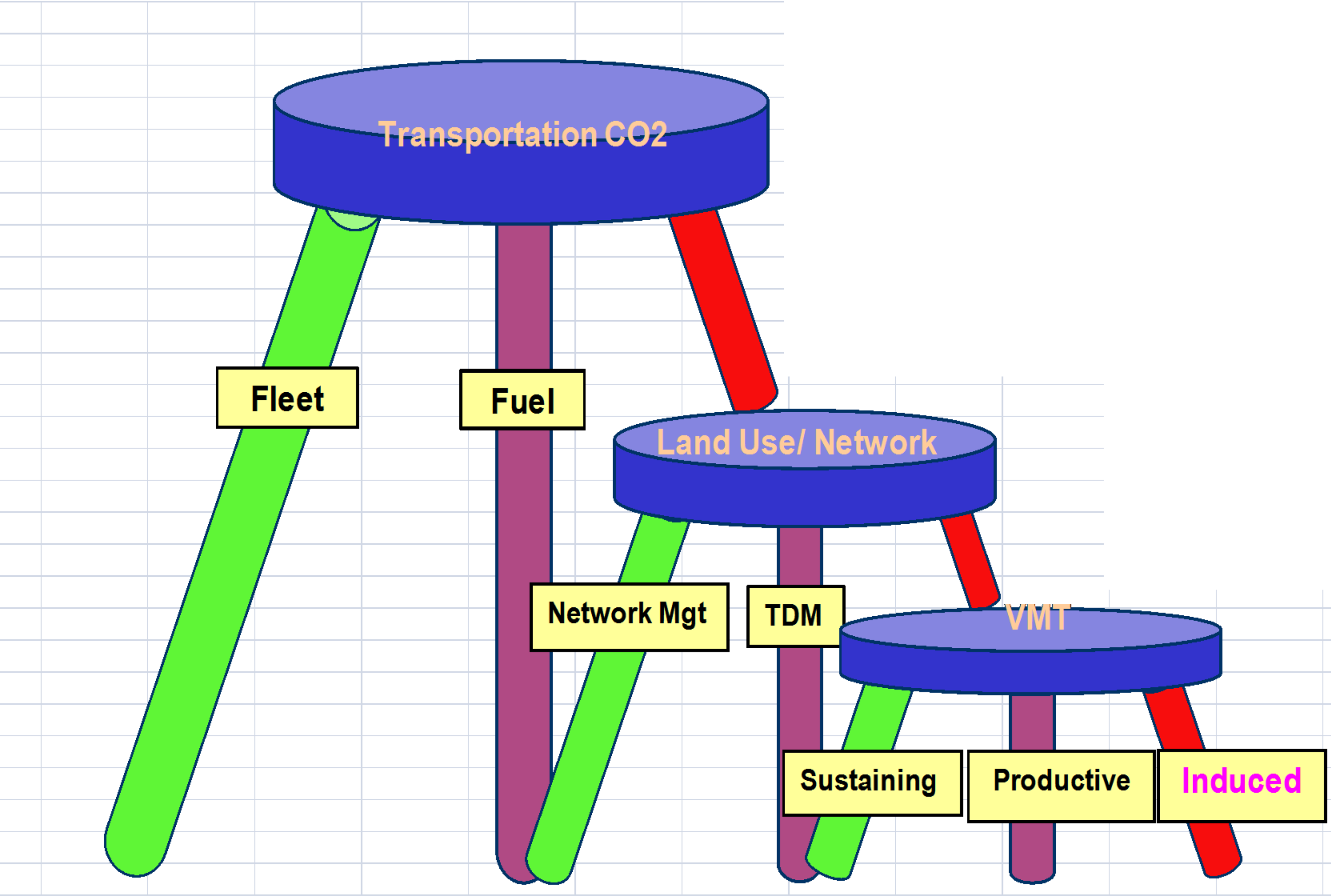
The Energy Consequences of Alternative Forms of Development

Jerry Walters

Fehr & Peers

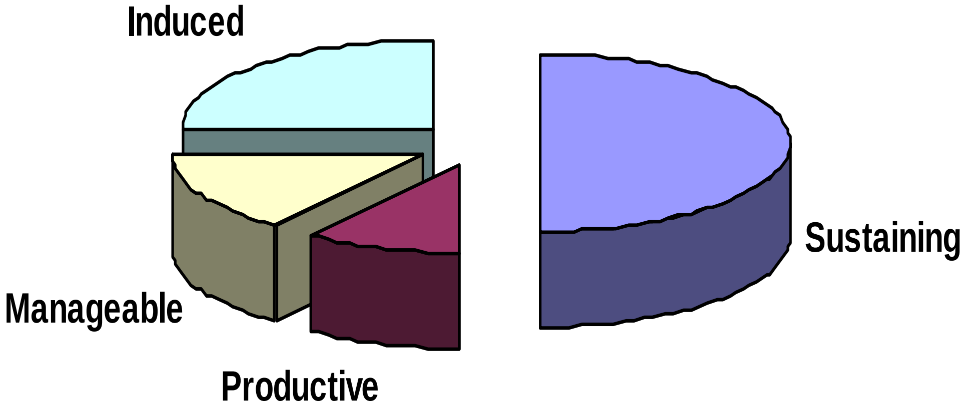
Relationships between VMT and Energy and Emissions



VMT Goals of SB375 RTP and SCS

- Transportation improvements <u>support</u> SCS
- Address interregional travel
- Limit induced travel*

* Types of VMT
  - Sustaining
  - Manageable
  - Productive
  - Induced



7 "D" Factors that Influence Trip Generation

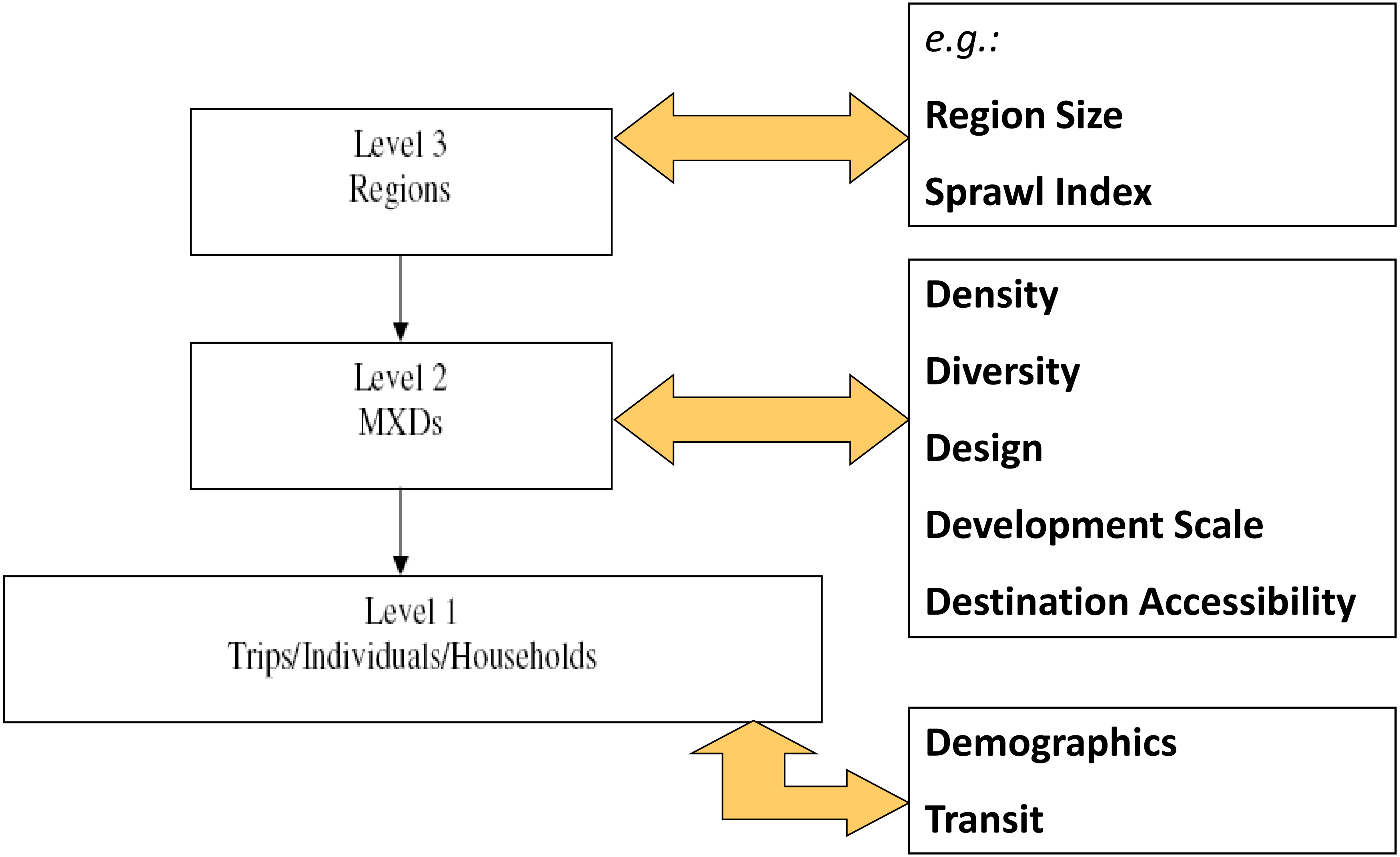
- **Density** dwellings, jobs per acre
- **Diversity** mix of housing, jobs, retail
- **Design** connectivity, walkability
- **Destinations** regional accessibility
- **Distance to Transit** bus, rail proximity
- **Development Scale:** population, jobs
- **Demographics** household size, income

Average VMT Elasticities with respect to Built-Environment Factors

Density: Household/population density	**- 0.04**
Diversity	
❑ Land use mix (entropy index)	**- 0.09**
❑ Jobs-housing balance	**–0.02**
Design	
❑ Intersection/street density	**- 0.12**
❑ % 4-way intersections	**- 0.12**
Destination accessibility	
❑ Job accessibility by auto	**- 0.20**
❑ Job accessibility by transit	**- 0.05**
❑ Distance to downtown	**- 0.22**
Distance to transit: nearest transit stop	**-0.05**

Ewing R, Cervero, R, Travel and the Built Environment, Journal of the American Planning Association, Summer 2010, Vol. 76, No. 3
http://dx.doi.org/10.1080/01944361003766766

Mixed-Use (MXD) Hierarchical Analysis



Level 3
Regions

Level 2
MXDs

Level 1
Trips/Individuals/Households

e.g.:

Region Size

Sprawl Index

Density

Diversity

Design

Development Scale

Destination Accessibility

Demographics

Transit

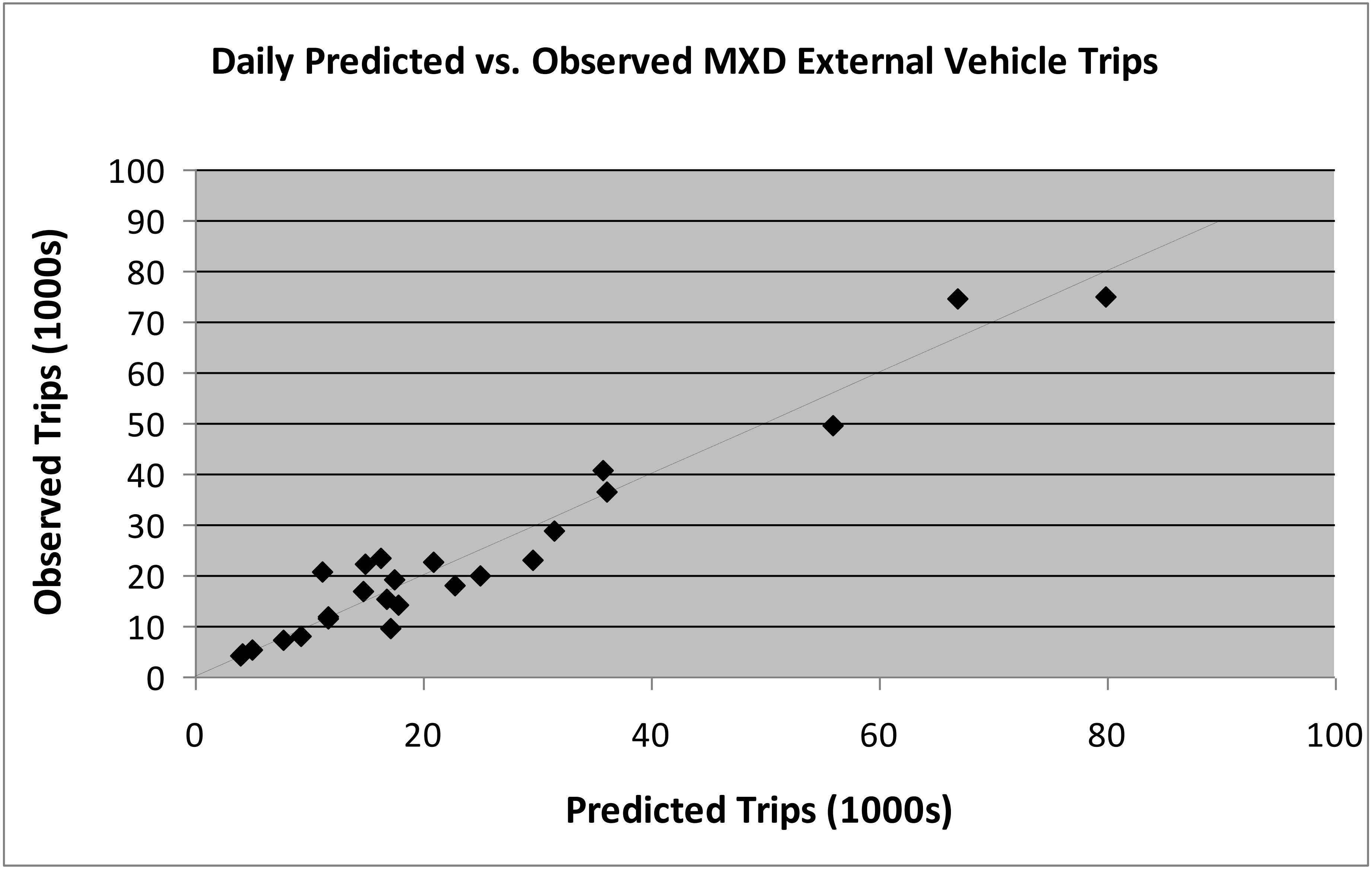
Nationwide Survey of MXD Travel

239 MXD: Seattle, Portland, Sacramento, Boston, Atlanta, Houston
Validation: San Diego, Orange County, No Cal, Texas, Georgia, Florida

Gateway Oaks, Sacramento

River Place, Portland

MXD Model Validation vs Counted Sites



Comparison of MXD Model to Current Methods for Validation Sites

	Current Methods	MXD Model
Average Model Error	16%	2%
Absolute Model Error	23%	17%
%RMSE	31%	20%
R Squared	0.85	0.94

Figure 1: SEM Structure - Production-End Model

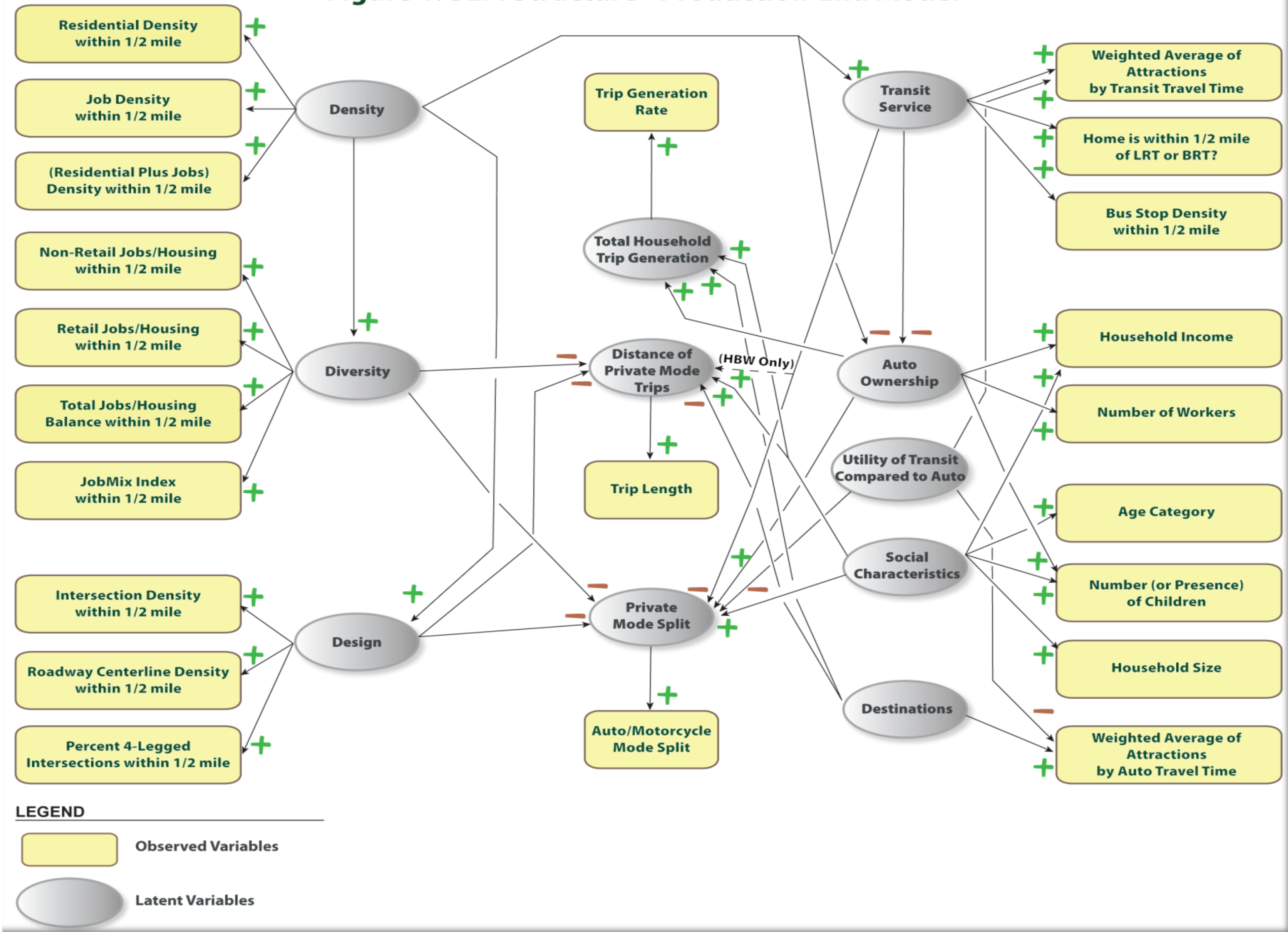
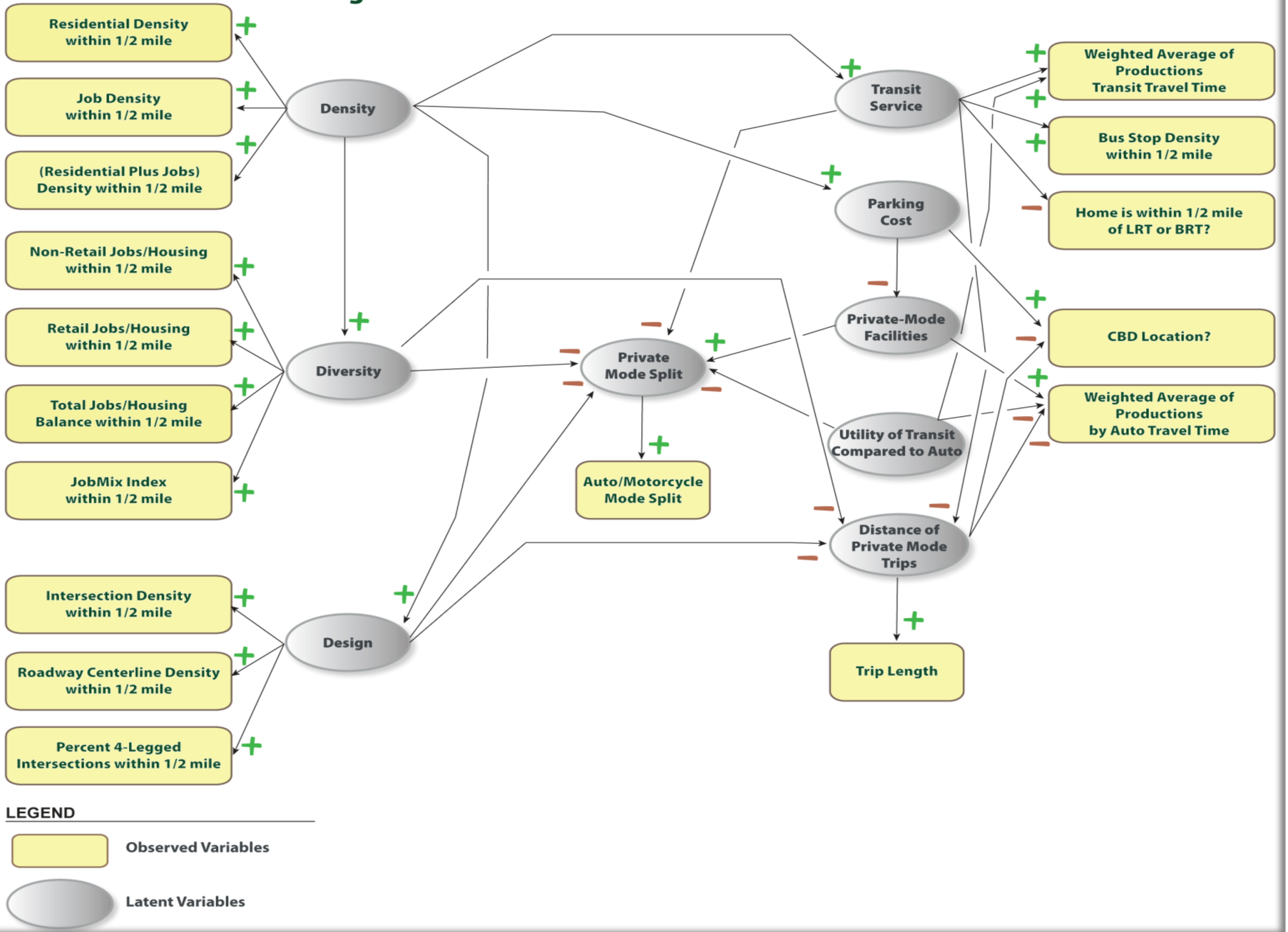
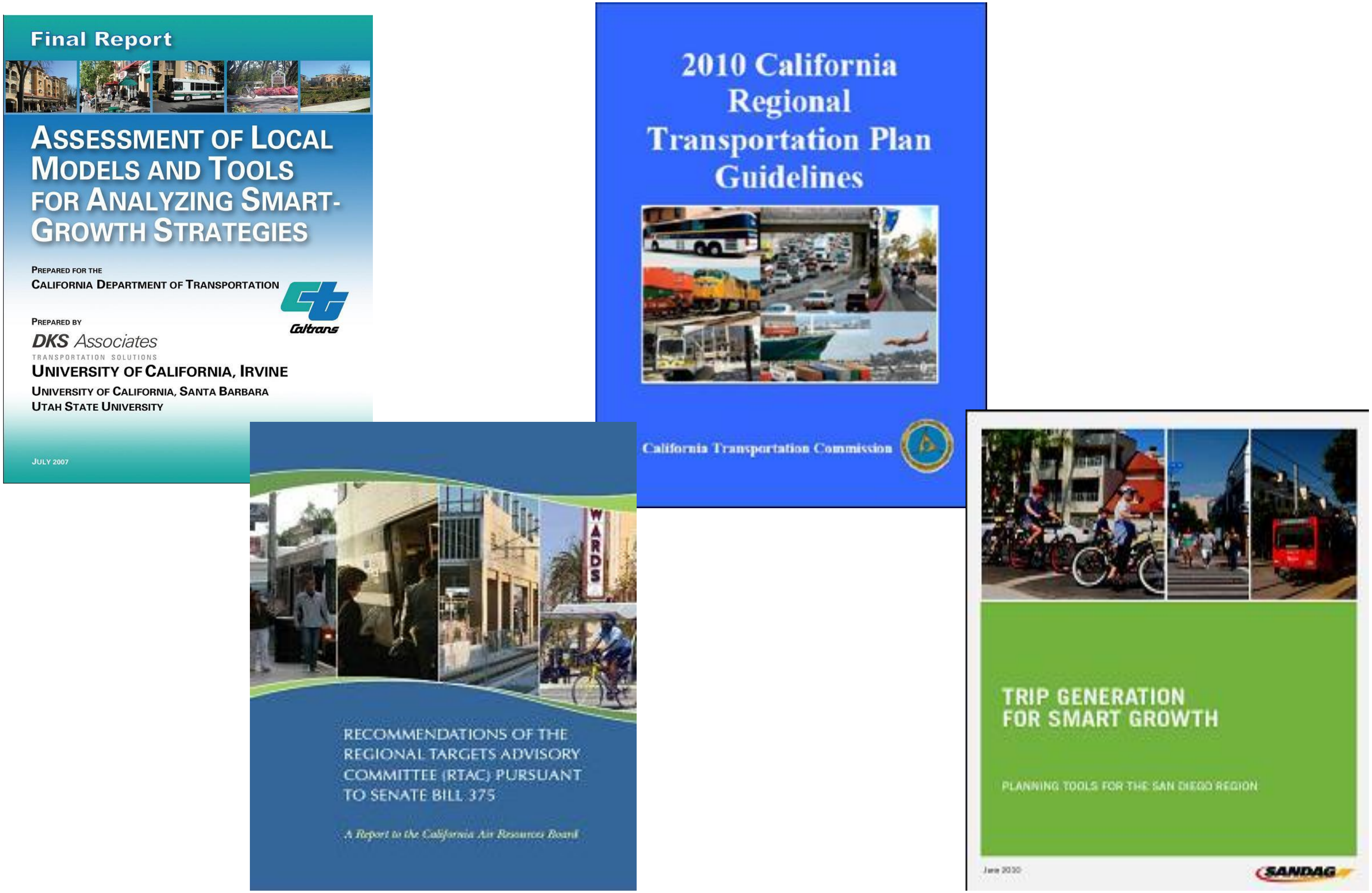


Figure 2: SEM Structure - Attraction-End Model



Recommended Practice on Trip Generation



Final Report

ASSESSMENT OF LOCAL MODELS AND TOOLS FOR ANALYZING SMART-GROWTH STRATEGIES

PREPARED FOR THE
CALIFORNIA DEPARTMENT OF TRANSPORTATION

PREPARED BY
DKS Associates
TRANSPORTATION SOLUTIONS
UNIVERSITY OF CALIFORNIA, IRVINE
UNIVERSITY OF CALIFORNIA, SANTA BARBARA
UTAH STATE UNIVERSITY

JULY 2007

2010 California Regional Transportation Plan Guidelines

California Transportation Commission

RECOMMENDATIONS OF THE REGIONAL TARGETS ADVISORY COMMITTEE (RTAC) PURSUANT TO SENATE BILL 375

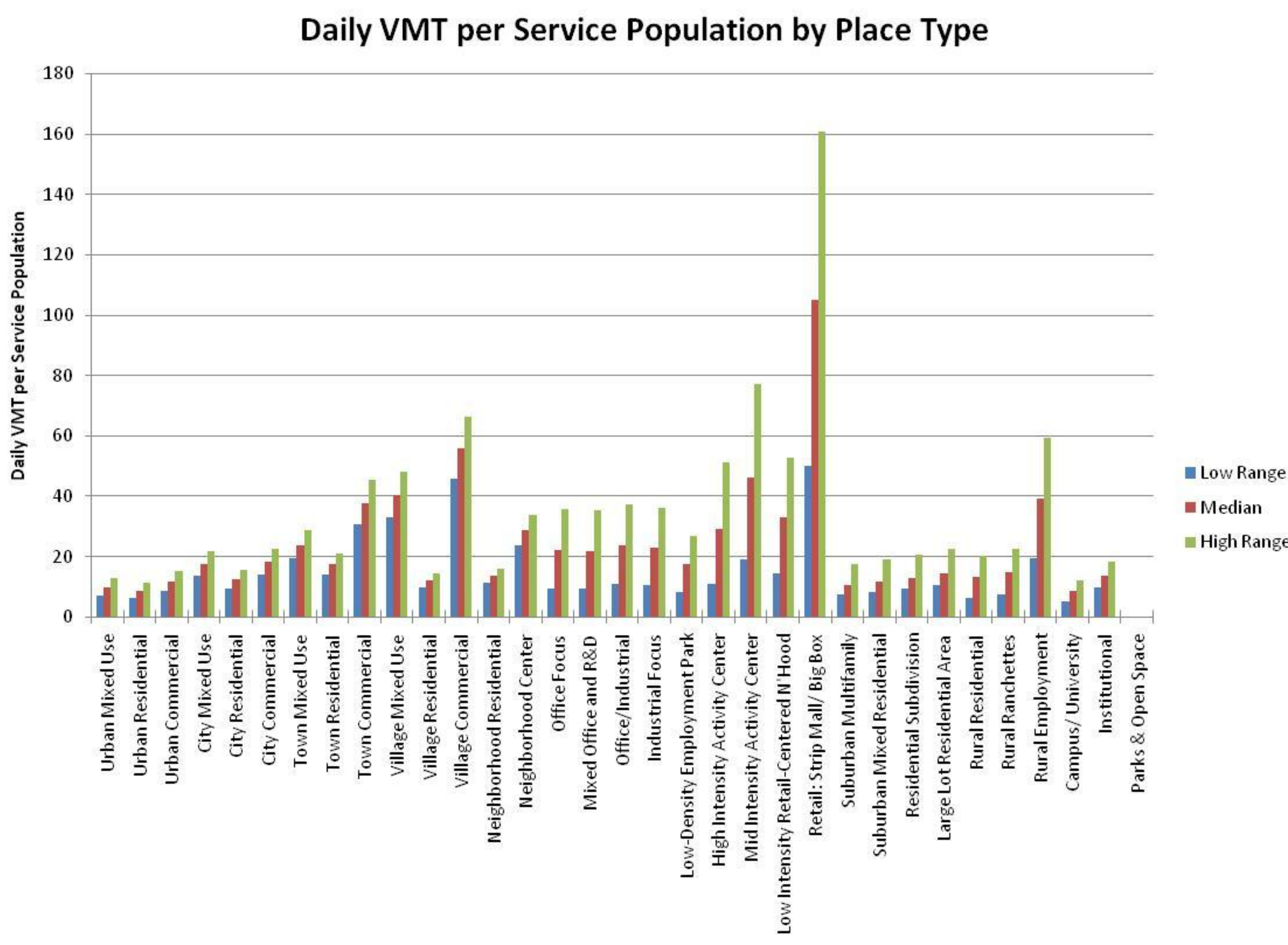
A Report to the California Air Resources Board

TRIP GENERATION FOR SMART GROWTH

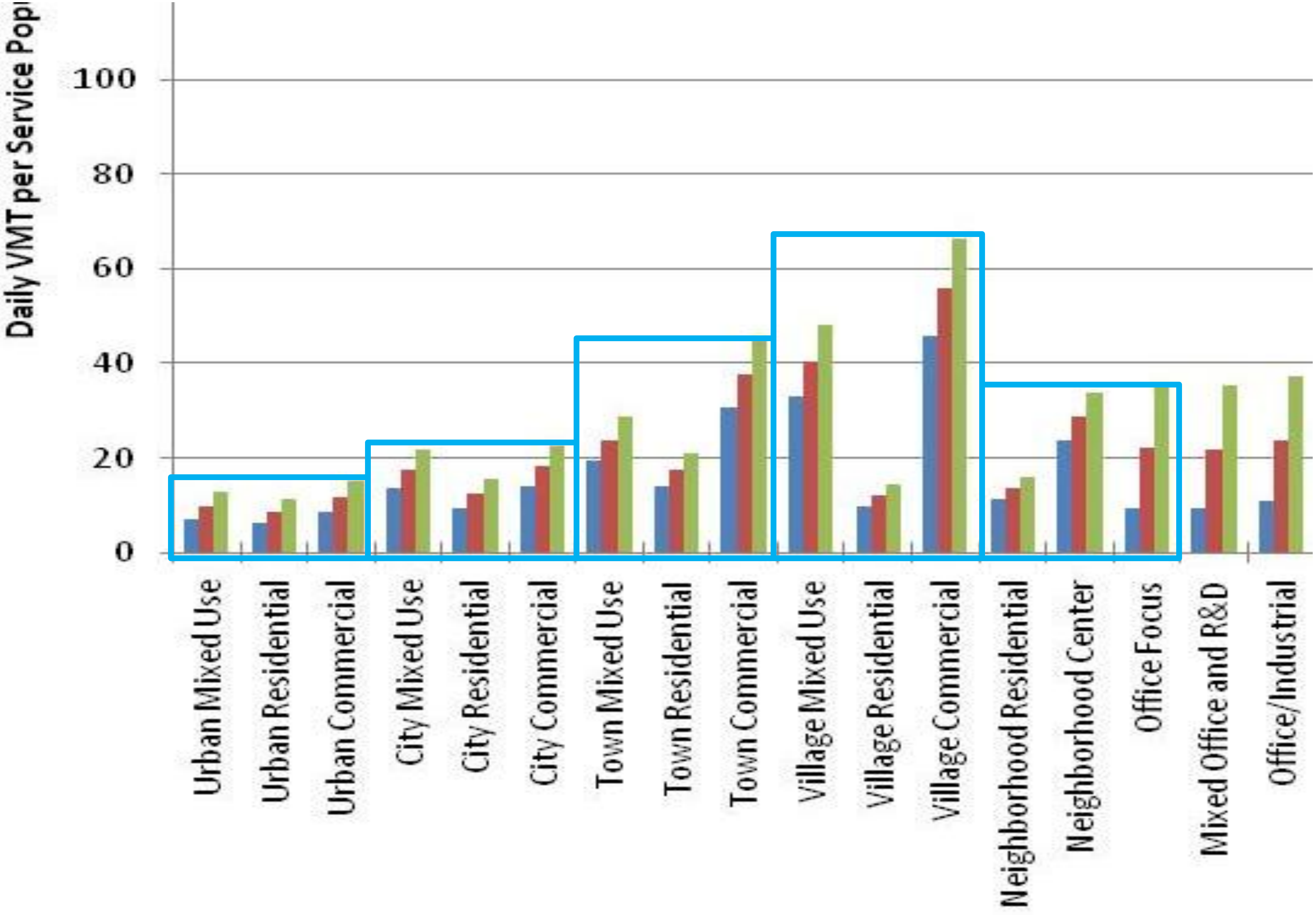
PLANNING TOOLS FOR THE SAN DIEGO REGION

June 2010

SANDAG


Daily VMT per Service Population by Place Type
Daily VMT per Service Population
180
160
140
120
100
80
60
40
20
0
Urban Mixed Use
Urban Residential
Urban Commercial
City Mixed Use
City Residential
City Commercial
Town Mixed Use
Town Residential
Town Commercial
Village Mixed Use
Village Residential
Village Commercial
Neighborhood Residential
Neighborhood Center
Office Focus
Mixed Office and R&D
Office/Industrial
Industrial Focus
Low-Density Employment Park
High Intensity Activity Center
Mid Intensity Activity Center
Low Intensity Retail-Centered N'Hood
Retail: Strip Mall/ Big Box
Suburban Multifamily
Suburban Mixed Residential
Residential Subdivision
Large Lot Residential Area
Rural Residential
Rural Ranchettes
Rural Employment
Campus/ University
Institutional
Parks & Open Space
Low Range
Median
High Range

VMT Rates for Different Development

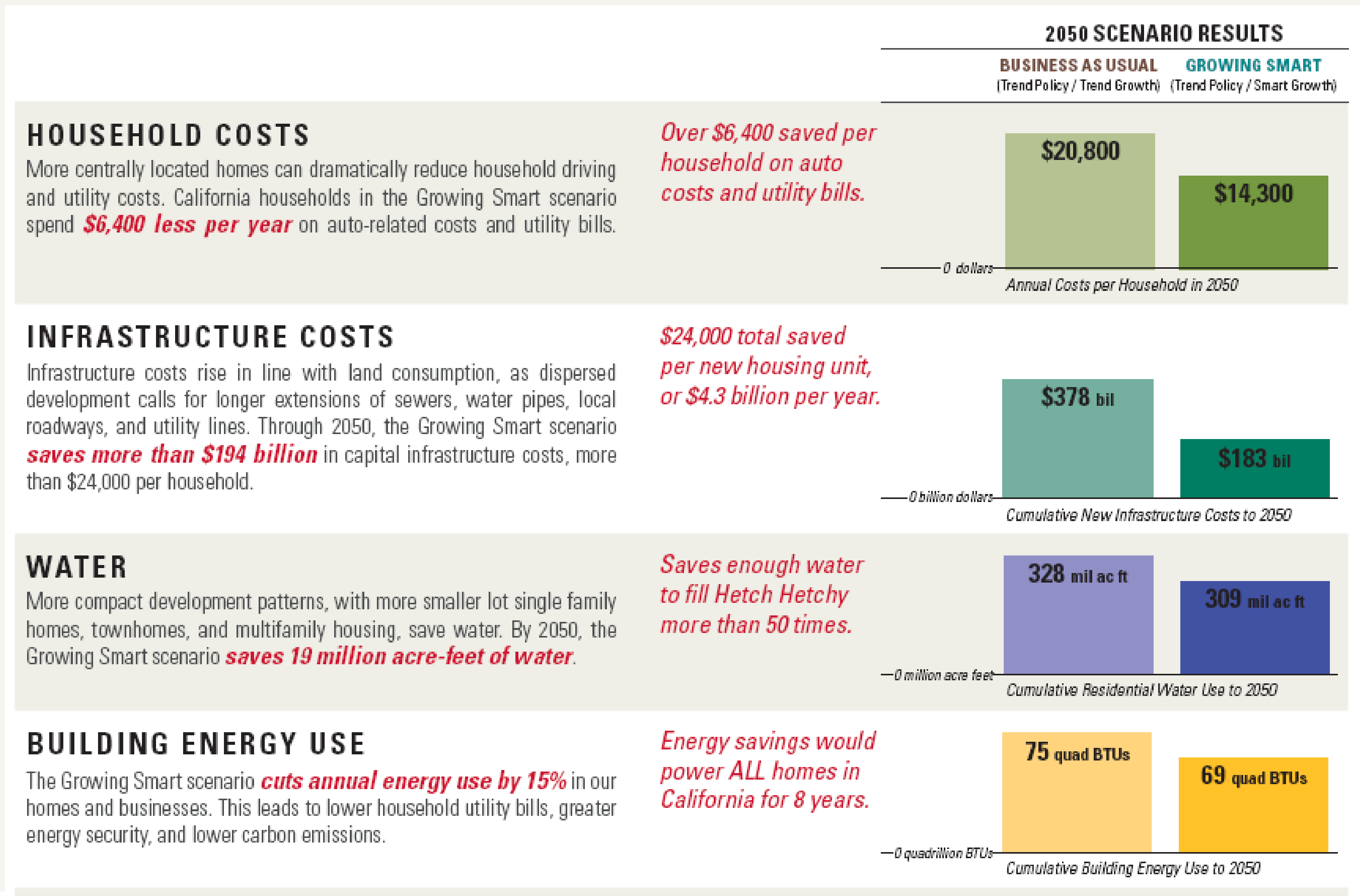


CA High Speed Rail -- Formative Framework

VISION CALIFORNIA | *CHARTING OUR FUTURE*

STATEWIDE SCENARIOS REPORT

Vision California – Preliminary Analysis



HOUSEHOLD COSTS

More centrally located homes can dramatically reduce household driving and utility costs. California households in the Growing Smart scenario spend ***$6,400 less per year*** on auto-related costs and utility bills.

Over $6,400 saved per household on auto costs and utility bills.

INFRASTRUCTURE COSTS

Infrastructure costs rise in line with land consumption, as dispersed development calls for longer extensions of sewers, water pipes, local roadways, and utility lines. Through 2050, the Growing Smart scenario ***saves more than $194 billion*** in capital infrastructure costs, more than $24,000 per household.

$24,000 total saved per new housing unit, or $4.3 billion per year.

WATER

More compact development patterns, with more smaller lot single family homes, townhomes, and multifamily housing, save water. By 2050, the Growing Smart scenario ***saves 19 million acre-feet of water***.

Saves enough water to fill Hetch Hetchy more than 50 times.

BUILDING ENERGY USE

The Growing Smart scenario ***cuts annual energy use by 15%*** in our homes and businesses. This leads to lower household utility bills, greater energy security, and lower carbon emissions.

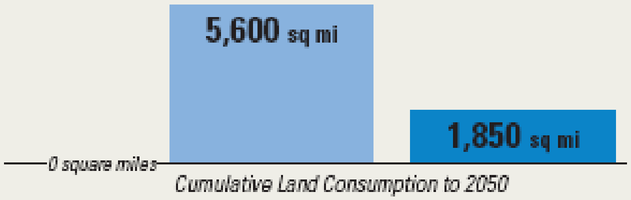
Energy savings would power ALL homes in California for 8 years.

Vision California – Preliminary Analysis

LAND CONSUMPTION

Trend development patterns will double California's urban footprint by 2050, consuming more than 5,500 square miles of farmland, open space, and recreation areas. The Growing Smart scenario ***saves over 3,700 square miles*** of this precious and finite resource.

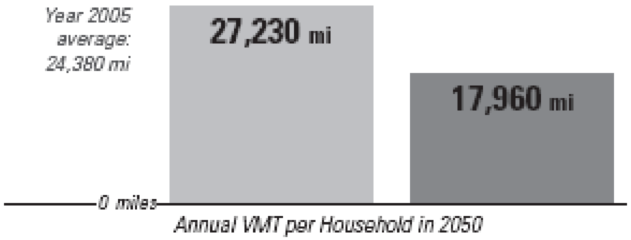
Saves more land than Delaware and Rhode Island combined.



VEHICLE MILES TRAVELED (VMT)

Automobile emissions account for about 40% of carbon emissions in California. They are also a primary cause of asthma and respiratory illnesses. How much we drive also impacts how much we spend on fuel, insurance, and maintenance. The Growing Smart scenario, with more walkable, transit-oriented development, reduces VMT by nearly ***3.7 trillion miles*** to 2050.

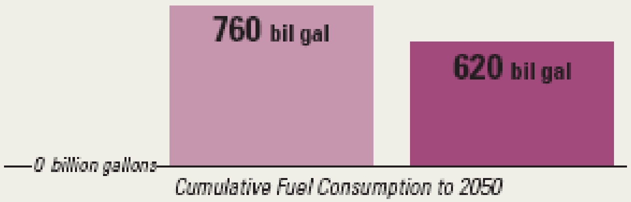
VMT reduction equivalent to taking ALL cars off California's roads for 12 Years.



FUEL CONSUMPTION

Reduced VMT in the Growing Smart scenario reduces automobile fuel consumption by nearly ***140 billion gallons*** to 2050. This saves the average California household ***$2,600 per year***.

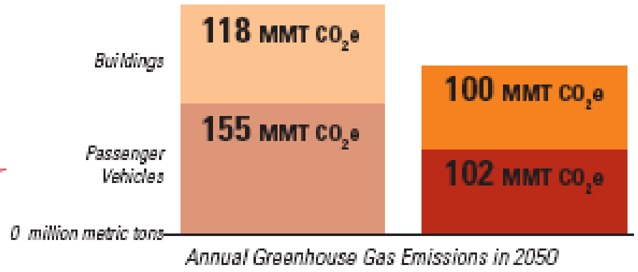
Fuel savings equivalent to nearly 2 years of oil imports to the US.



GREENHOUSE GAS EMISSIONS

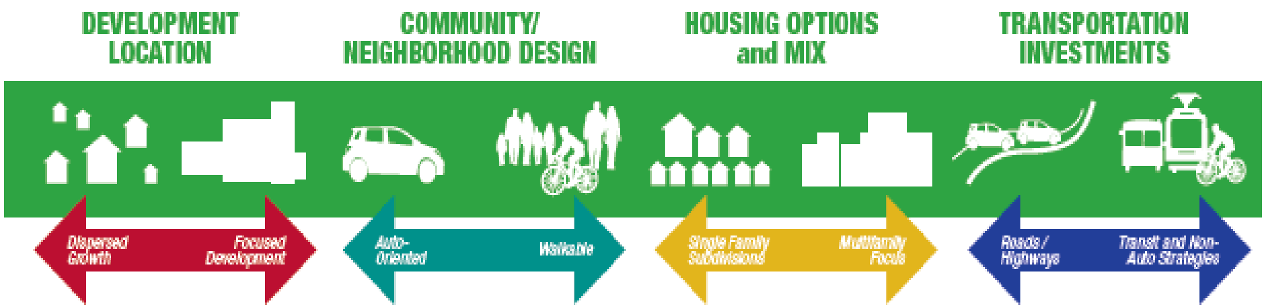
More compact development patterns, along with more efficient cars and buildings, cleaner fuels, and a cleaner energy portfolio are all essential in reducing GHG emissions. The Growing Smart scenario prevents the release of ***70 million metric tons*** of carbon dioxide equivalent in 2050, or 25% less than a Business as Usual future.

Savings equal to emissions offset by 45,000 square miles of trees in a year - a forest covering over 1/4 of California.



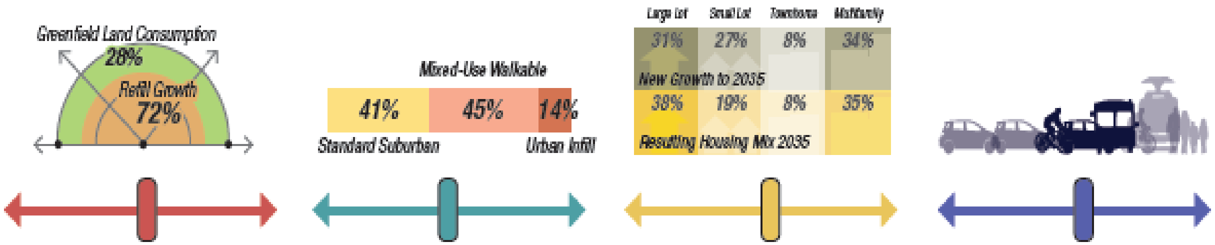
2012 RTP/SCS PUBLIC OUTREACH WORKSHOPS

2035 SCENARIO DESCRIPTIONS



1

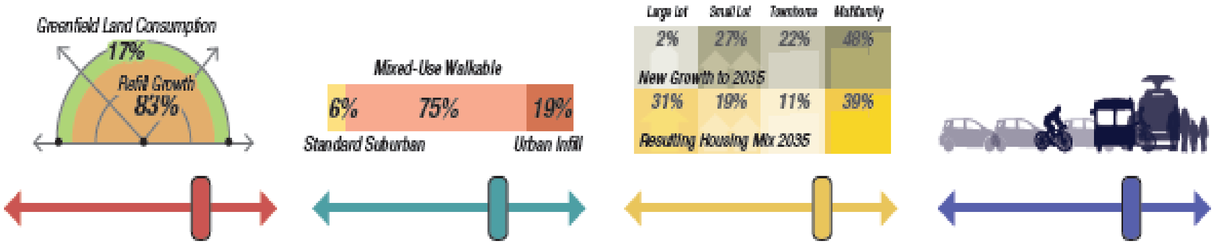
This scenario is based on the general plans prepared by cities. It includes a significant proportion of suburban, auto-oriented development, but also recognizes the recent trend of increased growth in existing urban areas and around transit. New housing is mostly single-family, with an increase in smaller-lot, townhome, and multifamily homes; housing mix still falls short of demand for these types, though. Transportation investments may favor automobile infrastructure slightly, but also support new transit lines and other non-auto strategies and improvements.



	Large Lot	Small Lot	Townhome	Multifamily
New Growth to 2035	31%	27%	8%	34%
Resulting Housing Mix 2035	38%	19%	8%	35%

2

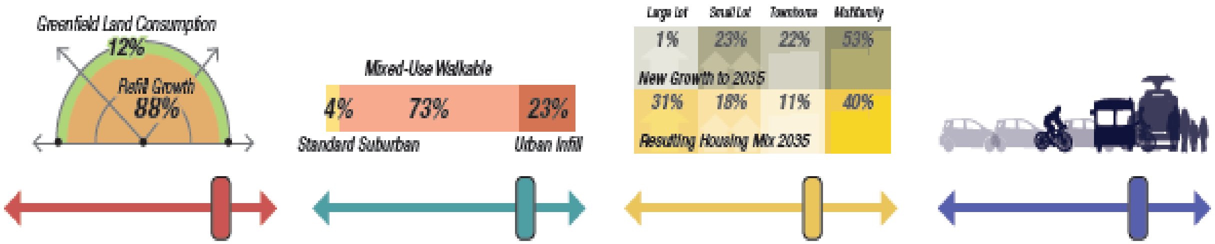
This scenario focuses more growth in walkable, mixed-use communities and in existing and planned high-quality transit areas. It would see increased investments in transit and non-auto modes, with strategies to support growth patterns that are less auto-dependent. Employment growth is focused in urban centers around transit. This scenario strives to meet demand for a broader range of housing types, and new housing is weighted towards smaller-lot single family homes, townhomes, and multifamily condos and apartments.



	Large Lot	Small Lot	Townhome	Multifamily
New Growth to 2035	2%	27%	22%	48%
Resulting Housing Mix 2035	31%	19%	11%	39%

3

This scenario builds on the walkable, mixed-use focus of the growth in Scenario 2, and also aims to improve fiscal and environmental performance by shifting a portion of the region's growth into areas that are closer to transit, less auto-centric, and less intensive for building energy and water needs. Like Scenario 2, this scenario aims to meet demand for a broader range of housing types, with new housing weighted towards smaller-lot single family homes, townhomes, and multifamily condos and apartments.



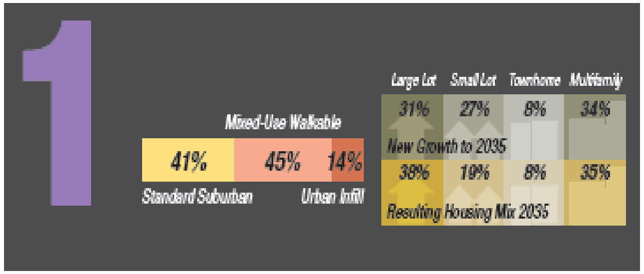
	Large Lot	Small Lot	Townhome	Multifamily
New Growth to 2035	1%	23%	22%	53%
Resulting Housing Mix 2035	31%	18%	11%	40%

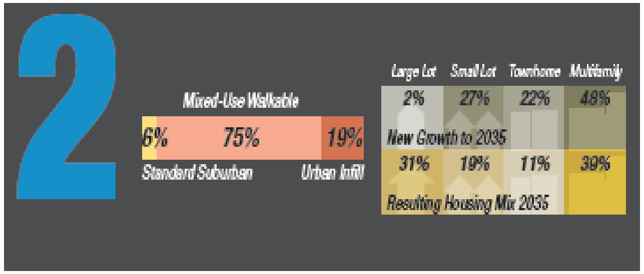
2012 RTP/SCS PUBLIC OUTREACH WORKSHOPS

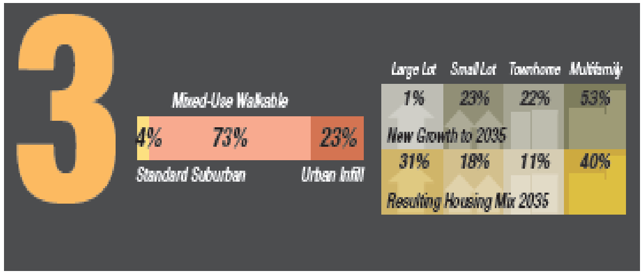
SOUTHERN CALIF
ASSOCIATION o

2035 SCENARIO OUTCOMES*

* Scenario outputs are meant for comparative purposes only. Model outputs at this stage in the RTP/SCS process are preliminary and subject to refinement as the scenario development and modeling process progresses.







	LAND CONSUMPTION	LOCAL INFRASTRUCTURE COSTS	VEHICLES MILES TRAVELED (VMT)	FUEL CONSUMPTION	HOUSEHOLD COSTS	GREENHOUSE GAS (GHG) EMISSIONS	BUILDING ENERGY USE
	Greenfield (Open Space) Land Consumption	Cumulative Capital Costs and General Fund Operations and Maintenance Expenditures Includes local roads, waste water and sanitary sewer, water supply, and parks and recreation	VMT (Auto Passenger Vehicle Travel)	Automobile Fuel Use	Annual Fuel, Auto Operating, Energy, and Water Costs per Household (HH)	GHG Emissions from Auto Passenger Transportation and Building Energy Use	Annual Commercial and Residential Energy Use
	[square miles]	[2009 dollars]	[miles]	[gallons]	[2009 dollars]	[Million Metric Tons CO_2e]	[Btu]
		Capital Operations/ Maintenance			Fuel/ Automobile Energy/ Water	Transportation Building	Commercial Residential
1	251 sq mi	$35 bil	20,920 mi per HH	5.5 bil gal	$15,100 per HH	96 MMT	835 tril Btu
2	127 sq mi	$31 bil	18,630 mi per HH	4.9 bil gal	$13,600 per HH	88 MMT	775 tril Btu
3	84 sq mi	$29 bil	18,250 mi per HH	4.8 bil gal	$13,350 per HH	86 MMT	760 tril Btu

CAPCOA Land Use BMP

Land Use/ Location

Max Reduction = 65% (urban), 30% (compact infill), 10% (suburban center), 5% (suburban)

Density (30%)

Design (21.3%)

Location Efficiency (65%)

Diversity (30%)

Destination Accessibility (20%)

Transit Accessibility (25%)

Neighborhood/ Site Enhancements

Max Reduction =
5% (without NEV)
15% (with NEV)

Pedestrian Network
(2%)

Traffic Calming (1%)

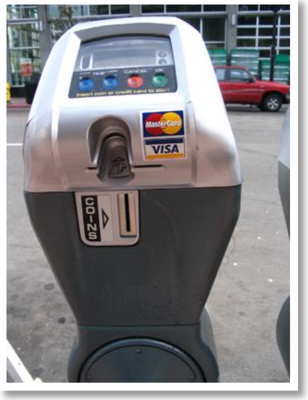
NEV Network (14.4%)
<NEV Parking>

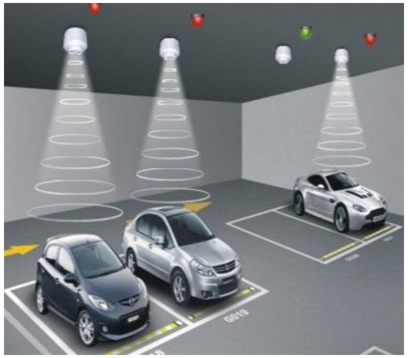
Car Share Program
(0.7%)

Bicycle Network
<Bike Lanes> <Bike Parking> <Land Dedication for Bike Trails>

Urban Non-Motorized Zones

CAPCOA Parking and Transit BMP





Parking Policy/ Pricing

Max Reduction = 20%

- **Parking Supply Limits** (12.5%)
- **Unbundled Parking Costs** (13%)
- **On-Street Market Pricing** (5.5%)
- Residential Area Parking Permits

Transit System Improvements

Max Reduction = 10%

- **Network Expansion** (8.2%)
- **Service Frequency/Speed** (2.5%)
- **Bus Rapid Transit** (3.2%)
- **Access Improvements**
- **Station Bike Parking**

CAPCOA Employer and Network BMP

Commuter Check

EcoDriving Practices

Tip #6: Maintain a steady speed.

Did you know that every 5 mph you drive over 60 mph is equivalent to paying 20 extra cents per gallon of gas.

MORE ECODRIVING PRACTICES

Maintain Your Vehicle

Tip #5: Check your tire pressure

Earn a free tank of gas every year. You can improve your gas mileage by about 3% just by keeping your tires properly inflated.

MORE MAINTENANCE PRACTICES

Commute Trip Reduction (CTR) Progams

Max Reduction = 25% work VMT

CTR Program
<Required> (21% work VMT)
<Voluntary> (6.2% work VMT)

Transit Fare Subsidy
(20% work VMT)

Employee Parking Cash-Out (7.7% work VMT)

Workplace Parking Pricing (19.7% work VMT)

Alternative Work Schedules and Telecommute Program
(5.5% work VMT)

CTR Marketing (4.0% work VMT)

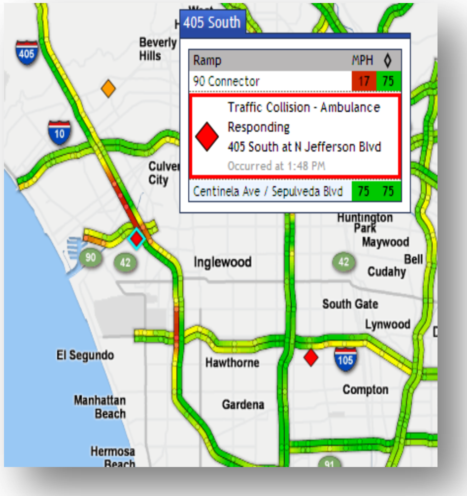
Road Pricing/ Management

Max Reduction =25%

Cordon Pricing
(22%)

Traffic Flow Improvements
(45% CO_2)

Required Contributions by Project



CAPCOA BMP Framework

Global Max Reduction (all VMT)
75% (urban), 40% (compact infill), 20% (suburban center or suburban with NEV), 15% (suburban)

Global Cap Road Pricing

Cross-Category Max Reduction (all VMT)
70% (urban), 35% (compact infill), 15% (suburban center or suburban with NEV), 10% (suburban)

Max Reduction Work, School: 25%/ 65%

Max Reduction (all VMT): 25%

Land Use/ Location *Max Reduction = 65% (urban), 30% (compact infill), 10% (suburban center), 5% (suburban)*	**Neighborhood/ Site Enhancements** *Max Reduction = 5% (without NEV) 15% (with NEV)*	**Parking Policy/ Pricing** *Max Reduction = 20%*	**Transit System Improvements** *Max Reduction = 10%*	**Commute Trip Reduction (CTR) Progams** *Max Reduction = 25% work VMT*	**Road Pricing/ Management** *Max Reduction =25%*
Density (30%)	**Pedestrian Network** (2%)	**Parking Supply Limits** (12.5%)	**Network Expansion** (8.2%)	**CTR Program** **<Required>** (21% work VMT) **<Voluntary>** (6.2% work VMT)	**Cordon Pricing** (22%)
Design (21.3%)	**Traffic Calming** (1%)	**Unbundled Parking Costs** (13%)	**Service Frequency/Speed** (2.5%)	**Transit Fare Subsidy** (20% work VMT)	**Traffic Flow Improvements** (45% CO_2)
Location Efficiency (65%)	**NEV Network** (14.4%) <NEV Parking>	**On-Street Market Pricing** (5.5%)	**Bus Rapid Transit** (3.2%)	**Employee Parking Cash-Out** (7.7% work VMT)	**Required Contributions by Project**
Diversity (30%)	**Car Share Program** (0.7%)	Residential Area Parking Permits	**Access Improvements**	**Workplace Parking Pricing** (19.7% work VMT)	
Destination Accessibility (20%)	**Bicycle Network** <Bike Lanes> <Bike Parking> <Land Dedication for Bike Trails>		**Station Bike Parking**	**Alternative Work Schedules and Telecommute Program** (5.5% work VMT)	
Transit Accessibility (25%)	**Urban Non-Motorized Zones**		**Local Shuttles**	**CTR Marketing** (4.0% work VMT)	

Network Management Strategies

Congestion Mitigation

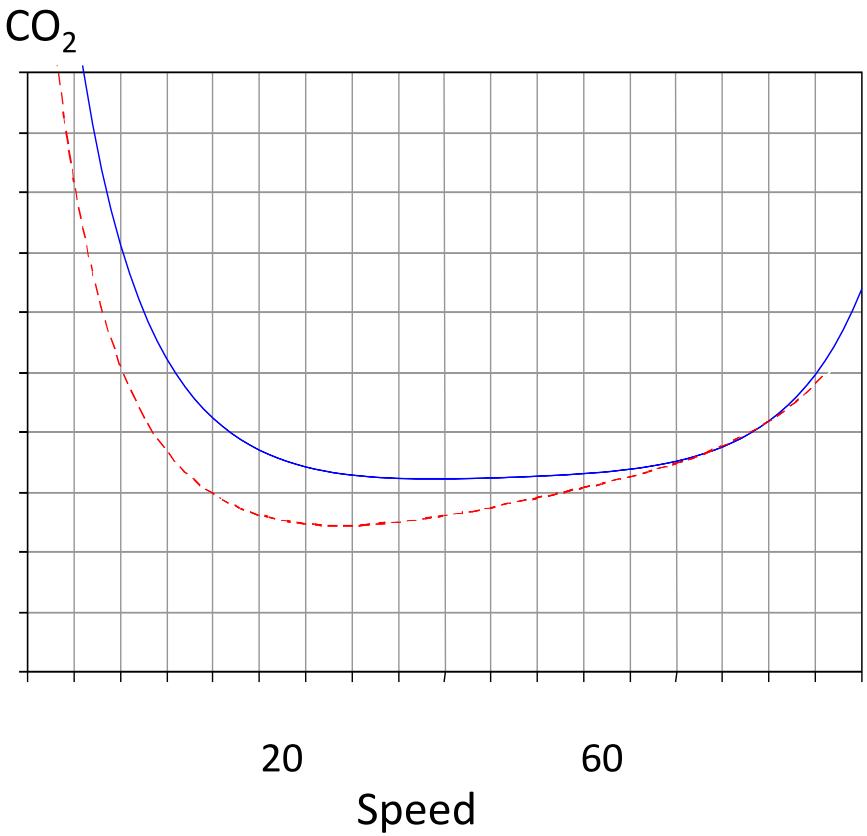
- Judicious capacity increases
- Signal coordination
- Ramp metering
- Incident management

Flow Smoothing Techniques

- Variable speed limit
- Intelligent speed adaptation

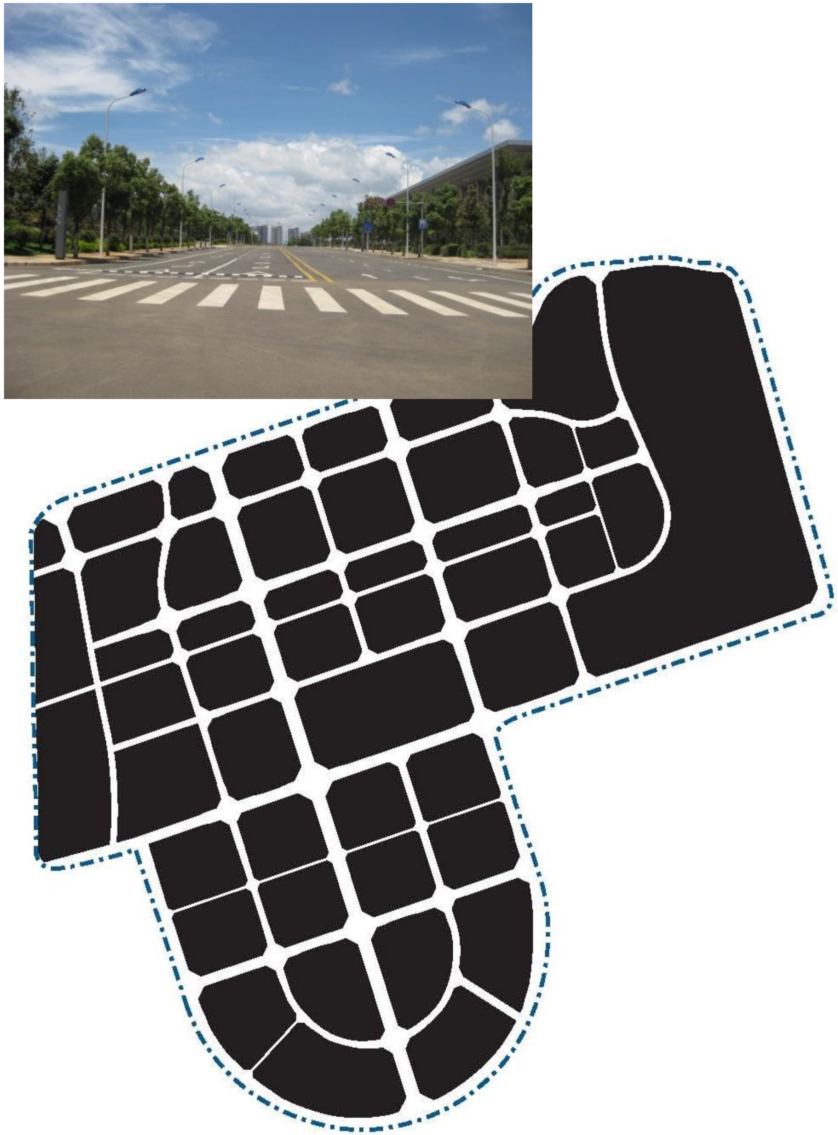
Speed Management

- Improved enforcement
- Speed limiters
- Active accelerator pedal

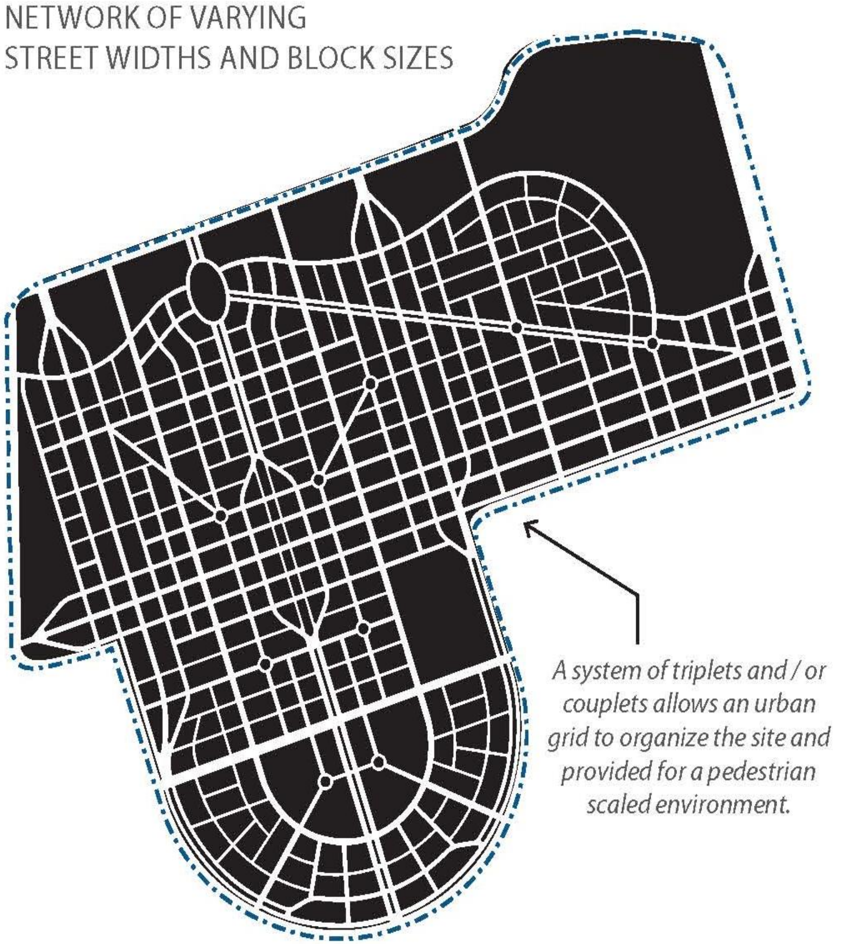


Source: Barth, Matthew; *ITS and the Environment,* UC Riverside, 2008

Kunming Case Study: Urban Network Form

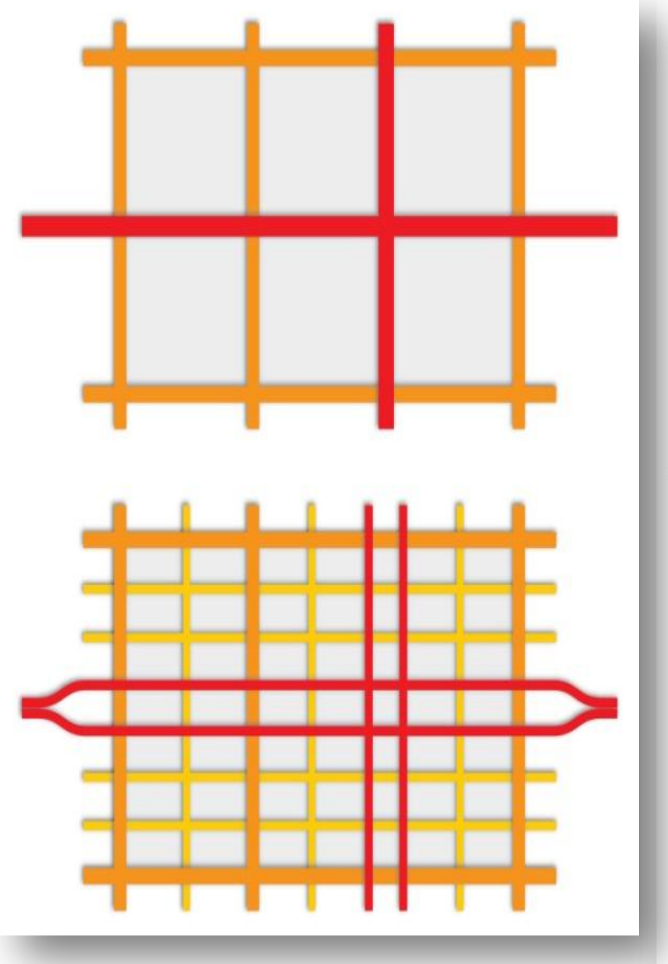


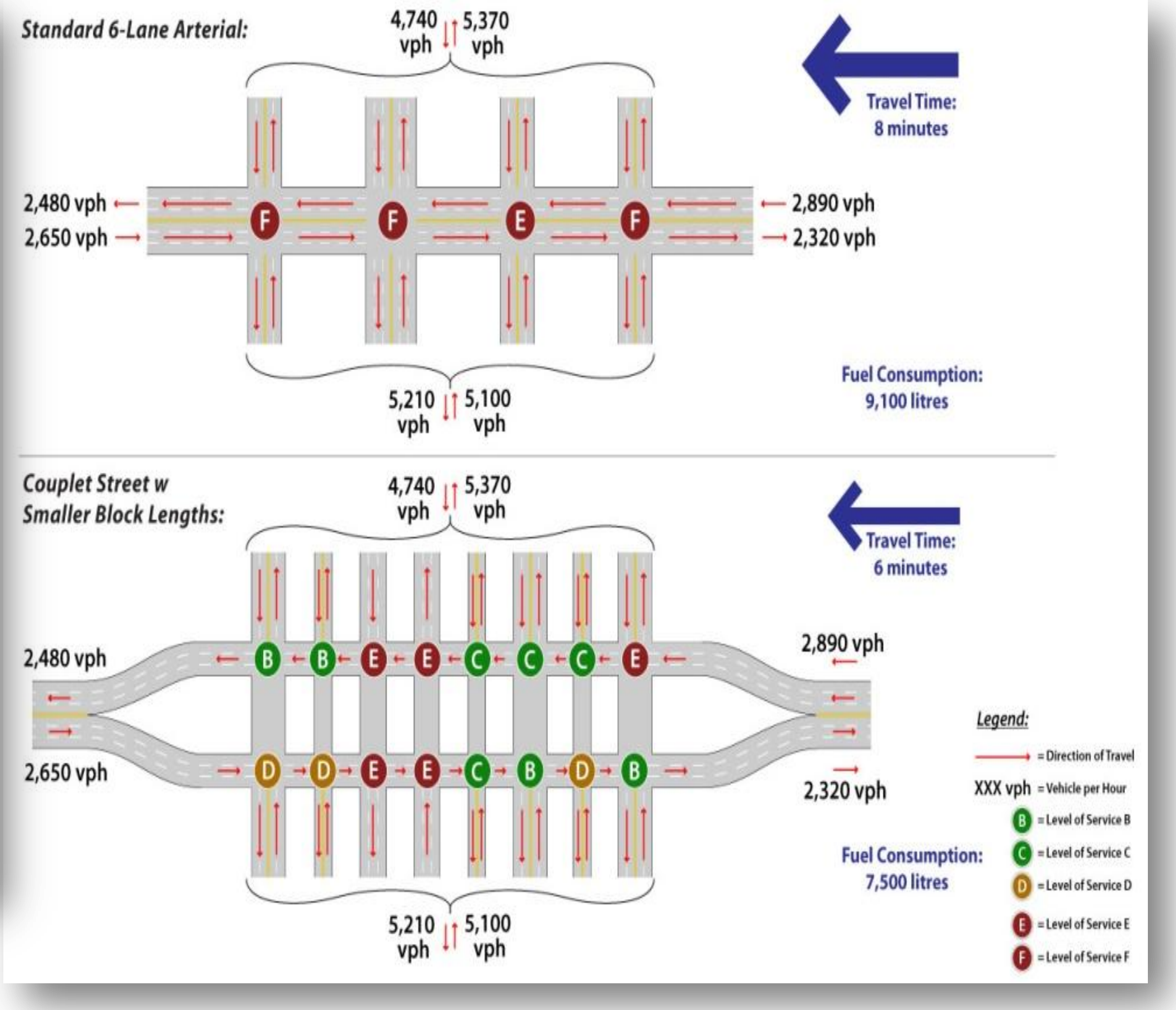
Conventional Network



Inter-Connected Network

Network Performance Comparison





Comparative Network Performance

Measure	Standard Arterial	Couplet
Min. Ped Crossing Time	37.3 seconds	13.6 seconds
Number of Signal Phases	4 to 8	2 to 5
# of LOS E/F Intersections	4 of 4 (100%)	5 of 16 (31%)

Comparative Sustainability Indicators

Measure	Standard Arterial	Couplet
East-West Travel Time	8 minutes	6 minutes (-25%)
Vehicle Hours of Delay	860 VHD	640 VHD (-25%)
Fuel Consumption	9,100 liters	7,500 liters (-18%)

Energy Savings and Freight

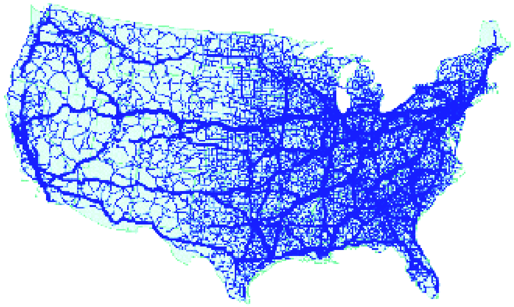
- Challenges: time-sensitive just-in-time pickups and deliveries complex supply chains growing congestion.

- Trucking Strategies: inland ports or freight villages, public logistic terminals or multi-company distribution centers for transfers and storage

- Intermodal Strategies: reservation times at ports, congestion-based road and runway tolling, variable pricing of capacity-constrained rail corridors

Truck Freight Flows, 1998

All Commodities, All Truck Types, Highway Freight Density (in tons)

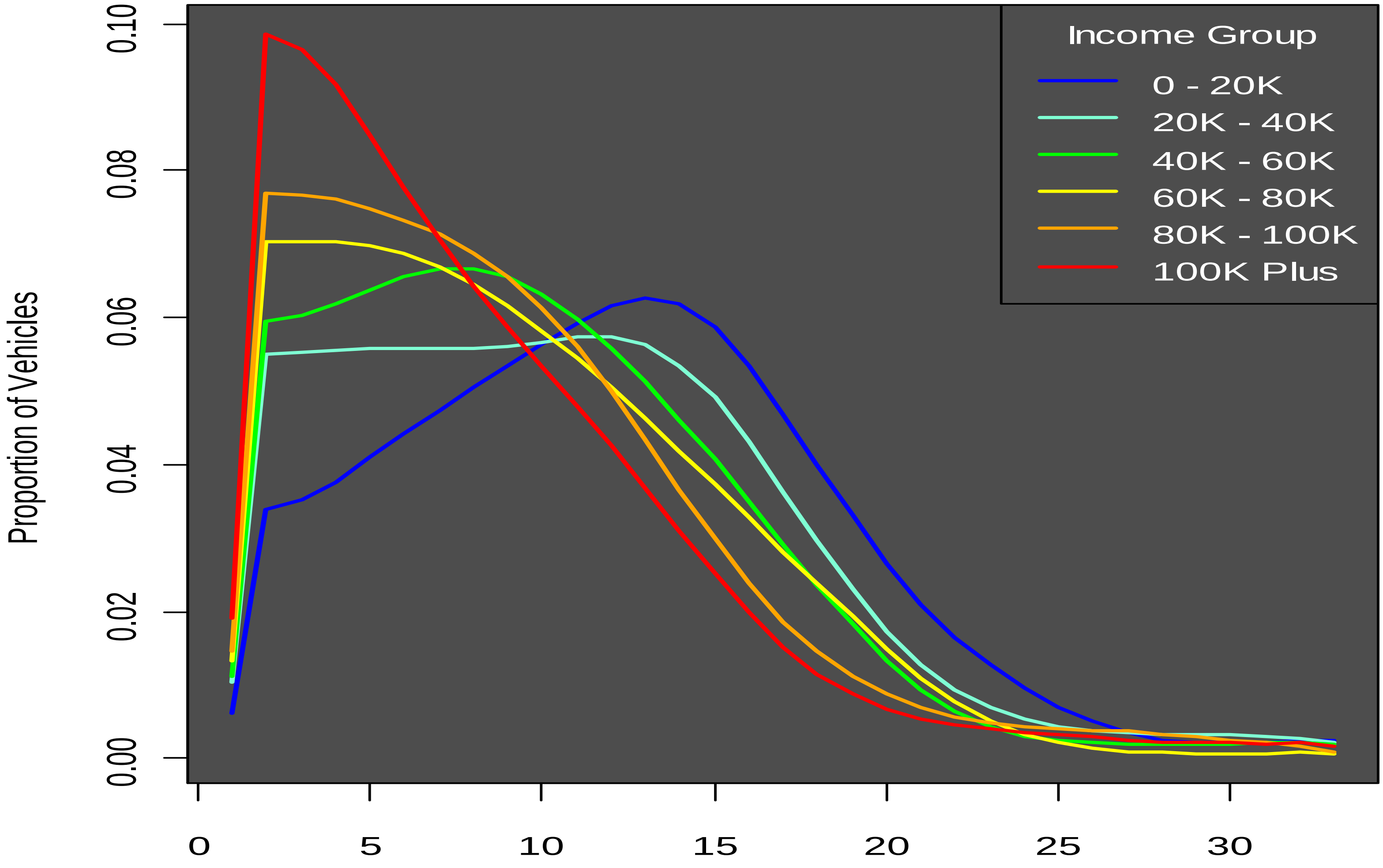


Energy Strategies for Freight

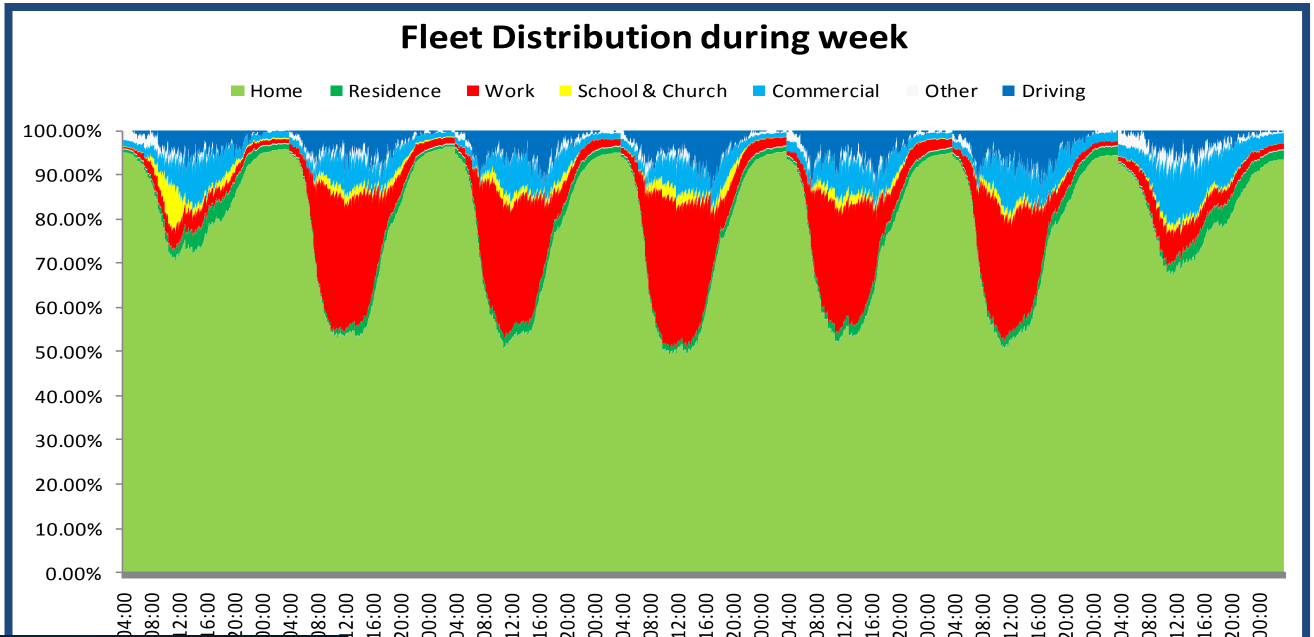
Land Use	**Urban Consolidation Centers**
	Industrial Land Reservation
Transportation System	**Bottleneck Removal**
	Capacity Expansion
	Intelligent Transportation Systems
	Terminal Operating Efficiencies
	Transporter Operations
	Change in Value Density
	Shifts to Lower Energy Modes
	Market Distance Shifts
	Fuel Tax
	VMT Tax
	Carbon Tax
Vehicles & Fuels	**Idle Reduction/Aux. Power**
	Vehicle Age, Technology
	Fuel Efficiency, Intensity

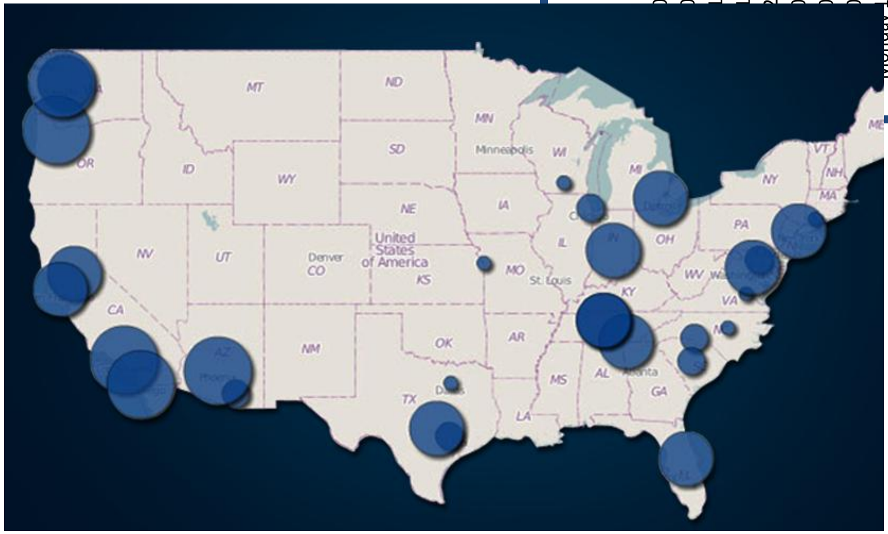
Auto Age Distribution by Income Group

(Western Census Region Households)



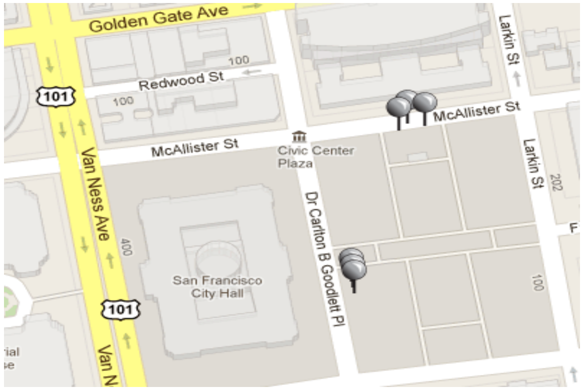
EV Recharge Opportunities

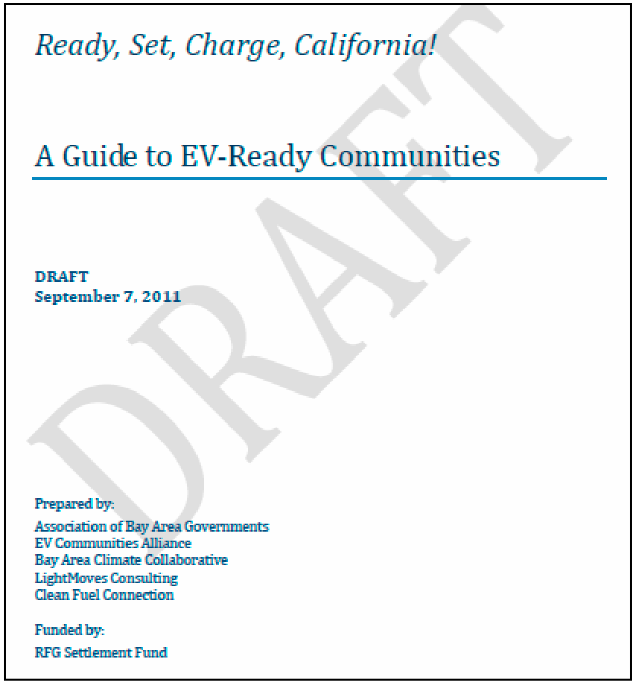




Challenges in Locating EV Charge Stations

- Convenient connections to heavily traveled corridors
- Distance to other parking facilities and land uses
- Ease of connection to energy source
- Cell phone service, wi-fi availability
- Short-term vs. monthly users
- Visibility, safe access
- Impact on parking revenue





Ready, Set, Charge, California!

A Guide to EV-Ready Communities

DRAFT
September 7, 2011

Prepared by:
Association of Bay Area Governments
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LightMoves Consulting
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Challenges in Layout of EV Charge Stations

- Cluster chargers vs. dispersing
- Source of electricity and electrical panel/circuits
- Excess electrical power capacity?
- ADA accessibility
- Cable management
- Lighting, shelter, signage improvements

The Energy Consequences of Alternative Forms of Development

Jerry Walters

Fehr & Peers

Questions?