Policy and Regulation System of Urban Transportation Sector on Climate Change and Air Quality issues in California and the US

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1 Introduction

There are increasing concerns around the globe about pollution and its impact on air quality and climate change. United States is currently the second largest contributor to worldwide Carbon dioxide emissions at 15%. Transportation sector is one of the largest causes of air pollution and emission in United States. It contributes 27% of the total Greenhouse gas emissions in 2015. Between 2990 and 2015, GHG emissions in the transportation sector increased more in absolute terms than any other sector due in large part to increased demand for travel.

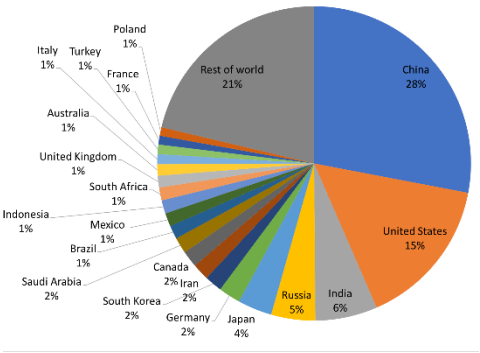

Fig 1. Share of global CO2 emissions from fuel consumption (2015) (Source: Union of Concerned Scientists, 2015)

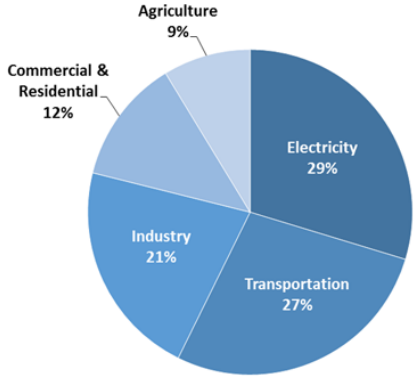

Fig 2. Total U.S. GHG emissions by economic sector in 2015 (Source: EPA, 2018)

Consequently, Federal government of the United States as well as state governments have created legislation and standards for transportation sector to improve air quality and to combat climate change. For example, from vehicle side, in 2010 EPA and National Highway Traffic Safety Administration (NHTSA) establish a 35.5-mpg standard for new light-duty vehicles by 2016. The following year, EPA and NHTSA proposed additional rules for a 54.5-mpg standard by 2025, and adopted additional GHG and fuel economy standards for other types of vehicles. At State and Local government levels, twenty-three states have adopted GHG reduction targets; 35 states have developed climate action plans. 500 mayors have signed the U.S. Conference of Mayors' Climate Protection Agreement. Many state and local governments are implementing transportation strategies to reduce GHG, such as S.B. 375, California's legislation on land use and transportation planning, etc.

It is commonly agreed that transportation air pollution and GHG reduction can be achieved from five areas include Vehicles, Fuels, Vehicle Miles Traveled (VMT), Operational Efficiency, and Construction, Maintenance, and Agency Operations. The previous efforts on combating air pollution and GHG reduction were heavily focused on the first two areas. But growing attention has been shifted to VMT as growth in travel could present a challenge to achieving environmental targets. If people travel more, especially on private cars, higher VMT and higher GHG emissions are generated. VMT per capita are higher in the US than in Europe and Canada. Even if future per-capita VMT stays flat, total VMT in the US still would grow at about 1% per

year because of population growth, offsetting some of the technological improvements in vehicles and fuels.

So, this report summarizes a number of legislations and plans on federal, state as well as local level that aiming to improve the efficiency and quality of public transportation, with a focus on public transit, as well as its interaction with biking/walking and integration with land use. The improvement of public transportation will help shift the travel from high emission private cars to cleaner transportation ways, thus reduce the emission from transportation sector.

2 Federal Level Policies

2.1 Structure of Federal Transportation Agencies:

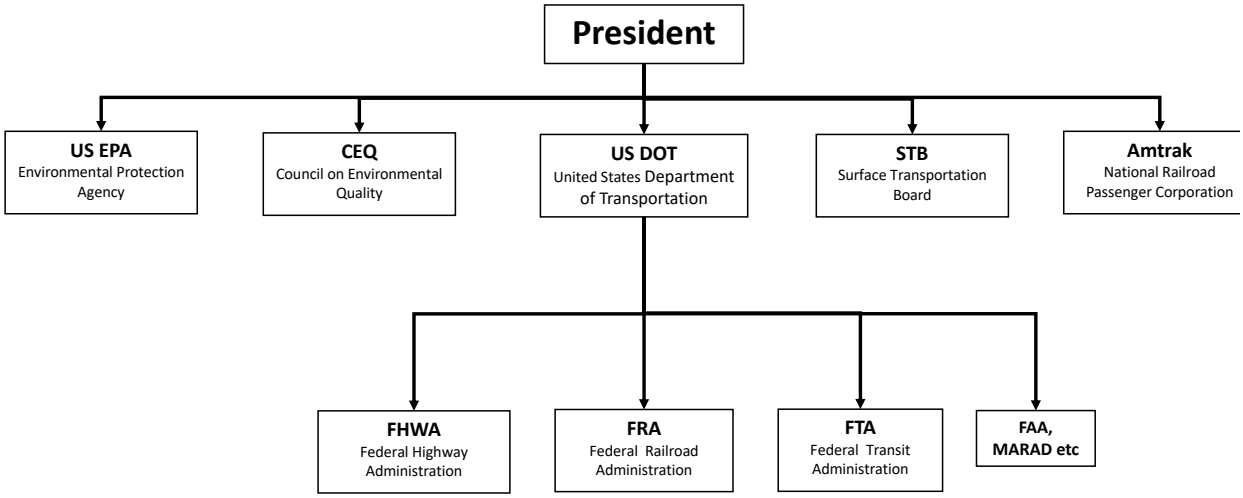

Fig 3: Structure of Federal Transportation-related agencies in the United States

1. United States Environmental Protection Agency (U.S. EPA): The United States Environmental Protection Agency (EPA or sometimes U.S. EPA) is an agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.

2. Council on Environmental Quality (CEQ): The Council on Environmental Quality (CEQ) is a division of the Executive Office of the President that coordinates federal environmental efforts in the United States and works closely with agencies and other White House offices on the development of environmental and energy policies and initiatives.

3. United States Department of Transportation (USDOT): The United States Department of Transportation (USDOT or DOT) is a federal Cabinet department of the U.S. government concerned with transportation. Its stated mission is to "serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future". USDOT has 10 subdivisions called administrations. Some of them are:

- **Federal Highway Administration (FHWA):** The Federal Highway Administration (FHWA) is a division of the United States Department of Transportation that specializes in

highway transportation. The agency's major activities are grouped into two "programs," the Federal-aid Highway Program and the Federal Lands Highway Program.

- **Federal Railroad Administration (FRA):** The purpose of FRA is to promulgate and enforce rail safety regulations, administer railroad assistance programs, conduct research and development in support of improved railroad safety and national rail transportation policy, provide for the rehabilitation of Northeast Corridor rail passenger service, and consolidate government support of rail transportation activities.

- **Federal Transit Administration (FTA):** The Federal Transit Administration is an agency within the United States Department of Transportation (U.S. DOT) that provides financial and technical assistance to local public transportation systems. Public transportation includes buses, subways, light rail, commuter rail, monorail, passenger ferry boats, trolleys, inclined railways, and people movers. The federal government, through the FTA, provides financial assistance to develop new transit systems and improve, maintain, and operate existing systems. The FTA oversees grants to state and local transit providers, primarily through its ten regional offices. These providers are responsible for managing their programs in accordance with federal requirements, and the FTA is responsible for ensuring that grantees follow federal mandates along with statutory and administrative requirements.

4. Surface Transportation Board (STB): The Surface Transportation Board (STB) of the United States is a federal, bipartisan, independent adjudicatory board. The STB has broad economic regulatory oversight of railroads, including rates, service, the construction, acquisition and abandonment of rail lines, carrier mergers and interchange of traffic among carriers. The STB also has oversight of pipeline carriers, intercity bus carriers, moving van companies, trucking companies involved in collective activities and water carriers engaged in non-contiguous domestic trade.

5. National Railroad Passenger Corporation (Amtrak): The National Railroad Passenger Corporation, doing business as Amtrak, is a passenger railroad service that provides medium- and long-distance intercity service in the contiguous United States and to three Canadian cities. It receives a combination of state and federal subsidies but is managed as a for-profit organization.

2.2 Federal Transportation Bills

2.2.1 MAP-21

MAP-21, the Moving Ahead for Progress in the 21st Century Act was signed into law by President Obama on July 6, 2012. It was a short-term bill intended to be valid for 2 years. It attempted to transform the policy and programmatic framework for investments to guide the growth and development of the country's vital transportation infrastructure. MAP-21 created a streamlined, performance-based, and multimodal program to address the many challenges facing the U.S. transportation system. These challenges include improving safety, maintaining infrastructure condition, reducing traffic congestion, improving efficiency of the system and freight movement, protecting the environment, and reducing delays in project delivery.

The bill strived to reform environmental review process in an effort to speed up project development. More projects could be categorically excluded from review, and there would be a four-year review deadline enforced with financial penalties. Funding for bicycle and pedestrian transportation was reduced and consolidated into a broader program called "Transportation Alternatives." Half of this funding would go to metropolitan planning organizations (MPOs) and the other half would go to states, which may choose to use the funds for other purposes. This change was heavily criticized by active transportation advocates as it could mean reduction in funding for active transportation modes. The bill also called for a national freight policy to be developed.

For performance-based evaluation of transportation projects, the bill proposed to focus on seven national goal areas – safety, infrastructure condition, congestion, system reliability, freight movement and economic vitality, environmental sustainability, reduced project delays. Performance measures must be incorporated into long-range planning and short-term programming processes. The bill directed United States Department of Transportation (USDOT) to establish measures in consultation with State DOTs, MPOs and other stakeholders. States, MPOs and transit operators were also instructed to set targets for each measure, incorporate in plans and programs and report progress. Long range plans, TIPs and STIPs must show the progress that is expected to be achieved by planned decisions and investments. USDOT would evaluate the appropriateness of state targets and the progress that the state is making in achieving performance targets. States and MPO plans would include performance reports that described the progress made toward achieving performance targets.

2.2.2 FAST Act

On December 4, 2015, President Obama signed the Fixing America's Surface Transportation (FAST) Act into law—the first federal law in over a decade to provide long-term funding certainty for surface transportation infrastructure planning and investment. The FAST Act authorized $305 billion over fiscal years 2016 through 2020 for highways, highway and motor vehicle safety, public transportation, motor carrier safety, hazardous materials safety, rail, and research, technology, and statistics programs. The FAST Act continued MAP-21 Act's focus on safety, continued efforts to streamline project delivery and, for the first time, provided a dedicated source of federal funding for freight projects. The bill was funded without increasing user fees like gas tax.

The bill attempted to facilitate commerce and the movement of goods by refocusing existing funding for a National Highway Freight Program and a Nationally Significant Freight and Highway Projects Program. It also expanded funding available for bridges of the National Highway System. It converted the Surface Transportation Program (STP) to a block grant program, increasing flexibility for states and local governments, and rolled the Transportation Alternatives Program into the STP Block Grant. This was seen by Active Transportation advocates as another major blow to development of active transportation modes.

The bill also streamlined the environmental review and permitting process to accelerate project approvals. It eliminated or consolidated at least six separate offices within the Department of Transportation and established a National Surface Transportation and Innovative Finance Bureau to help states, local governments, and the private sector with project delivery. It Increased transparency by requiring the Department of Transportation to provide project-level information to Congress and the public. The bill also attempted to promote the deployment of transportation technologies and congestion management tools and encourage installation of vehicle-to-infrastructure equipment to improve congestion and safety.

FAST Act strived for a multimodal transportation approach to solving the transportation challenges. Pursuant to this, the bill increased dedicated bus funding by 89% over the life of the bill and provided both stable formula funding and a competitive grant program to address bus and bus facility needs. It reformed public transportation procurement to make federal investment more cost effective and competitive. It also consolidated and refocused transit research activities to increase efficiency and accountability. Another important step was to establish a pilot program for communities to expand transit through the use of public-private partnerships. The bill also provided flexibility for recipients to use federal funds to meet their state of good repair needs and provided for the coordination of public transportation services with other federally assisted transportation services to aid in the mobility of seniors and individuals with disabilities. The bill also required a review of safety standards and protocols to evaluate the need to establish federal minimum safety standards in public transportation and required the results to be made public.

When it comes to rail transportation, FAST Act provided robust reforms for Amtrak, including reorganizing the way Amtrak operates into business lines. It gave states greater control over their routes, by creating a State-Supported Route Committee and consolidates rail grant programs for passenger, freight, and other rail activities. It also attempted to speed up the environmental review process for rail projects and to create opportunities for the private sector through station and right-of-way development. The bill also established a Federal-State Partnership for State of Good Repair grant program. It strengthened Northeast Corridor planning to make Amtrak more accountable and states equal partners and allowed competitors to operate up to three Amtrak long-distance lines, if at less cost to the taxpayer.

The bill also strengthened passenger and commuter rail safety, and track and bridge safety and vowed to preserve historic sites for rail while ensuring that safety improvements can move forward. It unlocked and reformed the Railroad Rehabilitation and Improvement Financing (RRIF) loan program and included reforms to get RRIF loans approved more quickly with enhanced transparency. The bill also provided commuter railroads with competitive grants and loans to spur timely Positive Train Control implementation. It also provided competitive opportunities for the enhancement and restoration of rail service.

2.3 Federal Air Quality Policy

2.3.1 Federal Clean Air Act

The Clean Air Act as amended in 1990 is the primary federal law that governs air quality. The Act contains key provisions to control common pollutants which, at the time of the 1970 amendments, formed dense, visible smog in many of the nation's cities and industrial centers. To protect public health and welfare nationwide, the law requires EPA to establish national ambient air quality standards based on the latest science and requires states to adopt enforceable plans to achieve the standards. State plans also must control emissions that drift across state lines and harm air quality in downwind states. Congress designed the law to minimize pollution increases from growing numbers of motor vehicles, and from new or expanded stationary sources (i.e., power plants, industrial plants, and other facilities that are not mobile). The law calls for new stationary sources to be built with best technology and allows less stringent standards for existing stationary sources.

The Act also contains specific provisions to address:

- "Hazardous" or "toxic" air pollutants that pose health risks such as cancer or environmental threats such as bioaccumulation of heavy metals,
- Acid rain that damages aquatic life and ecosystems, acidifies forest soils, damages property, and forms from pollution that degrades visibility and harms public health.
- Chemical emissions that deplete the stratospheric ozone layer which protects us from skin cancer and eye damage, and
- Regional haze that impairs visibility in national parks and other recreational areas.

In addition, the Act was drafted with general authorities that can be used to address pollution problems that emerge over time, such as greenhouse gases that cause climate change.

Air quality standards and their implementation

The Act requires EPA to set and revise national ambient air quality standards (NAAQS) for certain common and widespread pollutants, known as criteria pollutants, and provides authority for EPA to add additional pollutants. Standards are in effect today for six pollutants: sulfur dioxide, carbon monoxide, particles, nitrogen dioxide, ozone and lead.

EPA is directed to set primary standards that are requisite to protect public health, including the health of sensitive subpopulations, with an adequate margin of safety. Secondary standards are to be set at levels requisite to protect the public from adverse effects on soil, water, crops, buildings, and other matters separate from public health. Every five years, the Act requires EPA to review scientific data, and determine whether to revise the standards for a pollutant. An independent scientific advisory committee provides advice and recommendations to EPA for this review.

The air quality standards must be set based on science without regard to costs of implementing pollution controls to achieve the standards. Costs are considered during implementation of the standards.

Implementing the air quality standards is a joint responsibility of states and EPA. In this partnership, states are responsible for developing enforceable state implementation plans to meet and maintain air quality that meets national standards. Each state plan also must prohibit emissions that significantly contribute to air quality problems in a downwind state.

EPA assists state efforts by providing technical and policy guidance, and by issuing national emissions standards for new sources as described below. EPA reviews state plans to ensure that they comply with the Act. If a state fails to adopt and implement an adequate plan, EPA is required to issue a federal implementation plan.

Designation of 'Attainment' and 'Non-attainment Areas'

After EPA sets a new NAAQS or revises an existing NAAQS, EPA, considering state recommendations, determines whether areas do or do not meet the air quality standards. These determinations generally are based on data collected from air quality monitors located around the country.

Areas where the air quality falls short of national standards are designated as "non- attainment areas." Areas where air quality meets the standards are called "attainment areas." Areas for which data is lacking are designated "unclassifiable" and generally have the same obligations as attainment areas. An area can be in attainment for one pollutant and out of attainment for another. Air quality planning and control requirements differ for nonattainment and attainment areas.

State implementation Plans

States are required to devise and carry out state implementation plans (SIPs) to clean up dirty air and protect clean air from degradation. The Act sets minimum requirements for measures that must be included in these plans. Plans must be submitted to EPA for review to ensure that they meet the Act's requirements.

In the air quality planning process, states use emissions inventories, emissions projections, and computerized air quality models to estimate future air quality and improvements due to potential control measures. State implementation plans contain emission limits and compliance schedules for stationary pollution sources, such as power plants and factories. Depending on the pollutant, plans may also include state measures to reduce emissions from existing vehicles, such as state emissions inspection and maintenance programs that require cars with excessive emissions to be tuned-up or repaired.

National standards for new vehicles and engines, and fuels

The Act gives EPA authority to set and revise standards for all types of new vehicles and their engines, commonly called “mobile sources.” These include on-road vehicles such as cars, trucks, and buses; non-road engines and equipment such as farm and construction equipment, off-road motorcycles, recreational equipment, lawn and garden equipment, locomotives, and marine vessels; and aircraft. EPA rules under these provisions often help states attain and maintain air quality standards for common pollutants, as well as reduce toxic emissions. Recently, EPA has also used this authority to limit greenhouse gas pollution from motor vehicles.

Compliance with motor vehicle standards is monitored through testing and certification of new vehicles prior to sale by the manufacturer; authority for production line testing; and authority for in-use testing and recalls. In addition, the Act requires that manufacturers provide emissions-related warranties for design, defects and emissions performance. If the owner properly maintains and uses the vehicle and it fails a state inspection and maintenance test, the manufacturer is liable for repairs during the life of the warranty. For heavy-duty vehicles, EPA can allow sale of new vehicles that do not meet the standards if the manufacturer pays a non-compliance penalty.

2.3.2 National Ambient Air Quality Standards (NAAQS)

The Clean Air Act requires EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called criteria air pollutants. Periodically, the standards are reviewed and may be revised. The current standards are listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3-month average	0.15 $\mu g/m^3$	Not to be exceeded
Nitrogen Dioxide (NO2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and seconday	1 year	53 ppb	Annual Mean
Ozone (O3)	primary and seconday	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM 2.5	primary	1 year	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
	secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
	primary and seconday	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
PM 10	primary and seconday	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO2)	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Table 1: National Ambient Air Quality Standards (Source: NAAQS Table, US Environmental Protection Agency, 2018)

2.4 Intelligent Transportation Systems for Transit (by USDOT)

Intelligent Transportation Systems are techniques and methods for relieving congestion, improving road and transit safety, and increasing economic productivity. During the last few decades, there have been rapid advances in information and communications technology. Many transit agencies have employed a number of these different technologies in order to supplement or enhance the transportation services they offer to the public. Intelligent Transportation Systems (ITS) encompass a variety of different technology-based systems.

These are divided into two categories:

1. Intelligent Infrastructure Systems

- Arterial Management
- Freeway Management
- Transit Management
- Incident Management
- Emergency Management
- Electronic Payment & Pricing
- Traveler Information
- Information Management
- Crash Prevention & Safety
- Roadway Operations & Maintenance
- Road Weather Management
- Commercial Vehicle Operations
- Intermodal Freight

2. Intelligent vehicle systems

- Collision Avoidance Systems
- Driver Assistance Systems
- Collision Notification Systems

The Federal Transit Administration supports the use of ITS to further enhance public transportation service in the United States, which it does through the ITS Transit Program. The mission of the FTA's ITS Transit Program is to support America's public transportation systems by leading the innovative development and application of ITS technologies through research, operational tests/deployments, evaluation, training, and outreach. FTA supports this mission in coordination and cooperation with the transit industry.

The primary goals of the ITS Transit Program include:

- Support overall USDOT and FTA goals
    - **Safety:** Enhance public health and safety by working toward the elimination of transportation related deaths and injuries

    - **Mobility:** Increase the ability of all to travel by public transportation quickly, reliably, and comfortably to their desired destinations, and also when they would like to travel.
    - **Efficiency:** Provide efficient transportation services that make the most productive short and long-term use of Federal transit funds and overall transit resources.
    - **Economic Growth & Trade:** Facilitate a more efficient domestic and global transportation system that enables economic growth and development
    - **Environmental Stewardship:** Promote transportation solutions that enhance communities and protect the natural and man-made environment.
    - **Security:** Provide a safe and secure transportation system that is prepared for and responds to emergencies and natural disasters, and that balances homeland and national security requirements with the mobility needs of the nation.
    - **Organizational Excellence:** Provide effective and efficient implementation, management, and oversight of the ITS Transit Program through quality people and processes.
- Resolve issues regarding the development, implementation, and operation ITS Transit systems and their Integration
- Deployment of increasingly integrated systems (from within a single agency/mode, to all transit modes, to the complete transportation system) in order to provide mobility and meet the transportation needs for all
- Remove the technological barriers to using ITS Transit to provide seamless reliable, integrated transit services and transportation systems in general
- Remove the institutional barriers to using ITS Transit to provide seamless reliable, integrated transit services and transportation systems in general

3 State Level Policies

3.1 Introduction

Global concerns regarding climate change have been growing over the past decade and governments around the world have been devising new policies and programs to reduce GHG emissions and improve air quality. In United States, California has emerged as a leader in this regard by setting the most aggressive targets for GHG emission reductions and implementing a number of policies in order to achieve these targets.

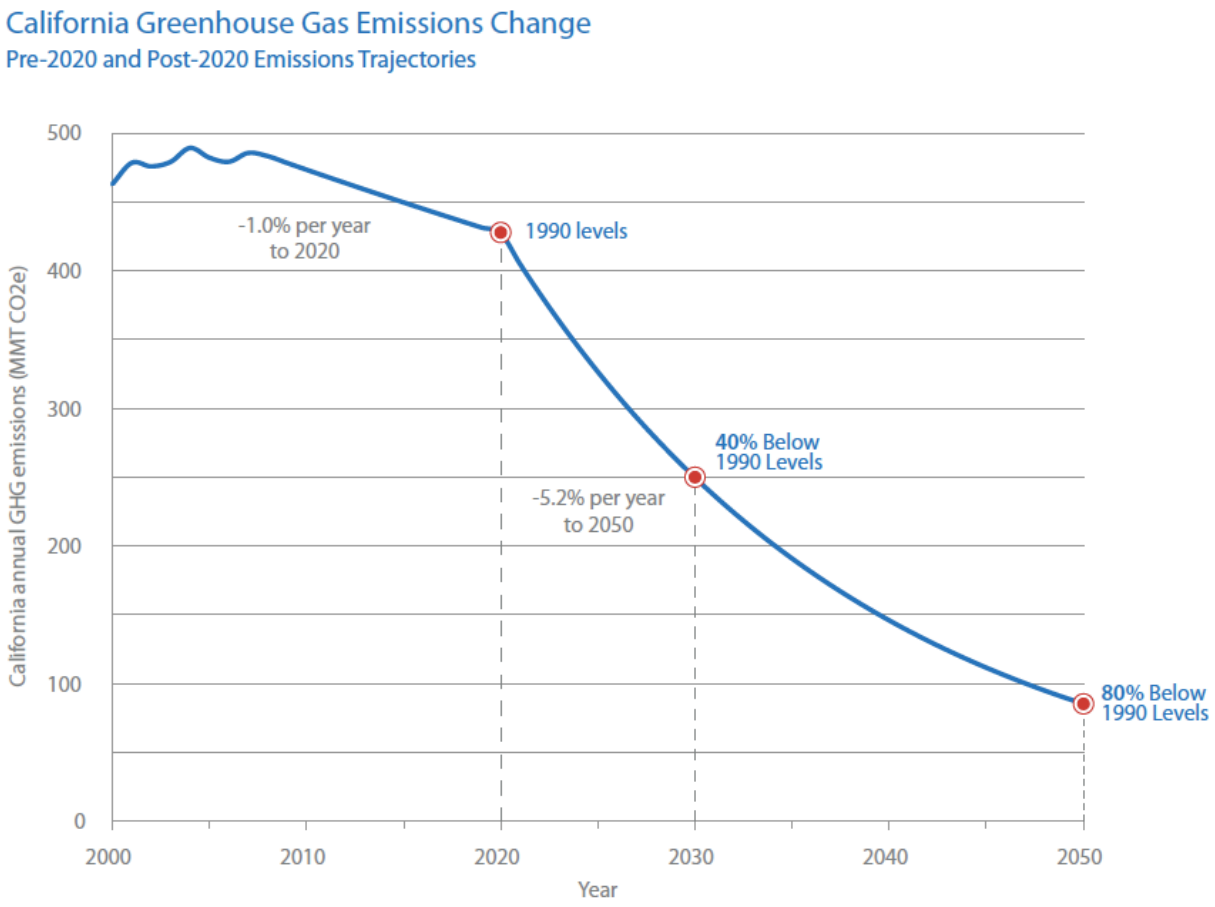

Fig 4. California greenhouse gas emissions change according to scoping plan by California Air Resources Board (Source: California Transportation Plan 2040, CalTrans, 2015)

The focus on climate change and greenhouse gas reduction started in California with the issuance of an executive order S-3-05 by Governor Schwarzenegger in 2005. This led to passing of AB 32 by the state legislature that set targets for greenhouse gas emission reduction for 2020 and 2050. In the same vein, bills like SB 375, AB 1358 and SB 743 were passed that made Climate change and GHG reductions as one of the main focuses for local, regional and state

level transportation planning. SB 32, passed in 2016 added new and stricter targets for GHG reductions by 2040. In order to achieve the targets set by AB 32 and SB 32 and to also meet the requirements of bills like SB 375 and SB 743, all new editions of statewide transportation related plans create models and made recommendations for a sustainable mobility future in California.

The objective of this section of the report is to list and review the policies and actions undertaken by California's state legislature, transportation agencies and environmental agencies to reduce greenhouse gas (GHG) emissions associated with transportation.

3.2 California – Major Environmental and Transportation Policies:

Following is a summary of major legislations, executive orders and plans related to transportation in the state of California:

a) Legislative Bills:

S. No.	Bill No.	Bill Title	Year signed	Remarks
1	AB 32	California Global Warming Solutions Act	2006	Sets GHG targets for 2020
2	SB 375	The Sustainable Communities and Climate Protection Act	2008	Regional GHG targets + Sustainable Communities Strategy
3	SB 391	California Transportation Plan	2009	CTP 2040
4	SB 743	Environmental Quality: ……	2013	Change in CEQA from LOS to GHG emissions
5	SB 350	Clean Energy and Pollution Reduction Act	2015	Targets for renewable electricity
6	AB 1482	Climate Adaptation	2015	CNRA to update 'Safeguarding California' strategy
7	SB 246	Climate Change Adaptation	2015	Integrated Climate Adaptation and Resiliency Program
8	AB 1358	California Complete Streets Act	2015	Requires complete streets policies by cities
9	SB 32	California Global Warming Solutions Act	2016	Sets GHG targets for 2030

Table 2: Major California Bills related to Transportation and Environment

b) Executive Orders:

S. No.	Executive Order No.	Governor	Year	Remarks
1	S-3-05	Arnold Schwarzenegger	2005	GHG targets for 2010, 2020 and 2050
2	B-30-15	Jerry Brown	2015	GHG targets for 2030
3	B-32-15	Jerry Brown	2015	California Sustainable Freight Action Plan

Table 3: Major California Executive Orders related to Transportation and Environment

c) Major Plans:

S. No.	Plan	Agency
1	California Transportation Plan	Caltrans
2	Regional Transportation Plan	MPOs
3	Sustainable Communities Strategy	MPOs
4	California Freight Mobility Plan	Caltrans

Table 3: Major California Statewide Plans related to Transportation

3.3 California's Transportation and Environmental Agencies:

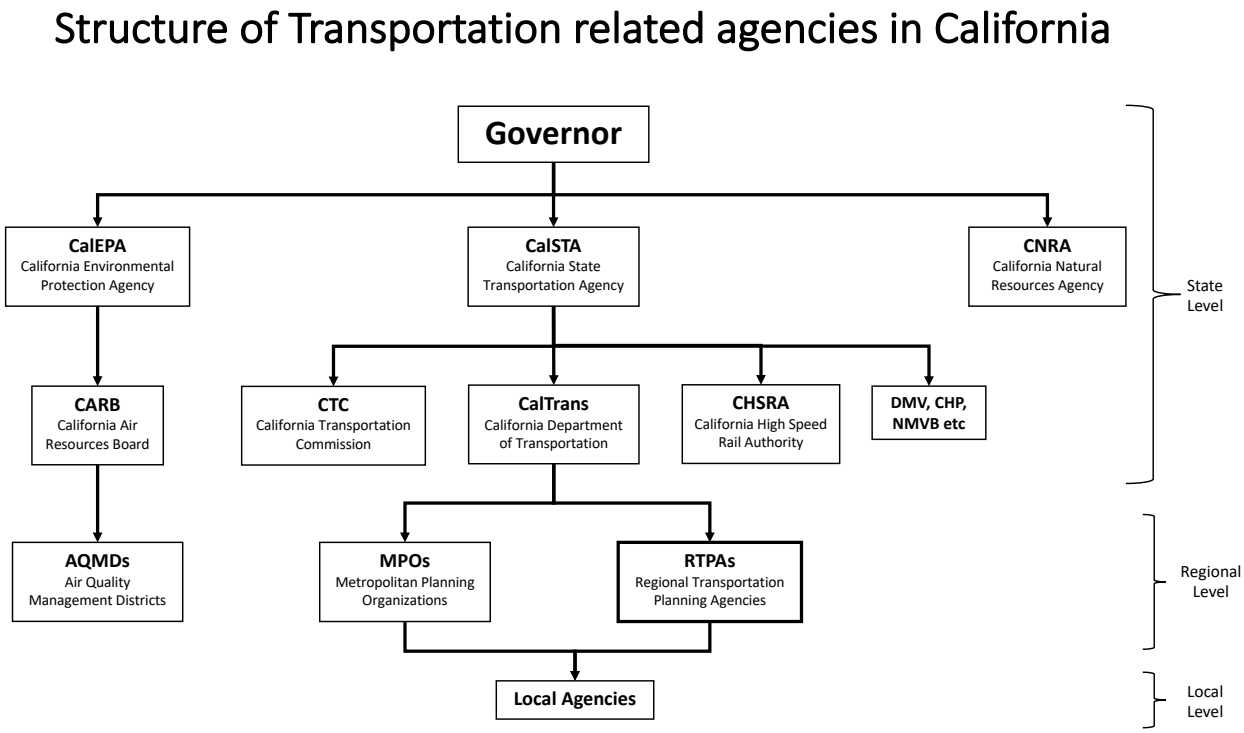

Fig 5: Structure of Transportation-related agencies in California

1**. California Environmental Protection Agency (CalEPA):**

The California Environmental Protection Agency is a state cabinet-level agency within the government of California. The mission of CalEPA is to restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality.

CalEPA currently has 6 boards or department under it namely, California Air Resources Board (ARB), Department of Pesticide Regulation (DPR), California Department of Resources Recycling and Recovery (CalRecycle), Department of Toxic Substances Control (DTSC), Office of Environmental Health Hazard Assessment (OEHHA), and State Water Resources Control Board (SWRCB).

- **California Air Resources Board (CARB):** The California Air Resources Board, also known as CARB or ARB, is the "clean air agency" in the government of California. The stated goals of CARB include attaining and maintaining healthy air quality; protecting the public from exposure to toxic air contaminants; and providing innovative approaches for complying with air pollution rules and regulations. CARB has also been instrumental in driving innovation throughout the global automotive industry through programs such as

its ZEV mandate. One of CARB's responsibilities is to define vehicle emissions standards. California is the only state permitted to issue emissions standards under the federal Clean Air Act, subject to a waiver from the United States Environmental Protection Agency. Other states may choose to follow CARB or federal standards but may not set their own.

2. **California State Transportation Agency (CalSTA):**

The California State Transportation Agency (CalSTA) is a state cabinet-level agency responsible for transportation-related departments within the state. The mission of the California State Transportation Agency is to develop and coordinate the policies and programs of the state's transportation entities to achieve the state's mobility, safety and air quality objectives from its transportation system.

The following transportation-related entities are under CalSTA:

- **California Transportation Commission (CTC):** The California Transportation Commission is responsible for programming and allocating funds for the construction of highway, passenger rail, transit and active transportation improvements throughout California. The Commission also advises and assists the Secretary of the California State Transportation Agency and the Legislature in formulating and evaluating state policies and plans for California's transportation programs.
- **Department of Transportation (Caltrans):** Caltrans manages the state's highway system, which includes the California Freeway and Expressway System, and is involved with public transportation systems throughout the state. It supports Amtrak California and Amtrak's Capitol Corridor. Caltrans's stated mission is to provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.
- **High-Speed Rail Authority (HSRA):** The California High-Speed Rail Authority (CHSRA) is a California state agency established to develop and implement high-speed intercity rail service in California.
- Office of Traffic Safety (OTS)
- New Motor Vehicle Board (NMVB)
- Board of Pilot Commissioners (BOPC)
- California Highway Patrol (CHP)
- Department of Motor Vehicles (DMV)

3. **California Natural Resources Agency (CNRA):** The California Natural Resources Agency is responsible for protecting historical, natural and cultural sites, monitoring and controlling state lands and waterways, and regulating fish and game use.

3.4 Executive Orders

3.4.1 EO S-3-05

Executive Order S-3-05 was signed by California governor Arnold Schwarzenegger in June 2005 to set greenhouse gas (GHG) emission targets for the state of California. The targets set by the executive order were:

- By 2010, reduce GHG emissions to 2000 levels
- By 2020, reduce GHG levels to 1990 levels
- By 2050, reduce GHG levels to 80 percent below 1990 levels

It also directed California Environmental Protection Agency (CalEPA) to coordinate with other state agencies to achieve these targets and biannually report to the Governor and the state legislature on the progress made towards meeting the targets as well as on the impacts to California of global warming and adaptation and mitigation plans.

The executive order led to passage of California Global Warming Solutions Act of 2006 (AB 32).

3.4.2 EO B-30-15

Executive Order B-30-15 was signed by California governor Jerry Brown in April 2015 to add an interim greenhouse gas (GHG) emission target for California to reduce GHG emissions to 40 percent below 1990 levels by 2030.

It also directed California Air Resources Board (CARB) to update the Climate Change Scoping Plan and directed California Natural Resources Agency (CNRA) to update the state's climate adaption strategy, 'Safeguarding California', every three years. State agencies were directed to take climate change into account in their planning and investment decisions and employ full life-cycle cost accounting to evaluate projects.

This executive order led to the passage of California Global Warming Solutions Act of 2016 (SB 32).

3.5 Legislative Bills

3.5.1 AB 32

California Global Warming Solutions Act of 2006, also known as Assembly Bill 32 (AB 32), was passed by California state legislature in August 2006 and signed into law by Governor Schwarzenegger in Sept 2006. In June 2015, Governor Schwarzenegger had signed Executive Order S-3-05 establishing Greenhouse Gas (GHG) emissions targets for 2010, 2020 and 2050. AB 32 was passed in order to give authority to California Air Resources Board (CARB) to implement measures to achieve those targets.

AB 32 was the first comprehensive program in the United States to address the problem of Climate Change with its stated aim to improve the environment, conserve and preserve California's natural resources, and mitigate the impacts of climate change while maintaining a robust economy. Along with Carbon Dioxide, the bill covers emission of six other groups of GHGs namely: Methane, Nitrous oxide, Hydrofluorocarbons, Perfluorocarbons, Sulfur hexafluoride, and Nitrogen triflouride.

AB 32 directed CARB to prepare and approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from sources or categories of sources of greenhouse gases by 2020. CARB was also instructed to adopt a regulation requiring the mandatory reporting of greenhouse gas emissions. The biggest impact of AB 32 was that it allowed CARB to introduce Cap and Trade system across California under which CARB has capped the amount of GHG emissions produced by individual organizations. CARB has also created a mechanism where organizations wishing to produce emissions above their cap can purchase credits to do so in an auction.

3.5.2 SB 32

California Senate Bill 32 (SB 32) was passed by California state legislature and signed into law by Governor Jerry Brown in 2016. The bill expands upon Assembly Bill 32 (AB 32) to include an interim Greenhouse gases (GHG) emissions target of 40% below 1990 levels in 2040 after Governor Brown signed an executive order B-30-15 for the same.

3.5.3 SB 375

The Sustainable Communities and Climate Protection Act of 2008, also known as Senate Bill 375 (SB 375) was passed by California legislature and signed into law by Governor Schwarzenegger in 2008. Whereas AB 32 set overall targets for all sectors and regions across California as a whole, SB 375 instructed CARB to set regional targets for emissions from passenger vehicles. In 2010, regional targets were established for 2020 and 2035 by CARB and these targets are to be updated every 8 years until 2050. The bill also requires Metropolitan Planning Organizations (MPOs) across the state to develop Sustainable Communities Strategies (SCS) as an integral part of its Regional Transportation Plan (RTP). SCS also needs to be consistent with Regional Housing Needs Allocation (RHNA).

The main objective of SCS is to reduce GHG emissions through coordinated transportation and land use planning with the goal of more sustainable communities. CARB must review the SCS to confirm that it would allow the region to meet its GHG emissions targets. If the SCS will not meet the region's target, the MPO must prepare a separate "alternative planning strategy (APS)" that is expected to meet the target. SB 375 also includes provisions to incentivize implementation of SCS by waiving certain CEQA environmental review requirements for new projects consistent with regional SCSs.

The hope is that SCSs will discourage suburban development distant from retail and employment centers and encourage retail, employment, urban infill and mixed-use development near public transportation. So far, SCSs of the largest metropolitan areas have promised heavy future funding for transit system development and are encouraging Transit Oriented Developments. A transit priority project (TPP) is exempted from CEQA requirements if it is part of a region's SCS. A transit priority project must be within a half-mile of a major transit stop, provide at least 50 percent residential use and have a minimum density of 20 dwellings per acre. Initially, some communities were skeptical about SCS requirements and intentions. However, some stakeholders are realizing the possible ancillary benefits, such as improved public health, additional conservation of agricultural lands, and reduced energy and fuel costs.

3.5.4 SB 743

Senate Bill 743 (SB 743) was passed by California legislature and approved by Governor Brown in Sept 2013. The bill exempts any residential, mixed-use residential or employment center projects on “an infill site” within a “transit priority area” from having to evaluate aesthetic and parking impacts under CEQA. However, these projects would still have to evaluate and mitigate the environmental impacts of traffic such as noise, air pollution and safety concerns. The bill directed Office of Planning and Research to prepare new criteria for determining significance of transportation impacts of projects within transit priority areas. The new criteria are required to promote reduction of Greenhouse gas (GHG) emissions, the development of multimodal transportation networks and a diversity of land use. This marked a major shift in transportation impact assessment from automobile delay and level of service (LOS) to other metrics like vehicle miles traveled (VMT), VMT per capita, automobile trips generated, automobile trip generation rate etc. Local authorities were also directed to more appropriately balance the need for congestion management with attempts to achieve goals for infill development, promotion of public health through active transportation and reduction in greenhouse gas emissions.

3.5.5 AB 1358

Assembly Bill 1358 (AB 1358), also referred to as Complete Streets Act was passed by California legislature and signed into law by Governor Schwarzenegger in September 2008. The bill requires California’s counties and cities to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways including motorists, pedestrians, bicyclists, children, persons with disabilities, seniors, movers of commercial goods, and users of public transportation during the next revision of their general plan. This approach is generally referred to as ‘Complete Streets’ due to the change in focus from only motorists to all users of streets especially pedestrians and bicyclists. However, the bill allows the local authorities to use their discretion in deciding what components of complete streets are suitable to the rural, suburban, or urban context of the general plan.

The bill also requires the Office of the Planning and Research in Governor’s Office to amend its guidelines for general plans to be consistent with above instructions. The bill authorizes the office to consult with transportation experts especially bicycle transportation planners, pedestrian planners, public transportation planners, local air quality management districts, and disability and senior mobility planners to prepare these guidelines.

3.6 California Transportation Plan 2040 (CTP 2040)

The passage of Assembly Bill 32 (AB 32) in 2006 and the subsequent executive orders shifted the focus of California's transportation agencies from reducing congestion and increasing level of service to building strategies for sustainable growth with focus on reducing Greenhouse gas (GHG) emissions. Pursuant to this, California's transportation agencies produce a number of plans at state, regional and local levels. California Transportation Plan (CTP) aims to tie together all these plans into a single long-range transportation plan. SB 391 passed in 2009 requires Caltrans to update the CTP every five years. The latest edition is the CTP 2040 which was published in 2015.

Goals, Purpose and Approaches

CTP 2040 lists the following as its six goals:

- Improve Multimodal Mobility and Accessibility for All People
- Preserve the Multimodal Transportation System
- Support a Vibrant Economy
- Improve Public Safety and Security
- Foster Livable and Healthy Communities and Promote Social Equity
- Practice Environmental Stewardship

CTP 2040 describes the main purpose of the plan as:

- Exploring major trends that will likely influence travel behavior and transportation decisions over the next 25 years.
- To help ensure that policy decisions and investments made at all levels of government and within the private sector will work congruently to enhance the State's economy, improve social equity, support local communities, and protect the environment, including achievement of the State's greenhouse gas (GHG) reduction goals

The CTP 2040 relies on these main approaches to reduce future GHG emissions for the movement of people and freight:

- Promote best practices in regional and local land use that support a diverse transportation system
- Increase a shift to more sustainable transportation modes (mode shift) to reduce per capita vehicle miles traveled (VMT)
- Efficiently manage, operate and maintain the transportation system (including construction practices)
- Reduce the number of petroleum powered vehicles from California roads, and replace with zero- to near-zero equipment and modes of travel throughout the State
- Improve technology for all transportation sector activities

Current Situation

California already has an extensive multi-modal transportation system with 174,991 miles of road network (2012), 2,550 miles of passenger rail corridors, 28 commercial service airports, 215 general aviation airports and 21,866 transit vehicles available for maximum service. However, the system is heavily car dependent as nearly 80 percent of commuters in California are still travelling to work in single occupancy vehicles (SOVs), according to a report by Public Policy Institute of California. This choice leads to greater congestion, greater emissions, and greater VMT. California has recognized the risks and challenges posed by climate change and has already taken actions towards reduction in GHG emissions. To meet the 2030 and 2050 GHG emission targets set by SB 32 and AB 32, transportation sector has to undergo a major transformation. California has to invest heavily in transit as well as bicycle and pedestrian infrastructure. California has also adopted a ZEV mandate that intends to put 1.5 million ZEVs on California's roads by 2025.

Another step towards sustainable mobility in California is the High-speed rail (HSR) system currently under construction. Phase 1 of California HSR is expected to be operational by 2029 consisting of 520 miles (840 km) of high-speed rail network and connecting San Francisco to Los Angeles and Anaheim via the central valley. Phase 2 is also planned to connect Sacramento, Inland Empire and San Diego to the network and taking the total system length to about 800 miles (1,300 km). A private company called XpressWest also intends to build a high-speed rail connection between Las Vegas and Palmdale in Los Angeles County.

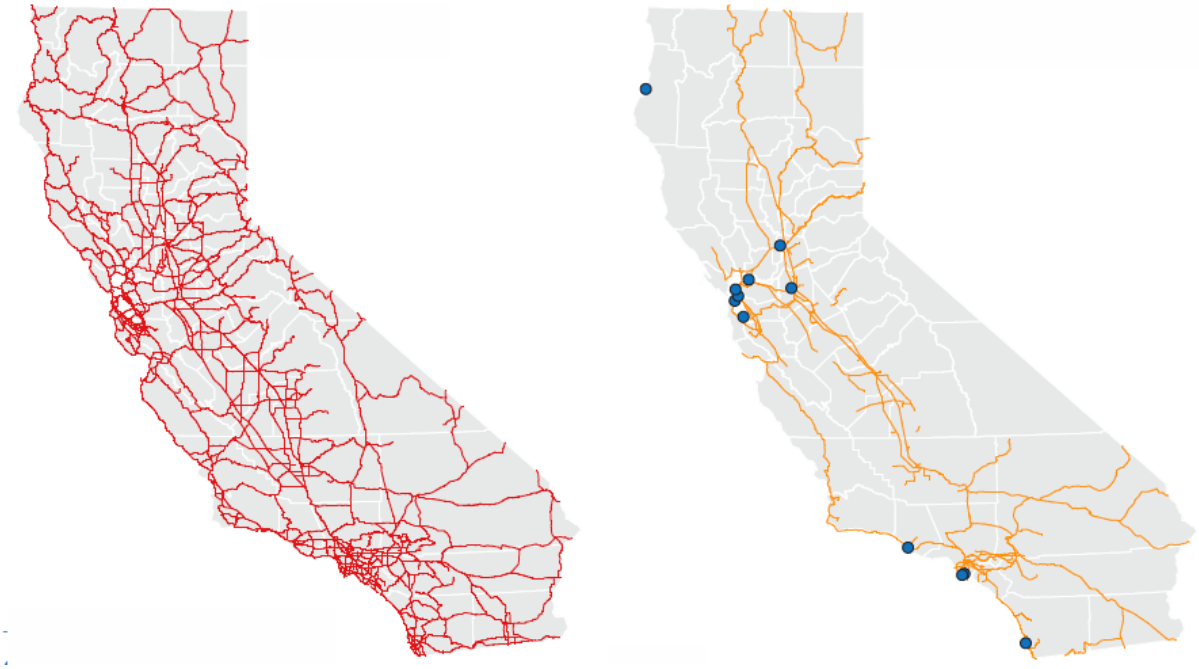

Fig 6. Road network in California (Map 1) and Passenger and Freight rail network in California (Map 2) (Source: California Transportation Plan 2040, CalTrans, 2015)

Fig 7. Under-construction High speed rail network in California (Source: California Transportation Plan 2040, CalTrans, 2015)

High-speed rail system is proposed to be powered by 100 percent renewable energy. It is also expected to spur additional infill development of housing and businesses near station areas, providing further environmental benefits. California High-speed Rail authority (CHSRA) intends to minimize and mitigate all GHG emissions and integrate life-cycle performance during the design and construction of HSR. CHRSA also plans to invest around $1 billion in local transit projects in the state to improve connectivity to HSR system. The 'Blended System' concept for HSR provides an overall framework for a statewide passenger rail system that integrates high-speed rail with existing intercity and commuter/regional rail systems. This integration entails coordinated infrastructure, scheduling, ticketing and operations, with the goal of providing a fully integrated trip from origin to destination.

Modelling

SB 391 requires CTP 2040 to analyze how the state can achieve its GHG emissions targets set by AB 32, SB 32 and the executive orders. For this purpose, CTP 2040 tried to model three transportation scenarios which build upon each other in a way such that the third scenario meets the 2050 statewide GHG remissions reduction targets. Scenario 1 includes 'Planned future condition'. These are the planned transportation and land use changes as detailed in Caltrans modal plans as well as the various Regional Transportation Plans (RTP) and Sustainable Communities Strategies (SCS). Scenario 2 includes Scenario 1's 'Planned future conditions' plus 'Statewide Transportation Efficiency Strategies' designed to reduce per capita VMT while increasing mobility for all transportation modes. In addition to both the components of Scenario 2, Scenario 3 includes 'New Clean Vehicle Fuel and Technologies' that will be required in order to reach 2050 GHG emissions targets.

For modelling the impacts of these scenarios, following modelling tools were used:

- California Statewide Travel Demand Model (CSTDM)
- ARB's EMission FACtors model (EMFAC) and Vision for Clean Air (VISION)
- Transportation Economic Demand Impact System (TREDIS) Model

STATEWIDE GHG EMISSIONS BY CTP TRANSPORTATION SCENARIO (ARB)

		2010	2012	2020	2040	2050
SCENARIO 1						
GHG Emissions (MMT CO2e / yr)	**Total**	175	167	158	154	**175**
	Target					**32**
GHG Relative Reduction Below Scenario 1 2020[1] (%)	**Total**				**-3%** ↓	**+10%** ↑
	Target					**-80%**
SCENARIO 2						
GHG Emissions (MMT CO2e / yr)	**Total**	175	167	157	123	**135**
	Target					**32**
GHG Relative Reduction Below Scenario 1 2020[1] (%)	**Total**				**-23%** ↓	**-15%** ↓
	Target					**-80%**
SCENARIO 3						
GHG Emissions (MMT CO2e / yr)	**Total**	175	167	156	64	**32**
	Target					**32**
GHG Relative Reduction Below Scenario 1 2020[1] (%)	**Total**				**-60%** ↓	**-80%** ↓
	Target					**-80%**

1 AB 32 requires that the 2020 total GHG inventory is the same as the 1990 GHG inventory, while the law does not require that each individual sector achieve its absolute 1990 value. Because the CTP project does not include all sectors, Caltrans has assumed that the transportation sector 2020 GHG value calculated for Scenario1 will be the reference point for the 2050 GHG reductions.

Fig 8. Statewide Emissions by CTP Transportation Scenarios (Source: California Transportation Plan 2040, CalTrans, 2015)

The modelling results showed that Scenario 1 would result in increase in daily total VMT by 10% in 2020 and by 34% in 2040. However, there would a reduction in per capita VMT by 2% in 2020

and by 3% in 2040. Scenarios 2 and 3 would result in 8% and 4% increase in daily total VMT in 2020 and 2040 respectively and a reduction of 5% and 28% in daily per capita VMT in 2020 and 2040 respectively.

To predict the changes in terms of GHG emissions, the model assumes that Scenario 1 would achieve the 2020 targets and would serve as a base for further reductions by 2050. The model predicts that Scenario 1 would result in an increase of 10% in transportation sector GHG emissions by 2050. Scenario 2 would result in a reduction of 15% and scenario 3 would result in a reduction of 80% over the same period.

Policy recommendations

The plan provides a number of policy recommendations that may help in achieving California's GHG emissions targets for 2020, 2040 and 2050. Following are some of the important transit-focused recommendations:

- The plan recognizes that people want a multimodal transportation network that can transport people safely, reliably and at a reasonable cost without sacrificing the environment, public health, or community character.
- The plan emphasizes the importance of seamless integration between various levels of public transportation systems – local, regional and statewide. Some of the important components of an integrated statewide transportation system mentioned in the plan are 'One-stop ticketing', 'Coordinated transfers' and 'Real-time system information'.
- Implementing programs like 'Employee transit incentives' can play an important role in increasing transit use.
- It is essential to ensure at least 90% on-time performance for all intercity rail corridors in order to make public transportation a more reliable mode choice.
- Transportation pricing strategies that better reflect the total cost of each mode, including health and environmental costs, while not economically over-burdening low-income system users can help induce a mode shift from Single occupant vehicles (SOV) towards public transit and active transportation.

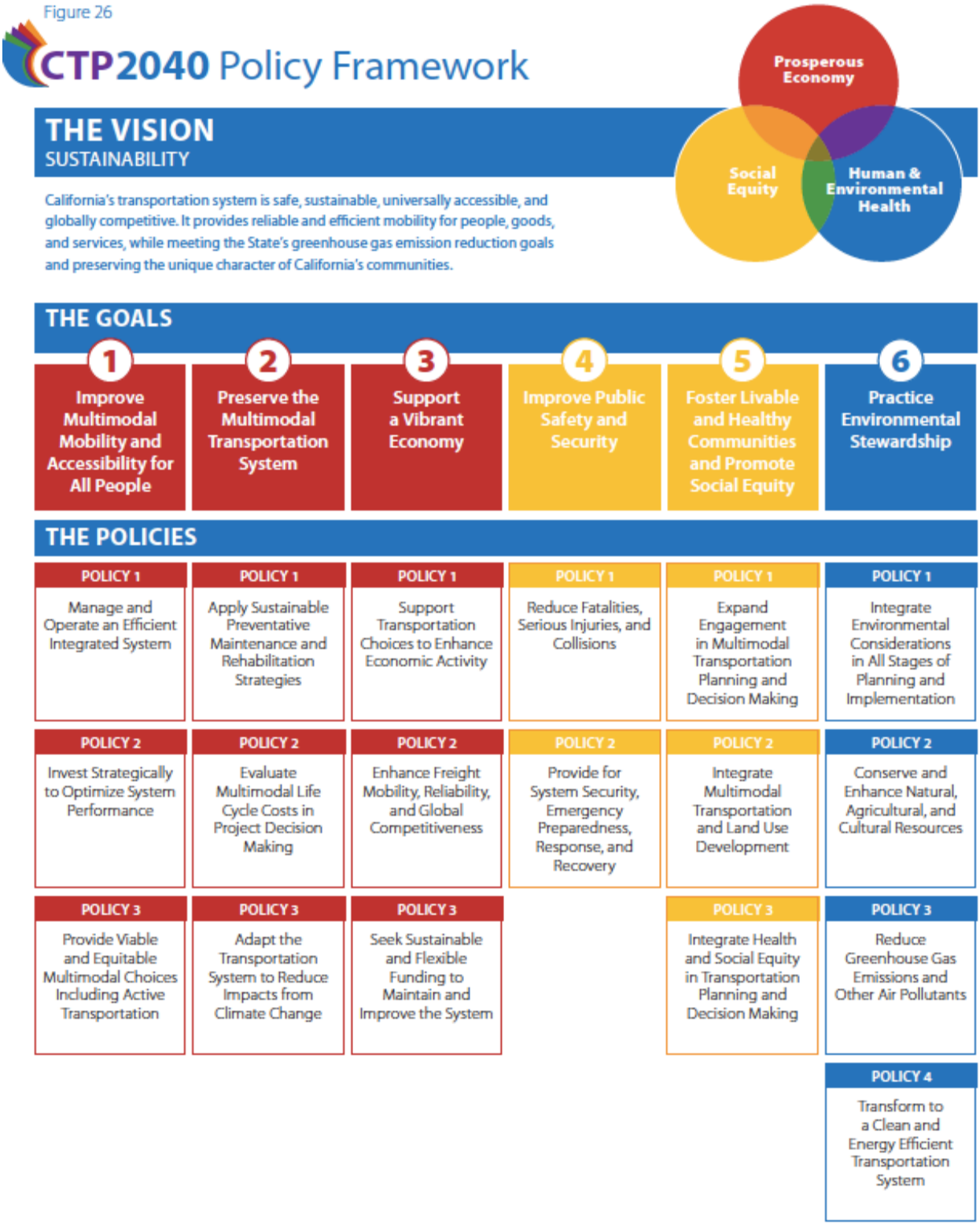

Fig 9: CTP 2040 Policy Framework (Source: California Transportation Plan 2040, CalTrans, 2015)

3.7 California State Rail Plan 2018

Caltrans in responsible for updating the California State Rail Plan every 5 years. It is a document that provides an in-depth look at state's rail system and the various trends and policies affecting it. The rail plan also proposes changes to the current system in order to achieve the future demand and meet climate change goals. The latest edition of the rail plan is scheduled to be released in 2018. A draft for the same has been released that includes a proposed Rail system map for California in 2040. The map includes the under-construction California High-speed Rail system as well as extensions to the existing conventional rail system, mainly in Bay Area-Sacramento region of the state.

Fig 10. Proposed California Rail System in 2040 (Source: California State Rail Plan, CalTrans, 2018)

3.8 California Statewide Transit Strategic Plan (CSTSP) 2012 recommendations

CSTSP is produced by Caltrans every 5 years with the last plan being published in 2012-13. As part of CSTSP 2012, UCLA Institute of Transportation Studies published a report analyzing transit data and providing recommendations for Caltrans and local transit agencies.

Pursuant to targets outlined in AB 32 and SB 32, State as well as local governments in California have identified increasing transit ridership as one of the most important parts of their Greenhouse Gas (GHG) emissions reduction plans. This focus on Transit and Transit ridership can be seen in bills like SB 391 and SB 375 and also in Sustainable Communities strategies (SCSs) adopted by various Metropolitan Planning Organizations (MPOs). For example, Southern California Association of Governments (SCAG) region expects a 36% increase in total transit and rail boardings by 2035. This is nearly double the 18.5% statewide increase in transit trips experienced between 1991 and 2010. GHG isn't the only reason to invest in better transit as it is also important for achieving various types of statewide economic, environmental, and social goals. In SB 391, state legislature acknowledged the relationship between gasoline prices and transit ridership as California saw a historic rise in transit ridership during a period of continuously increasing gas prices from 1995 to 2009 as shown in Fig 1.

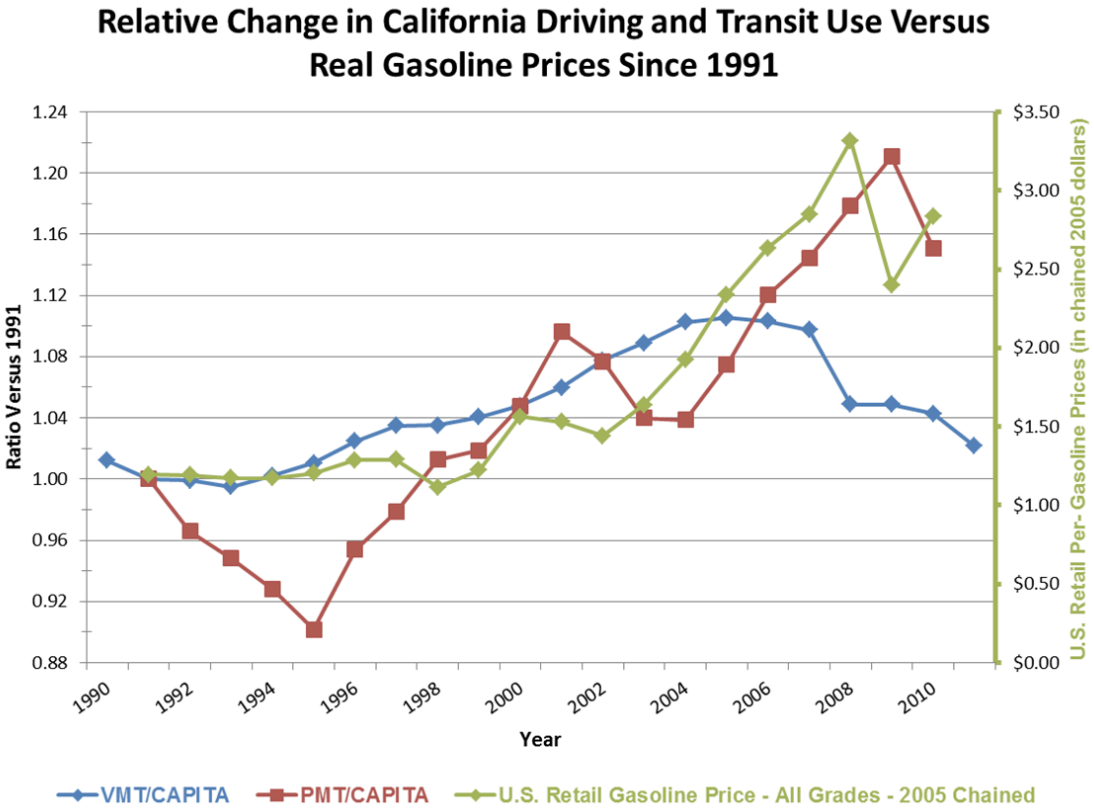

Fig 11. Effect of Gasoline prices (Green) on Transit ridership (Red) and Driving (Blue) (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

Most transit decisions are made by local governments and local governments also end up bearing the lion share of the operational costs of transit. According to the report, fare revenues have made up only 20-30% of operating funds in California (Fig 2). The remaining funding is provided by state and federal grants.

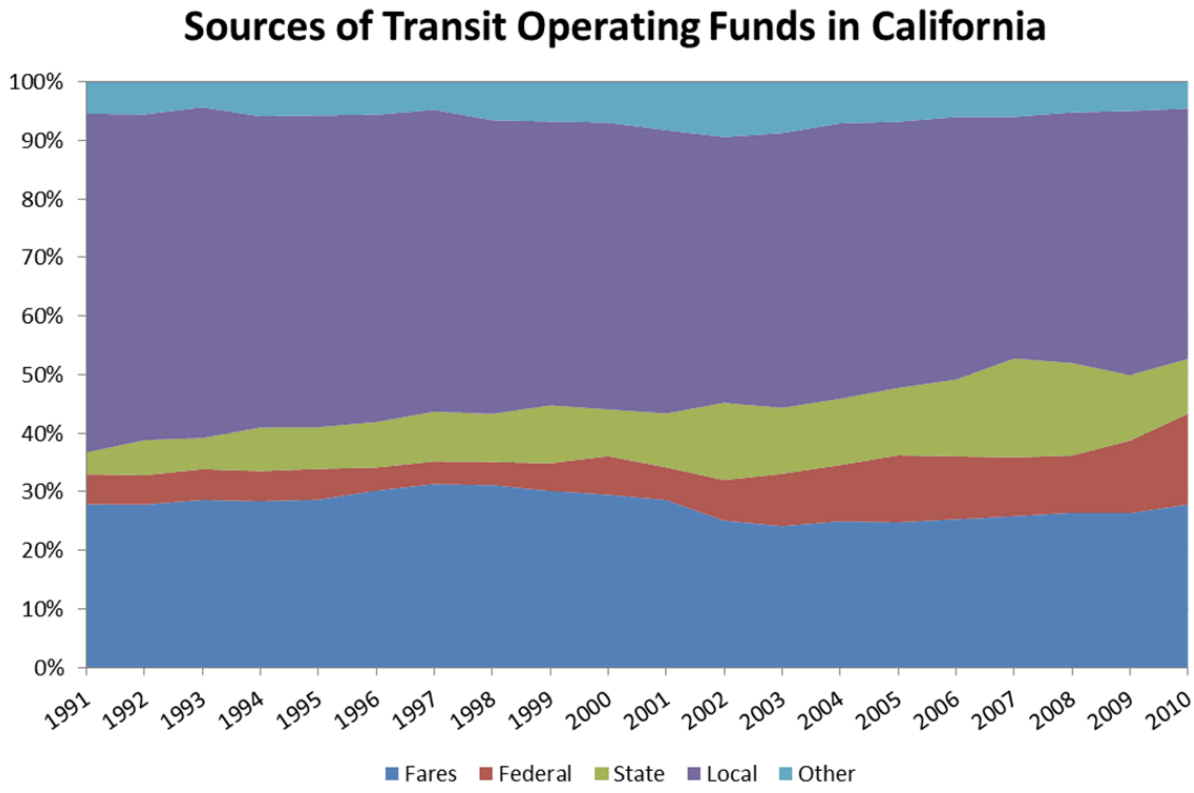

Fig 23. Local governments foot the largest bill to operate transit (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

Over a period of 20 years between 1990 and 2010, California transit agencies' inflation-adjusted operating costs per trip have steadily increased. While inflation-adjusted operating expense per passenger mile travelled has remained fairly constant, the increase in operating expenses has been mainly caused by increase in passenger miles travelled per unlinked passenger trip over the same period. In other words, cost of operating transit has increased due to increased trip lengths.

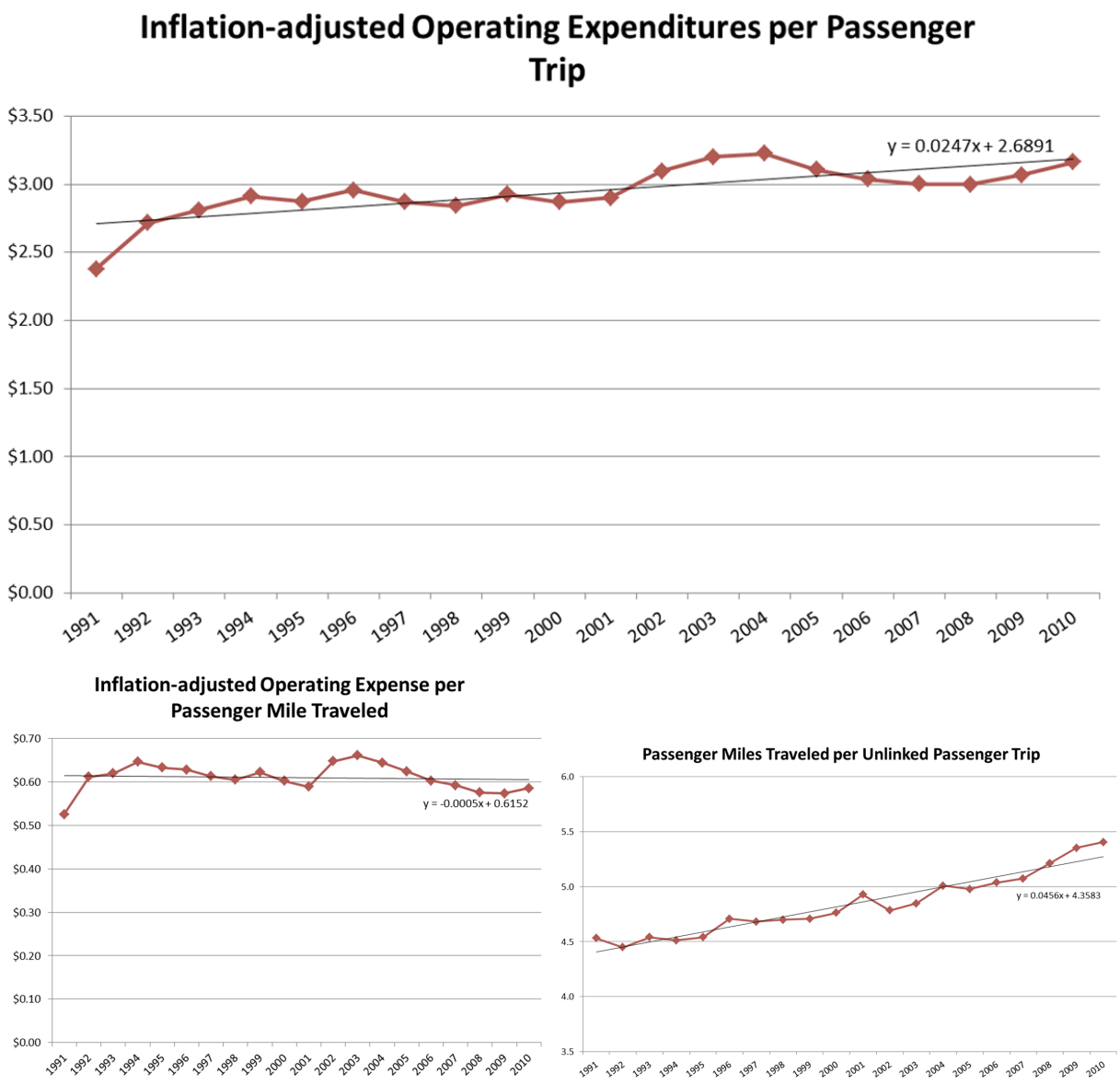

Fig 13. Trends in transit expenditure and passenger miles travelled from 1990 to 2010 (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

Consequently, transit agencies have limited options to increase ridership:

1. Lobby for new sources of funding
2. Increase revenue from existing sources
3. Develop new sources for local funds
4. Reduce the cost of attracting new riders
5. Increase the cost-effectiveness of existing operations

This report focuses on the last two options. Based on that, following are the some of these recommendations:

1. Understand the demographics:

According to the report, growth in transit does not occur uniformly across the state. Some people (high-propensity transit riders) are more likely to choose transit than others depending on demographics, socioeconomics and psychographics. The state and local agencies should try to identify and attract these potential riders to use transit. Caltrans is recommended to commission a statewide market research analysis and create a model on which individual agencies can build when developing local plans.

<table>
<tr><th colspan="3"><- less costly to acquire and maintain ———————— costlier to acquire and maintain -></th></tr>
<tr><th>Existing High-Propensity Transit Users</th><th>New High Propensity Transit Users</th><th>Low-Propensity Transit Users</th></tr>
<tr><td rowspan="4">This category includes current ‘transit-dependent’ users who lack viable alternatives. This can be due to an inability or unwillingness to drive, or lack of regular access to a vehicle. Because these users lack alternatives, they are less sensitive to service quality than other groups.</td><td>New high-propensity transit users will make up the bulk of ridership increases. Individuals may have a high propensity to use transit for three reasons:</td><td rowspan="4">These users generally drive to most of their destinations. However, they may use transit occasionally for trips to parking-constrained neighborhoods or for special events. They might consider carpools and vanpools if the service quality is high.</td></tr>
<tr><td>Economic Motivation:
This group of people may or may not own a vehicle or use transit based on the current and future economic conditions. They make up a large chunk of increase in transit ridership during times of high gas prices.</td></tr>
<tr><td>Demographic Motivation:
This group comprises of people who won’t be able to drive in the near future due to aging and related problems. As median age of the state increases, more people come under this category and ultimately become ‘transit-dependent.</td></tr>
<tr><td>Psychographic Motivation:
This group of people have the economic means and physical ability to own and operate an automobile, but they might prioritize saving or consumption of other goods and services over transportation. Their concerns about environment can also play an important role in their decision to use transit. These ‘choice riders’ have alternatives, so they are more sensitive to service quality than existing high-propensity users.</td></tr>
</table>

Table 4. Sample segmentation of future riders and non-riders (reproduced with changes from California Statewide Transit Strategic Plan) (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

2. **Improve perception**:

According to the report, Caltrans should work with other transit agencies in the state to create a marketing campaign to promote alternatives to single occupant car travel and improve the perception of transit. Ad campaigns by Power and Water agencies have been successful in the past in changing people's behavior. A statewide marketing campaign focused on inducing voluntary behavioral change in transportation to reduce congestion, emissions, and household transportation expenses could have similar effects.

3. **Integrate Planning at various levels:**

Over the past few decades, California has invested heavily in improving and expanding commuter rail. Consequently, commuter rail ridership increased by 390% between 1991 and 2010 while overall transit ridership across all modes increased by only 141% over the same period.

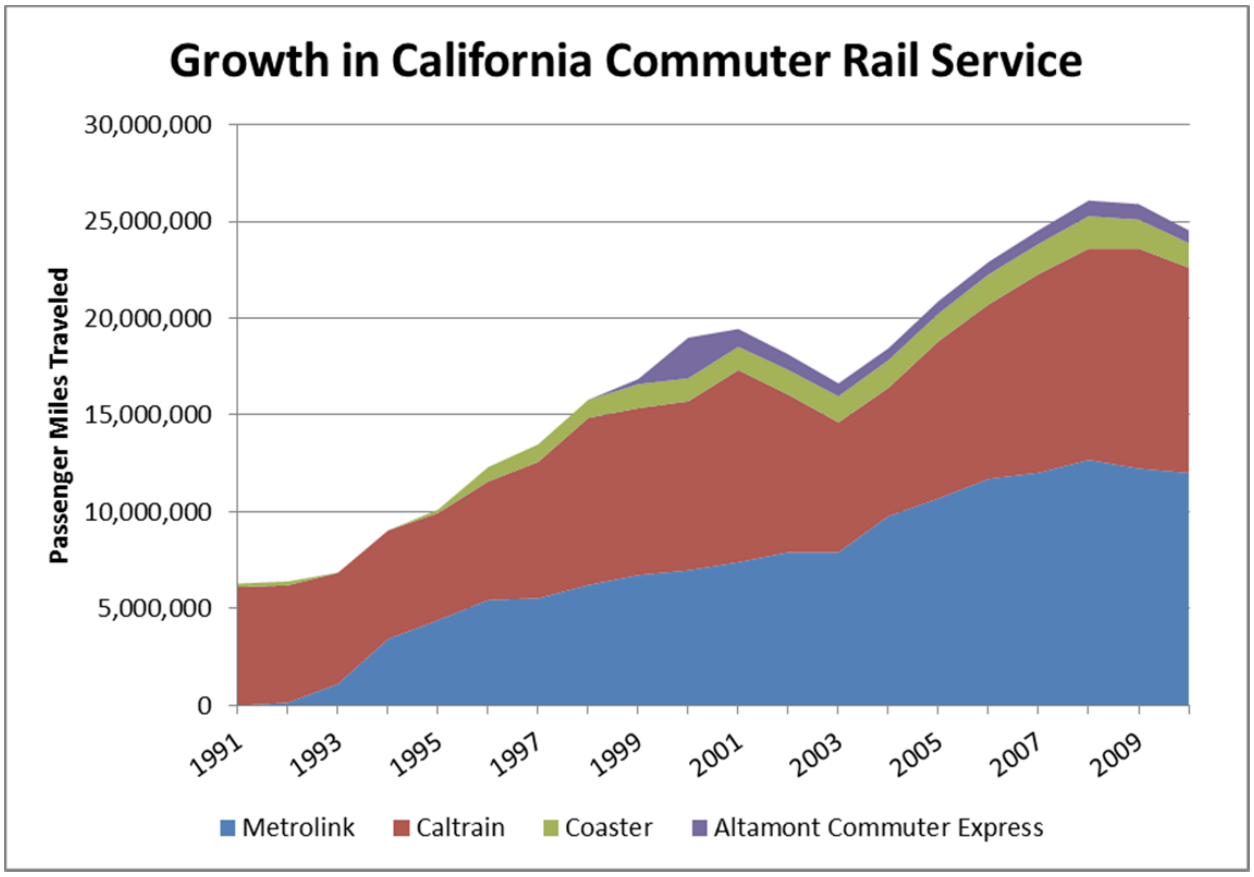

Fig 14. Commuter rail total passenger miles travelled across California from 1991 to 2010 (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

However, planning for commuter rail riders requires coordination between various city and county governments and the state agencies. Also, nearly all commuter rail users use multiple modes for their trip like urban subway or bus, biking, walking etc. So, it is important to integrate planning at local, regional and state levels to provide door to door transit service.

4. Leverage private investment:

Along with public transit, California is also served by private alternatives to automobile travel, mainly intercity bus services like Greyhound and Megabus. According to the report, the state should focus its subsidies on low-volume and less economically feasible routes while letting private intercity bus service providers to service the high-volume routes.

5. Provide statewide expertize:

Caltrans should take initiative to provide statewide expertize and best practices for local agencies. It should fund pilots and other transportation related studies which can help local agencies in better planning and implementation. For example, a study found that real-time arrival information on services like Google Maps was responsible for a small but measurable increase in ridership. Caltrans can help local agencies to take advantage of this technology.

Web based tools	Past Caltrans studies	Possible future studies
<u>Caltrans Funded:</u> • PATH BRT Information Clearing House • Tool for Analyzing Station Characteristics <u>Funded by others:</u> • Fehr & Peers: LOS+, Ridership+	• "State & Federal Project Development Procedures for Bus Rapid Transit: Managing Differences and Reducing Implementation Delays" • "Assess the Trade-Offs between People Through-put and Level of Service Degradation in the Conversion of a Mixed Flow Lane to a Bus Only Lane on US 101" • "Authority for Use of Freeway Shoulders by Transit Buses"	• Best practices for community engagement on bus priority projects. • Study legal ramifications value-capture finance strategy specific to the contemporary California policy landscape. • Statewide evaluation of RFID credit/debit transactions for cash fare payment • Fuel procurement strategies to leverage buying power and reduce fuel price risk • Case study on early implementation of real-time arrival and routing information • Information about how value-added amenities affect ridership (e.g. WiFi service on Santa Clara VTA)

Table 5. Sample of some studies conducted, and tools created by Caltrans and others and some suggestions for the future (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2012)

Private Provision of Shared Transportation Services in California

In recent years, new private companies have entered the market to provide shared transportation services, though they are excluded from the federal definition of public transportation. These companies provide and broker three kinds of services:

1. Inter-city bus services
2. Private shared transportation focused on scheduled commuter trips like employer-provided shuttles and Chariot.
3. Point-to-point on-demand services provided by TNCs, both as a potential alternative to traditional public transit, and a complement to it.

Transportation Network Companies (TNCs)

The introduction of Transportation Network Companies has arguably been one of the most significant transportation developments in decades. Several transportation agencies have partnered with TNCs to support carpooling and provide connections with public transit stations. In the Bay Area, MTC partnered with Lyft to match commuters interested in carpooling, while the Livermore / Amador Valley Transit Authority (LAVTA) partnered with both Lyft and Uber to offer discounts on rides in specific areas. In Southern California, LA Metro has partnered with Uber to discount rides to and from stations along the Exposition Line extension to Santa Monica during its opening. Meanwhile, OCTA has partnered with Lyft to provide discounted rides after discontinuing two bus lines in San Clemente. These partnerships offer further evidence that private companies are impacting the market for public transportation in California.
A growing number of private inter-city bus companies serve an expanding market for travel between major cities in California. In addition to Amtrak Thruway and other federally-funded services, approximately twelve companies provide long-distance travel between cities in and around California. These include five companies with service between greater Los Angeles (LA) and the San Francisco Bay Area, six companies with service between LA and the Las Vegas area, and two companies with service between LA and Mexico.

The California Public Utilities Commission (CPUC) defines a Transportation Network Company (TNC) as “a company or organization operating in California that provides transportation services using an online-enabled platform to connect passengers with drivers using their personal vehicles”. TNCs existed in a legal gray area until September 2013, when the CPUC established the TNC regulatory category and began issuing permits to TNCs. As of October 2016, the CPUC has issued permits to eight TNCs, including four which are specifically licensed to transport children. As drivers must be using a personal car, either owned, leased, or rented, to qualify as a TNC, the category excludes other shared mobility services such as buses, taxis, limousines, and vanpools, although increased technological sophistication is causing these products to resemble TNCs in many ways.

Although the dominant TNCs provide luxury and shared ride options, their core product is an on- demand ridehail by smartphone and provided by private individuals in their own private cars; Uber and Lyft call this service UberX and Lyft, respectively. Uber's service area extends throughout nearly all of California, while Lyft's service areas are clustered around major cities.

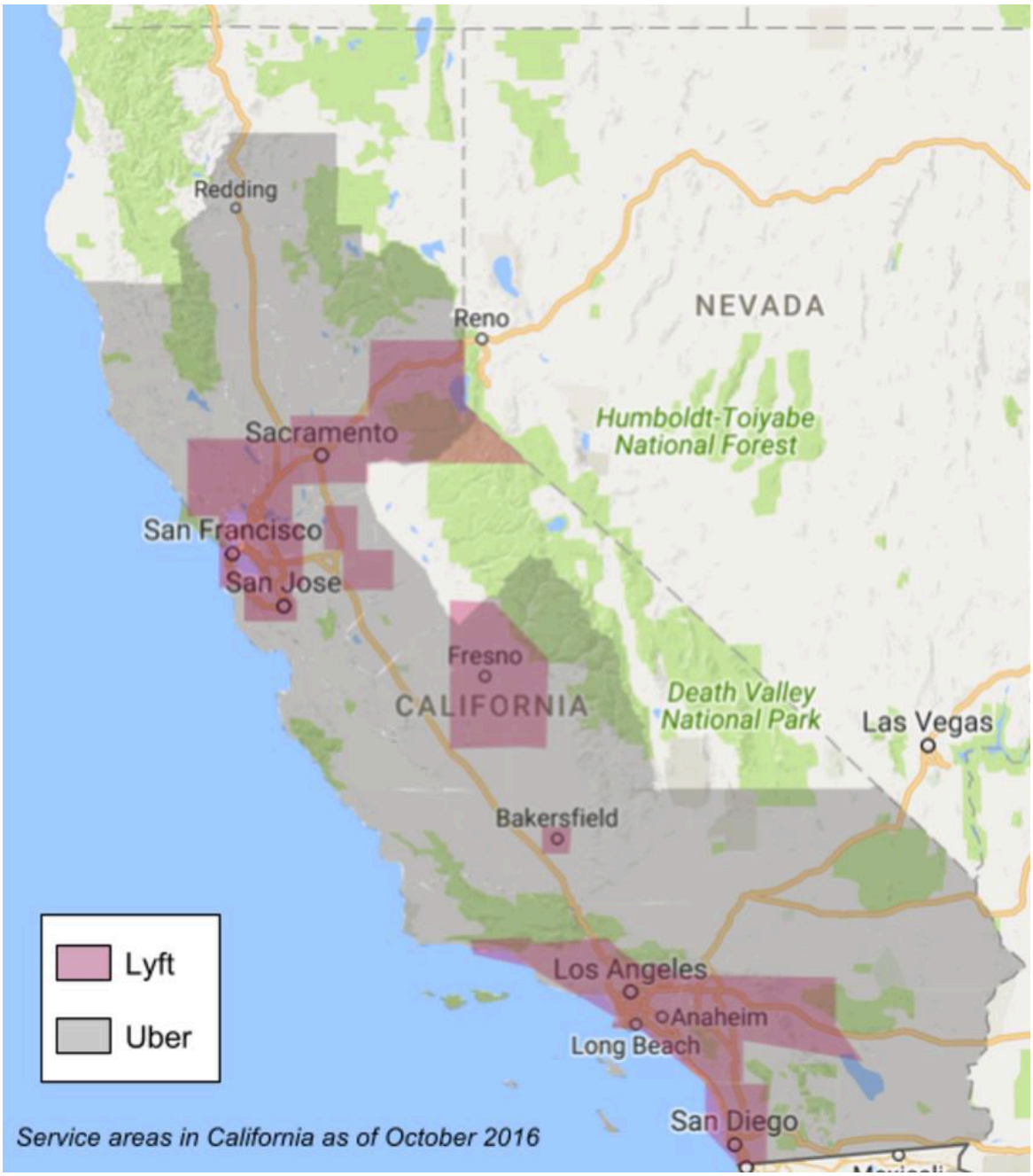

Fig 15. Service areas of Lyft and Uber in California (Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2018)

TNCs can affect public transit in four main ways.

First, TNCs can allow those with limited or no access to private cars to purchase automobility on a per-trip basis. Transit offers per-trip pricing, but without the flexibility of automobility. Some agencies see TNCs as a viable alternative to per-trip services, either low-productivity routes or origin-to-destination services that require flexible routing.

Second, by providing auto-like service for those trips that traditional transit does not serve well, TNCs may make it easier to be carless or car-light in transit-intensive areas, thus encouraging more transit use in the years ahead. It can do this by offering people different mode options for mobility on different legs of a multi-leg journey. For example, someone who takes transit to a bar at 8pm may take a TNC home after midnight when transit offers reduced service.

Third, by partnering to address first and last mile challenges, TNCs could make transit more attractive. Enabling passengers to avoid parking challenges at transit stations while maintaining the flexibility of auto ingress and egress can reduce the need for agency-provided transit stations.

Fourth, TNCs may affect the operations of transit vehicles. In dense urban areas like San Francisco, TNCs may compete for curb space with transit buses or make drop-offs/pickups without pulling out of traffic, slowing all vehicles including buses. This could negatively impact transit speeds and the relative attractiveness of transit versus other mobility options.

Each of these could significantly impact transit patronage in the future.

Many transit agencies in the United States have incorporated transportation network companies (TNCs) or related application-facilitated mobility services into their plans, policies, and marketing strategies. These efforts have largely focused on how TNCs can complement, rather than substitute for, traditional mass transit. Nationwide, public transit ridership has increased as transportation network companies have expanded operations.7 However, this trend may be a result of other factors, and it is unlikely to hold across all locations and time periods. In California, Lyft and Uber have partnered with several transit agencies to offer a variety of service enhancements and modifications.

California agencies have established at least four partnerships with TNCs as of November 2016. Other states are exploring new partnerships as well, particularly in the provision of paratransit services. In September 2016, the Massachusetts Bay Transit Authority (MBTA) partnered with Uber and Lyft to launch a one-year pilot program offering on-demand paratransit. Under this partnership, MBTA subsidizes up to $13 of rides costing $15 or less, ensuring that customers pay $2 for most rides. Additionally, customers can request rides on-demand. Previously, MBTA's RIDE service cost passengers $3.15 per ride and required booking rides one day in advance. Lyft partnered with a local non-emergency medical transportation firm to obtain wheelchair-accessible vehicles for the pilot program, while Uber used existing wheelchair-accessible vehicles in their system as part of their UberASSIST service.

Private Intercity Bus Companies and Routes

Roughly a dozen private companies provide intercity bus services in California. Table 7-2 below outlines some of the most popular services provided by private operators, drawing from the list of services provided in the 2008 *California Statewide Rural Intercity Bus Study* and adding additional services that cater to specific communities. The list was compiled based on a review of California Public Utilities Commission data and internet searches for regularly-scheduled intercity bus service with additional focus on companies serving populations that speak languages other than English.

In general, most of these services connect the major destinations in or near California, including the Los Angeles metropolitan area, the San Francisco Bay Area, Las Vegas, and Mexico. Figure 7-4 below, provided by the *2008 California Statewide Rural Intercity Bus Study*, shows the extent of the statewide network in 2008.

Fig 16. Intercity Bus service in California *(Source: California Statewide Transit Strategic Plan 2012, CalTrans, 2018)*

3.9 California Clean Air Act

The Clean Air Act as amended in 1990 is the primary federal law that governs air quality. This law mandates the U.S. EPA to establish the standards for the concentrations of pollutants that can be in the air. The U.S. EPA must review the standards every five years and revise them as necessary to protect public health and welfare. These standards are called National Ambient Air Quality Standards (NAAQS). Standards have been established for six criteria pollutants that have been linked to health concerns; the criteria pollutants are: carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), particulate matter (PM), lead (Pb), and sulfur dioxide (SO2). The State Implementation Plan (SIP) is the statewide plan for achieving the goals of the Clean Air Act and describes how the NAAQS will be met. The SIP has both statewide and regional components. The California Air Resources Board is responsible for submitting the SIP to the U.S. EPA, and for developing and implementing statewide control measures such as those related to on-road mobile sources (vehicle emission controls). Local air pollution control and air quality management districts (APCD or AQMD) are responsible for regional control measures, which may also include measures that affect mobile sources (e.g., fleet rules, indirect source review requirements).

There is a California Clean Air Act in the Health and Safety Code that is generally similar in concept to the Federal Clean Air Act. Under the California Clean Air Act, the California Air Resources Board sets and updates State air quality standards. The State air quality standards are usually more stringent than the Federal, but the State air quality planning structure does not include the fixed attainment deadlines and conformity process found in the Federal program.

APCD or AQMD perform regional air quality planning in consultation with the MPO, including development of on-road mobile source emission budgets that are part of the SIP required by the Federal Clean Air Act. APCDs and AQMDs are the main implementation agencies for stationary source emission control programs.

The U.S. EPA designates an area as “attainment” if the area meets the NAAQS mandated by the Clean Air Act. If the area does not meet the NAAQS, it is designated as a nonattainment area. The area must then submit an attainment plan showing how the area will meet the NAAQs. Once a nonattainment area attains a NAAQS, the area may develop a maintenance SIP and submit a re-designation request, the U.S. EPA can re-designate the area as a “maintenance” area. The shaded areas on the map below illustrate the areas of the State that have not attained, or have attained with a maintenance SIP, the NAAQS. All of California except Lake County fails to attain one or more of the State ambient air quality standards.

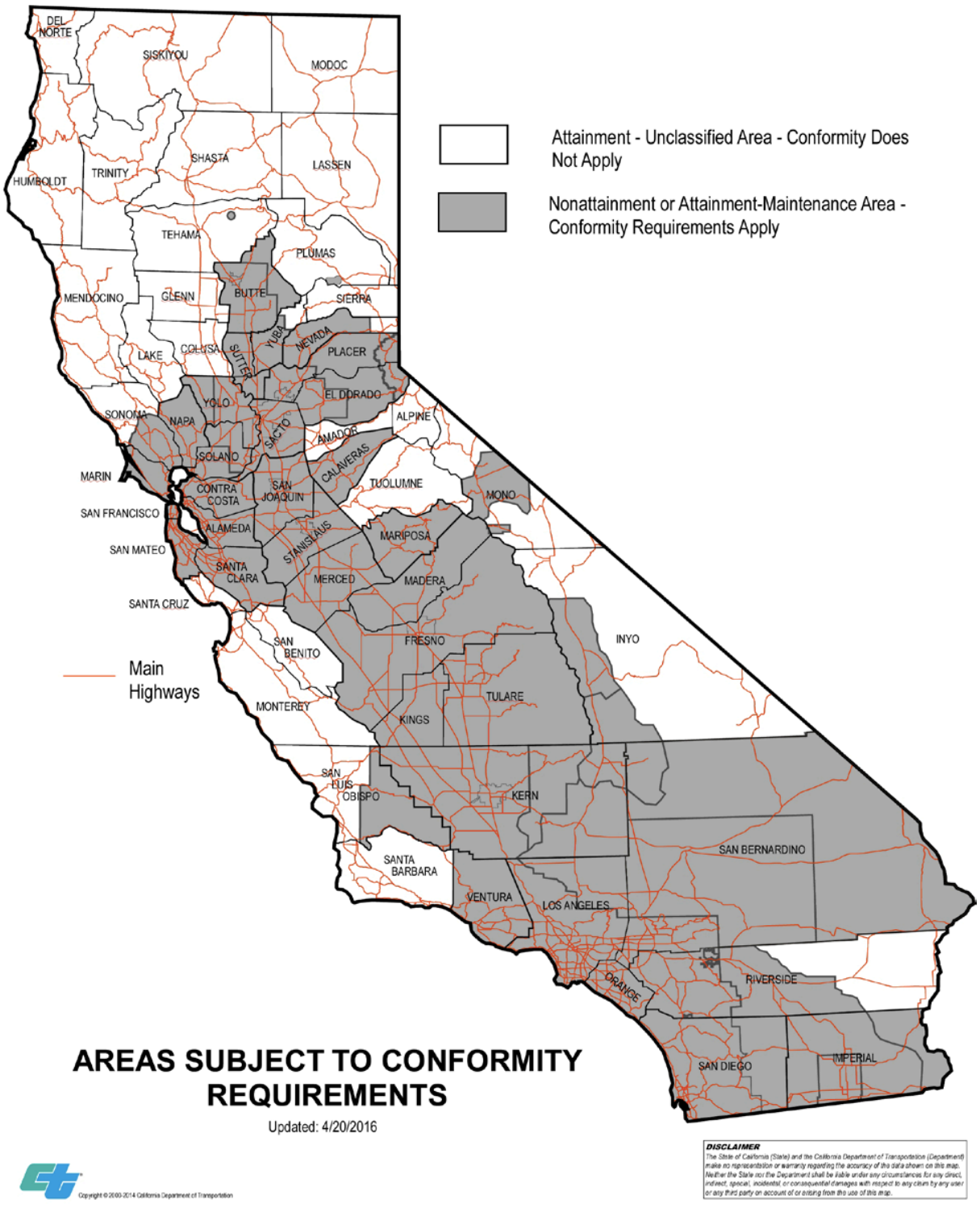

Fig 17. Air Quality 'attainment' and non-attainment' areas in California (Source: Regional Transportation Plan Guidelines for Metropolitan Planning Organizations, CalTrans, 2017)

3.10 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations

Every Metropolitan Planning Organization (MPO) is required by law to conduct long range planning in the form of Regional Transportation Plans (RTPs). RTPs have to follow a number of federal as well as state guidelines but they can be creative to best fit their regional needs. In 2008, California passed a bill called "Sustainable Communities and Climate Protection Act of 2008" (or SB 375) that requires MPOs to also produce a Sustainable Communities Strategy (SCS) that that integrates transportation, land-use and housing policies to plan for achievement of the emissions target for their region. Federal requirements and guidelines come mainly from "Moving Ahead for Progress in the 21st Century (MAP-21)" and "Fixing America's Surface Transportation (FAST)" Acts. RTPs and SCSs are updated every 4 years in non-attainment areas and every 5 years in attainment areas.

3.10.1 RTP

Federal legislation passed in the early 1970's required the formation of an MPO for any urbanized area with a population greater than 50,000. MPOs were created in order to ensure that existing and future expenditures for transportation projects and programs were based on a continuing, cooperative and comprehensive (3-C) planning process. One of the core functions of an MPO is to develop an RTP through the planning process. There are 18 MPOs in California (See Fig 1). The areas not covered by any MPO (mainly in rural northern counties and the counties in Sierra Nevada mountain range) have Regional Transportation Planning Agencies (RTPAs) that are similarly tasked with producing RTPs for their respective regions.

The purpose of RTPs is to encourage and promote the safe and efficient management, operation and development of a regional intermodal transportation system that, when linked with appropriate land use planning, will serve the mobility needs of goods and people. The RTP Guidelines are intended to provide guidance so that MPOs will develop their RTPs to be consistent with federal and state transportation planning requirements. The regional transportation planning led by the MPOs is a collaborative process that is widely participated by the federal, state, local and tribal governments/agencies, as well as other key stakeholders and the general public. The process is designed to foster involvement by all interested parties, such as the business community, California Tribal Governments, community groups, environmental organizations, the general public, and local jurisdictions through a proactive public participation process conducted by the MPO in coordination with the state and transit operators.

Fig 18. MPOs and RTPAs in California (Source: Regional Transportation Plan Guidelines for Metropolitan Planning Organizations, CalTrans, 2017)

While new federal MAP-21/FAST Act requirements are addressed in Section 1.7 of these guidelines, the traditional steps undertaken during the regional planning process include:

1. Providing a long-term (20 year) visioning framework
2. Monitoring existing conditions
3. Forecasting future population and employment growth
4. Assessing projected land uses in the region and identifying major growth corridors
5. Identifying alternatives and needs and analyzing, through detailed planning studies, various transportation improvements
6. Developing alternative capital and operating strategies for people and goods
7. Estimating the impact of the transportation system on air quality within the region
8. Developing a financial plan that covers operating costs, maintenance of the system, system preservation costs, and new capital investments.

The overall scope of the RTP prepared by MPOs has expanded as a result of SB 375 to require the inclusion of a Sustainable Communities Strategy (SCS):

1. Transportation projects, non-auto mobility strategies, and the forecasted development pattern in the RTP must be modeled to determine their impacts on regional GHG emissions. Current travel models are not always sensitive to the land use and transportation strategies in an SCS; therefore, MPOs have had to find alternative methods to quantify the GHG emissions reduction benefits of these strategies. Off-model methods are discussed further in Chapter 3.

2. The RTP must contain an SCS that includes a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if feasible, the GHG emission reduction target approved for the region by the ARB. The MPO will need to coordinate with cities and counties within the region to work towards strategies that will reduce regional GHG emissions.

3. The MPO must prepare an Alternative Planning Strategy (APS) if the SCS is unable to reduce GHG emissions to achieve the GHG emissions reduction targets established by the ARB. The APS shall be a separate document from the RTP, but it may be adopted concurrently with the RTP.

RTP State Goals and Performance Measures

Regional Transportation Plans are developed to reflect regional and local priorities and goals and they are also instruments that can be used by federal and state agencies to demonstrate how regional agency efforts contribute to those federal and state agencies meeting their own transportation system goals. A clear articulation of regional goals helps regions select projects in furtherance of their own goals, but also helps the federal and state government understand how the regional plans will contribute to statewide or nationwide goals. The RTP vision, goals and related performance measures are developed through a bottom-up process that involves input from stakeholders in the region, including the MPO member jurisdictions and the public.

The RTP, including goals and performance measures, are formally adopted at the discretion of the MPO governing board. Some regional performance measures are based on the regional Blueprint plans which were the predecessors of the SCS under SB 375. The number and type of measures that a region chooses can vary widely depending on the region's unique vision, goals and an assessment of feasibility to measure. Tradeoffs between performance measure thresholds should be clearly identified and priorities set to avoid confusion about plan objectives, because some of these measures may compete or conflict with one another. The following are state policies and goals that MPOs are encouraged to use in the development of their performance measures:

- Preserve transportation infrastructure
- Improve mobility and accessibility
- Reduce GHG and improve air quality
- Improve public health, e.g., increase physical activity
- Conserve land and natural resources
- Encourage sustainable land use patterns
- Increase supply of affordable housing
- Improve jobs and housing balance
- Improve mobility and accessibility for low-income and disadvantaged communities
- Support economic development
- Increase safety and security of the transportation system for motorized and non-motorized users

If existing modeling and data are a limitation for some MPOs, qualitative goals may be used instead of quantitative measures. The Policy element of the RTP would include the goals and objectives, and the Action element is what would provide the result/s. For example, the Action element would provide a comparison of what is being measured, how it is measured and the results and analysis of the eventual outcomes. In small urban areas, to support performance-based planning consistent with federal law, developing partnerships with neighboring jurisdictions, and collecting data and information is recommended.

In the context of SB 375, performance measures are essential to assessing and comparing alternative transportation and land use scenarios before selecting the preferred RTP/SCS scenario that, if feasible, not only meets the region's GHG reduction target, but also provides substantive co-benefits while supporting social equity. They are also critical for tracking the progress of an SCS. ARB staff analyzes performance measures that are related to the land use and transportation strategies in the SCS to determine whether they provide supportive, qualitative evidence that the SCS could meet its GHG targets. The more robust the MPO's performance measurement, the better an MPO can substantiate its GHG determinations. MPOs are encouraged to clearly communicate the elements of the SCS (both strategies and investments) that are driving change in the region and resulting in the forecasted outcomes.

RTP Content

RTPs are required to include the following four parts:

1. Policy Element
2. Sustainable Communities Strategy
3. Action Element
4. Financial Element

The Policy Element:

The purpose of the Policy Element is to identify legislative, planning, financial and institutional issues and requirements, as well as any areas of regional consensus. Consider referring to the CTP policy framework which provides goals and policies that can help with development of policies and strategies at the most regional level. The Policy Element presents guidance to decision-makers of the implications, impacts, opportunities, and foreclosed options that will result from implementation of the RTP. Moreover, the Policy Element is a resource for providing input and promoting consistency of action among state, regional and local agencies including; transit agencies, congestion management agencies, employment development departments, the California Highway Patrol, private and public groups, tribal governments, etc. The policy element is required to include following:

1. Describes the transportation issues in the region
2. Identifies and quantifies regional needs expressed within both short and long-range planning horizons
3. Maintains internal consistency with the Financial Element and fund estimates.

The Policy Element should clearly convey the region's transportation policies and supportive strategies and related land use forecast assumptions. These land-use assumptions take into account the latest planning documents and associated policies of the local jurisdictions. As part of this Element, the discussion should: (1) relay how these policies were developed, (2) identify any significant changes in the policies from the previous plans and (3) provide the reason for any changes in policies from previous plans. The Policy Element should clearly describe the SCS strategies, including land use, transportation, and other measure intended to reduce per capita GHG emissions from passenger vehicles. It should also explain how the financial commitments are consistent with and support the land use pattern and personal mobility objectives of the RTP.

The Sustainable Communities Strategy (SCS)

The second component of the RTP (for MPOs only) is a Sustainable Communities Strategy (SCS), as required by SB 375. The SCS is required by law to:
1. Identify the general location of uses, residential densities, and building intensities within the region.

2. Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth.
3. Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region.
4. Identify a transportation network to service the transportation needs of the region.
5. Gather and consider the best practically available scientific information regarding resource areas and farmland in the region.
6. Consider the state housing goals.
7. Utilize the most recent planning assumptions, considering local general plans and other factors.
8. Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the ARB.
9. Provide consistency between the development pattern and allocation of housing units within the region.
10. Allow the regional transportation plan to comply with the federal Clean Air Act.

The Action Element

The third major component required is an Action Element. The Action Element of the RTP must describe the programs and actions necessary to implement the RTP, including the SCS, and assigns implementation responsibilities. The action element may describe the transportation projects proposed to be completed during the RTP plan horizon and must consider congestion management activities within the region. All transportation modes (highways, local streets and roads, mass transportation, rail, maritime, bicycle, pedestrian and aviation facilities and services) are addressed. The action element is critical to providing clear direction about the roles and responsibilities of the MPO and other agencies to follow through on the RTP's policies and projects. It consists of short and long-term activities that address regional transportation issues and needs. In addition, the Action Element should also identify investment strategies, alternatives and project priorities beyond what is already programmed. The Action Element is divided into two sections. The first section includes a discussion of the preparatory activities such as identification of existing needs, assumptions, and forecasting and potential alternative actions. The second section addresses the data and conclusions.

The Financial Element

The Financial Element is also required by law. The Financial Element is fundamental to the development and implementation of the RTP. It identifies the current and anticipated revenue sources and financing techniques available to fund the planned transportation investments described in the Action Element. The intent of the Financial Element is to define realistic financing constraints and opportunities. Finally, with this financing information, alternatives are

developed and used by State and local decision-makers to determine which projects should be planned for funding.

There are six major components that constitute the Financial Element:

1. Summary of costs to operate and maintain the current transportation system
2. Estimate of costs and revenues to implement the projects identified in the Action Plan
3. Inventory of existing and potential transportation funding sources
4. List of candidate projects if funding becomes available
5. Potential funding shortfalls
6. Identification of alternative policy directions that affect the funding of projects.

It is very important that RTPs reflect the transportation needs of the specific region. There are State statutory content requirements for the SCS, Policy, Action and Financial Elements of the RTP, however, there is flexibility in choosing a format for the presentation of this information. Most MPOs/RTPAs use the categories of Policy, Action and Financial to organize their RTP.

Other RTP Contents

The RTP should also include the following:
1. Executive Summary – An Executive Summary of the RTP as an introductory chapter. The Executive Summary should provide a regional perspective and identify the challenges and transportation objectives to be achieved.
2. Reference to regional environmental issues and air quality documentation needs.
3. Discussion of types of potential environmental mitigation activities that might maintain or restore the environment that is affected by the RTP.

The RTP is required to satisfy federal and state clean air acts. California Government also requires that an MPO demonstrate that its SCS would, if implemented, achieve the GHG reduction targets set by California Air Resources Board (CARB). These targets are established for each MPO region, for the years 2020 and 2035. MPOs are required to submit their final SCSs and quantification of the GHG emissions reductions to ARB for review and concurrence with the MPO's determination. If the SCS would not achieve the targets, then the MPO must prepare and adopt an Alternative Planning Strategy, describing the obstacles to achievement of the targets and alternative measures that would need to be taken to achieve the targets. Integration of climate change policies in the RTP coupled with analysis of climate impacts, and mitigation of significant impacts identified in the environmental document, supports the statewide effort to reduce GHG emissions and combat the effects of climate change.

In California, the environmental review associated with the RTP and the subsequent project delivery process is two-fold. MPOs are responsible for the planning contained in the RTP that precedes project delivery. Typically, a local government, consultant or Caltrans is responsible for the actual construction of the project i.e. project delivery. CEQA applies to the planning document (RTP) while both NEPA and CEQA may apply to the individual projects that

implement the RTP during the project delivery process. A change to transportation analysis in environmental review under CEQA occurred with the Governor's approval of SB 743 which requires an update in the metrics of transportation impact used in CEQA from Level of Service and vehicle delay to one that promotes the reduction of GHGs, the development of multimodal transportation networks, and a diversity of land uses for transit priority areas.

Modal Discussion

The RTP is the key document prepared by the MPO that reflects future plans of the transportation system for the region. This future vision includes all modes of transportation and is one of the key functions of the RTP. Both federal regulations and state statute require RTPs to address each transportation mode individually. It is also important for MPOs to integrate modal considerations to enable the development of a complete and connected multimodal transportation system. As modes often overlap (e.g. transit vehicles and private vehicles use the same modes, and people and goods use multiple modes), consider how all transportation modes interact with one another, and how improvements in one mode can benefit the entire transportation system.

SB 375 requires MPOs to meet GHG per capita reduction targets, if feasible. It allows discretion in scenario development. Transportation infrastructure investment, among many other factors, affect travel patterns, mode choice, and VMT. In general, the RTP Guidelines recognize that some studies suggest that investments in roadway capacity tend to cause increases in VMT and GHGs; however, there are exceptions depending on project location and the current transportation network.

Transit

Transit plays a key role in the regional effort to reduce traffic congestion, VMT and vehicle emissions particularly in urbanized areas. The increased use of transit is a key element to meeting legislative requirements such as AB 32 and SB 375 that aim to reduce GHG emissions that contribute to global warming. Transit systems also play an important role in the mobility for those who are unable to drive, including youth and the elderly, as well as low-income individuals, and people with disabilities. Given these reasons, it is crucial for MPOs to engage in a continual and comprehensive dialogue with the transit operators within their region. The CTP highlights the positive impacts of public transportation and suggests the integration of multimodal transportation and land use development which can help establish areas within regions that can be possible locations for Transit Oriented Developments (TODs).

The section of the RTP addressing mass transportation issues (including regional transit services and urban rail systems) is recommended to address:

1. Identification of passenger transit modes within the region (bus, light and heavy rail, etc.)

2. Integration with transit, highway, street and road projects (including identification of priorities)
3. Implementation plans, operational strategies and schedule for future service (including construction and procurement)
4. Operational integration between transit fleets, and other modes (passenger rail, aviation, taxis, etc.)
5. First/last mile transit connectivity considerations
6. Summation of the short and long-range transit plans along with the capital finance plans for the 20-year period of the RTP
7. Short and long-range transit plans and capital finance plans for the 20-year RTP period
8. Inventory of bus fleets by fuel type (diesel, natural gas, and other alternative fuels)
9. Unmet transit needs
10. Urban and commuter rail project priorities
11. ITS elements to increase efficiency, safety and level of service
12. Integration with local land use plans that could increase ridership
13. A measure of transit capacity utilization for peak and off-peak service to evaluate service effectiveness.

In addition, MAP-21/FAST Act added a new requirement for RTPs to also include transportation and transit enhancement activities, including consideration of the role that intercity buses may play in reducing congestion, pollution, and energy consumption in a cost-effective manner and strategies and investments that preserve and enhance intercity bus systems, including systems that are privately owned and operated, including transportation alternatives.

Coordination with Programming Documents

The Federal Transportation Improvement Program (FTIP) is a four-year prioritized listing of federally funded and non-federally funded regionally significant transportation projects that is developed and formally adopted by an MPO as part of the metropolitan transportation planning process. MPOs work cooperatively with public transportation agencies as well as other local, state, and federal agencies to propose projects for inclusion in the FTIP. Each project or project phase in the FTIP must be consistent with the approved RTP. The FTIP must be updated at least every four years.

Projects included in the FTIP may include projects from two other State programming documents: (1) the State Highways Operation and Protection Program (SHOPP), and (2), the State Transportation Improvement Program (STIP). The purpose of the SHOPP program is to maintain safety, operational integrity and rehabilitation of the State Highway System. The STIP is a five-year capital improvement program of transportation projects on and off the State Highway System funded with revenues from the State Highway Account and other sources. Caltrans manages the SHOPP program, while the CTC manages the STIP. The STIP is a five-year document and is updated every other year. The SHOPP is a ten-year document and is adopted by the CTC in August of each odd numbered year. These two programs are major components of the FTIP.

The Federal Statewide Transportation Improvement Program (FSTIP) is a compilation of the FTIPs prepared by the 18 MPOs. It also includes projects in rural areas of the state not represented by an MPO (Caltrans programs projects in the FSTIP for the rural areas). The FSTIP is prepared by Caltrans and submitted to the FHWA and FTA for approval. The FSTIP covers a four-year period and must be updated at least every four years. States have the option to update more frequently, if desired. Federally funded projects or non-federally funded regionally significant projects cannot be added to the FTIP or FSTIP unless they are included in the RTP.

Congestion Management Process

The RTP is required to describe and identify the transportation system management (TSM) and operations strategies, actions and improvements it will employ to manage and operate the urban freeway system, its corridors and major local parallel arterials for highest or increased productivity. Increased productivity can include all modes, including transit, bicycles, and pedestrians. There may be many ways to increase mobility without increasing GHG emissions. One way may be to improve the efficiency and productivity of the corridor through operational, transit and highway projects. TSM and operations strategies, actions and improvements shall include at a minimum traffic detection, traffic control, incident response and traveler information. Transportation demand strategies shall also be identified and can include, but are not limited to: Pricing, Transportation Planning, and Investment Strategies. Section 6.28 and Appendix L of the Guidelines contain additional information on strategies that can be used to manage congestion and reduce regional GHG emissions. The approach to TSM and operations shall be integrated into system planning documents.

Effective with the MAP-21/FAST Act, MPOs serving a TMA may develop a congestion management plan that includes projects and strategies that will be considered in the FTIP. If developed, the MPO shall consult with employers, private and nonprofit providers of public transportation, transportation management organizations, and organizations that provide job access reverse commute projects or job-related services to low-income individuals.

3.10.2 Sustainable Communities Strategies (SCS)

SB 375 instructed the California Air Resources Board (CARB) to set regional emissions' reduction targets from passenger vehicles. The Metropolitan Planning Organization for each region are also required to then develop a "Sustainable Communities Strategy" (SCS) that integrates transportation, land-use and housing policies to plan for achievement of the emissions target for their region. SCS is required to be produced with each revision of Regional Transportation Plan (RTP).

Addressing Housing Needs in the SCS

The passage of SB 375 increased the linkage of the Regional Housing Need Allocation (RHNA) process required by State Housing Element Law with the RTP development and adoption process. Regional Transportation Plans are to be updated at least every four years for nonattainment areas, and every five years for attainment areas unless decided otherwise. Housing element updates are now to be adopted every 8 years for jurisdictions within nonattainment areas, except for those which must update every four years if they fail to adopt their housing element update within 120 days of the due date. Housing elements for jurisdictions within attainment area MPOs not within MPOs are to continue to be adopted every 5 years except in those regions that elect to adopt an RTP every four years. The SCS must accommodate the RHNA and consider the state housing goals. The development pattern of the SCS must consider existing residential zoning obligations to accommodate the RHNA of the current housing element planning period as well as residential density implications for the pending RHNA with which the SCS is being coordinated. The SCS must identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan, taking into account net migration into the region, population growth, household formation, and employment growth.

Unlike the RHNA process which allocates a minimum amount and economic distribution of housing to be accommodated within the housing element planning period, there are not comparable, formal parameters for the entire RTP planning period. The planning period for the RTP is at least 12 years longer than the housing element planning period accommodated in the RTP.

Thus, MPOs should include an analysis within the SCS that looks forward over the entire planning period and reasonably addresses what the housing need may be and where the region can meet its housing needs for all economic segments of the population over the course of the RTP planning period. This analysis should assume a variety of housing types and densities including multi-family densities in each jurisdiction. Documentation to support this analysis should be prepared and may include a narrative description, map, data, or other resources that identifies where within the region this need can be met. Like all planning assumptions, assumptions related to identifying housing needs beyond the RHNA allocation period should be reevaluated each time the RTP is updated.

SCS Transportation System

SB 375 requires that an SCS identify a transportation system to service the transportation needs of the region. While the SCS requirements for the RTP do not change the process used to establish transportation needs for the region, the SCS forecasted development pattern and transportation network, measures, and policies should complement one another to reduce regional GHG emissions from light duty trucks and automobiles. Decisions to expand or modify the transportation system should be made in recognition of the effects of transportation on development location and density, and also in recognition of the following relationships between land use and transportation:

• Transit investments need supporting levels of land use density and intensity.
• The speed of the network and the cost of travel may influence the location choices of new development.
• Placing land uses closer together and minimizing unnecessary barriers to circulation increases travel choices such that transit, walking, and bicycling become viable while also reducing transportation sector energy use and GHG emissions.

The SCS may also include transportation policies designed to reduce GHG emissions such as strategies for Transportation Demand Management (TDM) and Transportation System Management (TSM).

Land Use & Transportation Strategies to Address Regional GHG Emissions

Better land use and transportation strategies will continue to be important to MPOs in developing their RTPs to meet local, regional and statewide mobility and economic needs while meeting the requirements of SB 375 and AB 32 to reduce regional GHG emissions. MPOs can encourage well-designed and sustainable local and regional projects that encourage reductions in GHG emissions by considering and implementing land use and transportation strategies. Following are the suggested methods that may help the MPO to reduce regional GHG emissions.

Land use strategies can include:

- Mixed use, infill, and higher density development projects.
- Public transit incorporated into project design.
- Open space, parks, existing trees, and replacement trees.
- “Brownfields” and other underused property near existing public transportation and jobs developed.
- Pedestrian and bicycle-only streets and plazas within developments.
- Consideration of current and future school sites and needs regarding school-related trips.

Transportation strategies can include:

- Promote ride sharing programs.
- Employer-sponsored shuttle services
- Encourage or use low or zero-emission vehicles
- Create car sharing programs
- Provide shuttle service to public transit
- Incorporate bicycle-friendly intersections into street design
- Create active transportation plans
- A school district may provide bussing to students based on the distance from a school, other hazards to walking to the school, or other district criteria. Consider opportunities to incorporate existing and planned school district busing to supplement and complement public transit options.
- Consider opportunities to protect or improve designated and proposed school district safe routes to school in community wide transportation strategies and investments (e.g. transit improvements bifurcating neighborhoods near schools disrupting pedestrian/bike access).

Social Equity in SCS

The inclusion of the entire range of community interests in the development of the RTP (including the SCS) is a key element in the process and is required by state and federal law. Providing more transportation and mobility choices such as increased transit, bicycle, and pedestrian facilities, as well as appropriate housing choices near job centers increases opportunities for all segments of the population at all income levels. Each MPO is encouraged to develop, enhance, and use visioning tools during the SCS development process enabling the public and policy makers to clearly see social equity impacts of various planning scenarios and make informed choices. Some MPOs include disadvantaged groups that are not defined by the traditional parameters of the low income and minority groups, such as groups identified as disadvantaged due to environmental impacts identified under CalEnvironScreen. Social equity impacts include air quality, access to transit, access to electric vehicle charging, household transportation costs, housing costs and overall housing supply.

3.11 SCAG RTP/SCS 2016

Every Metropolitan Planning Organization (MPO) is required by law to conduct long range planning in the form of Regional Transportation Plans (RTPs). SB 375 instructed the California Air Resources Board (CARB) to set regional emissions' reduction targets from passenger vehicles. The Metropolitan Planning Organization for each region are also required to then develop a "Sustainable Communities Strategy" (SCS) that integrates transportation, land-use and housing policies to plan for achievement of the emissions target for their region. SCS is required to be produced with each revision of Regional Transportation Plan. Currently, there are 18 MPOs in California. One of those MPOs is Southern California Association of Governments (SCAG) that is responsible for long-term transportation policy for the Los Angeles Metropolitan region as well as the surrounding areas that include Orange county, San Bernardino County, Riverside County, Ventura County and Imperial County.

SCAG produces an RTP as well as an SCS every 4 years and the last iteration was the 2016 RTP/SCS report. In order to achieve its regional Greenhouse Gases reduction targets, SCAG has identified expanding and improving transit in the region as one of its most important goals. The 2016 RTP/SCS includes $56.1 billion for capital transit projects and $156.7 billion for operations and maintenance. This includes significant expansions of the Metro subway and Light Rail Transit (LRT) system in Los Angeles County. Meanwhile, new Bus Rapid Transit (BRT) routes will expand higher-speed bus service regionally; new streetcar services will link major destinations in Orange County; and new Metrolink extensions will further connect communities in the Inland Empire. Other extensive improvements are planned for local bus, rapid bus, BRT and express service throughout the region.

To make transit a more attractive and viable option, the 2016 RTP/SCS also supports implementing and expanding transit signal priority; regional and inter-county fare agreements and media; increased bicycle carrying capacity on transit and rail vehicles; real-time passenger information systems to allow travelers to make more informed decisions; and implementing first/last mile strategies to extend the effective reach of transit.

The Plan calls for maintaining the commitments in the 2012 RTP/SCS, including Phase 1 of the California High-Speed Train and the Southern California High-Speed Rail Memorandum of Understanding (MOU), which identifies a candidate project list to improve the Metrolink system and the LOSSAN rail corridor, thereby providing immediate, near-term benefits to the region while laying the groundwork for future integration with California’s High-Speed Train project. These capital projects will bring segments of the regional rail network up to the federally defined speed of 110 miles per hour or greater and help lead to a blended system of rail services.

2016 RTP/SCS Plan also emphasizes the need for Transportation System Management (TSM) improvements. These include extensive advanced ramp metering, enhanced incident management, bottleneck removal to improve flow (e.g., auxiliary lanes), expansion and integration of the traffic signal synchronization network, data collection to monitor system

performance, integrated and dynamic corridor congestion management, and other Intelligent Transportation System (ITS) improvements.

The 2016 RTP/SCS plans for continued progress in developing our regional bikeway network, assumes all local active transportation plans will be implemented, and dedicates resources to maintain and repair thousands of miles of dilapidated sidewalks. The Plan also considers new strategies and approaches. To promote short trips, these include improving sidewalk quality, local bike networks and neighborhood mobility areas. To promote longer regional trips, these strategies include developing a regional greenway network and continuing investments in the regional bikeway network and access to the California Coastal Trail. Active transportation will also be promoted by integrating it with the region's transit system; increasing access to 224 rail, light rail and fixed guideway bus stations; promoting 16 regional corridors that support biking and walking; supporting bike share programs; educating people about the benefits of active transportation for students; and promoting safety campaigns.

Land Use Strategies:

Senate Bill 375 requires that SCAG, as the region's MPO, strive to develop a vision of regional development patterns that integrate with and support planned transportation investments. As part of that mandate, an overall land use pattern has been developed that respects local control, but also incorporates best practices for achieving state-mandated reductions in greenhouse gas emissions through decreases in per capita vehicle miles traveled (VMT) regionally.

The foundational policies, which have guided the development of this Plan's strategies for land use, are:

- Identify regional strategic areas for infill and investment
- Structure the plan on a three-tiered system of centers development
- Develop "Complete Communities"
- Develop nodes on a corridor
- Plan for additional housing and jobs near transit
- Plan for changing demand in types of housing
- Continue to protect stable, existing single-family areas
- Ensure adequate access to open space and preservation of habitat
- Incorporate local input and feedback on future growth.

Based on the above foundational policies, the plan proposes a number of strategies to achieve the land use goals. First strategy proposed is to reflect the changing population and demands. The land use pattern strives to accommodate housing for the changing demographics as well as increasing population of the region. The land use pattern also encourages improvement in the jobs-housing balance to accommodate even more people. This 2016 RTP/SCS reflects a continuation of the shift in demographics and household demand since 2012. This shift is

apparent in the land use development pattern, which assumes a significant increase in small-lot, single-family and multifamily housing that will mostly occur in infill locations near bus corridors and other transit infrastructure. In some cases, the land use pattern assumes that more of these housing types will be built than currently anticipated in local General Plans. This shift in housing type—especially the switch from large-lot to small-lot single-family homes—is already occurring as developers respond to new demands.

The plan instructs the jurisdictions in the SCAG region to continue to be sensitive to the possibility of gentrification and work to employ strategies to mitigate its potential negative community impacts. Generally, the SCAG region will bene t from higher-density in ll development, which means that neighborhoods will be adding to the local housing stock rather than maintaining the current stock and simply changing the residential population. In addition, local jurisdictions are encouraged to pursue the production of permanent affordable housing through deed restrictions or development by non-pro t developers, which will ensure that some units will remain affordable to lower-income households.

The second strategy in the land use plan is to focus new growth around transit. The 2016 RTP/SCS overall land use pattern reinforces the trend of focusing new housing and employment in the region's High-quality transit areas (HQTAs). The overall land use pattern moves new development from areas outside of HQTAs into these areas. SCAG incorporated land use plans provided by local jurisdictions into this pattern. The 2016 RTP/SCS assumes that 46 percent of new housing and 55 percent of new employment locations developed between 2012 and 2040 will be located within HQTAs, which comprise only three percent of the total land area in the SCAG region. HQTAs are a cornerstone of land use planning best practice in the SCAG region because they concentrate roadway repair investments, leverage transit and active transportation investments, reduce regional life cycle infrastructure costs, improve accessibility, avoid greenfield development, create local jobs, and have the potential to improve public health and housing affordability. Here, households have expanded transportation choices with ready access to a multitude of safe and convenient transportation alternatives to driving alone—including walking and biking, taking the bus, light rail, commuter rail, the subway and/or shared mobility options. Households have more direct and easier access to jobs, schools, shopping, healthcare and entertainment, especially as Millennials form households and the senior population increases. Moreover, focusing future growth in HQTAs can provide expanded housing choices that nimbly respond to trends and market demands, encourage adaptive reuse of existing structures, revitalize main streets and increase Complete Street investments.

The third strategy, The Livable Corridors strategy seeks to revitalize commercial strips through integrated transportation and land use planning that results in increased economic activity and improved mobility options. From a land use perspective, Livable Corridors strategies include a special emphasis on fostering collaboration between neighboring jurisdictions to encourage better planning for various land uses, corridor branding, roadway improvements and focusing retail into attractive nodes along a corridor. Livable Corridors should include increased investments in Complete Streets to make these corridors and the intersecting arterials safe for

biking and walking. Livable Corridor strategies include the development of mixed-use retail centers at key nodes along the corridors, increasing neighborhood-oriented retail at more intersections and zoning that allows for the replacement of under-performing auto- oriented strip retail between nodes with higher density residential and employment. These strategies will allow more context sensitive density, improve retail performance, combat blight and improve fiscal outcomes for local communities.

The fourth strategy proposed is to provide more options for shorter trips. Thirty-eight percent of all trips in the SCAG region are less than three miles. The 2016 RTP/SCS includes land use strategies, Complete Streets integration and a set of state and local policies to encourage the use of alternative modes of transportation for short trips in new and existing Neighborhood Mobility Areas and Complete Communities. Land use strategies include pursuing local policies that encourage replacing motor vehicle use with Neighborhood Electric Vehicle (NEV) use. NEVs are a federally designated class of passenger vehicle rated for use on roads with posted speed limits of 35 miles per hour or less. Development of "complete communities" can provide households with a range of mobility options to complete short trips. The 2016 RTP/SCS supports the creation of these mixed-use districts through a concentration of activities with housing, employment, and a mix of retail and services, located in close proximity to each other. Focusing a mix of land uses in strategic growth areas creates complete communities wherein most daily needs can be met within a short distance of home, providing residents with the opportunity to patronize their local area and run daily errands by walking or cycling rather than traveling by automobile.

The plan also proposes following local strategies to reduce VMT and GHG emissions:

- Affordable housing requirements
- Reduced parking requirements
- Adaptive reuse of existing structures
- Density bonuses tied to family housing units such as three- and four- bedroom units
- Mixed-use development standards that include local serving retail
- Increased Complete Streets investments around HQTAs.

4 Local Level Policies

4.1 Introduction

Transit agencies can both reduce GHG emissions from the transportation sector and reduce their own GHG emissions. Transit reduces, or displaces, emissions from other modes of transportation in three ways. First, buses, vans, trains, and ferries can move more people with less fuel compared with private cars. Second, transit service can reduce congestion on roadways and thus reduce emissions from vehicles idling in congested conditions. Third, transit service facilitates compact development patterns that allow people to walk and bike instead of drive, thereby saving energy and reducing emissions. Furthermore, transit agencies can also reduce and minimize their own GHG emissions by using efficient vehicles and alternative fuels, and decreasing the impact of their auxiliary functions such as construction and maintenance. As illustrated in Figure 19, this displacement can be thought of as a "credit" on a ledger, while the emissions produced by transit operations and facilities can be thought of as a "debit".

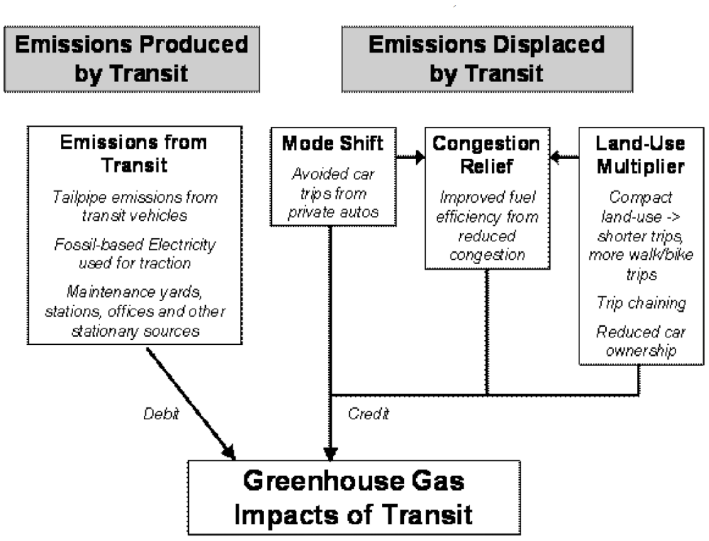

Fig 19: Components of transit's impact on GHG emissions (source: Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit: Draft, APTA Climate Change Standards Working Group, Mar. 2008, p.12)

Transit agencies can pursue specific strategies to achieve reductions in each of these areas. Some strategies reduce GHG emissions through more than one of the four mechanisms.

STRATEGIES	MEASURES
Increase transit ridership	Expanding transit service
	Expanding route Coverage
	Increase service Frequency

	Extending operating hours
Increase vehicle passenger loads	Improving transit access, comfort and safety
	Improving service speed, reliability and convenience
	Transit information, promotion and incentives
	Optimizing transit routes
Strategies to mitigate congestion	Most transit strategies that mitigate congestion are the same strategies that increase ridership. Transit mitigates congestion primarily through travel mode shift, as removing private vehicles from roadways tends to reduce congestion.
Strategies to promote compact development	Compact development patterns are best planned in conjunction with transit service. Transit agencies can establish TODs on property they own surrounding transit stations and major transit nodes. TOD development should reduce dependency on automobiles, increase the share of trips made by walking and biking, foster safe areas around stations, enhance connection to transit, and provide a mix of land uses.
Vehicle emission reduction strategies	Alternative vehicle and fuel technologies
	Operates and maintenance
Strategies to reduce emissions from construction and maintenance	Reduce emissions embodies in any materials used
	Reduce emissions from on-road transportation of materials, construction, workers, and waste
	Reduce emissions from construction and maintenance equipment
Other energy-efficiency and renewable energy measures	Reduce energy consumption in office building, stations, shelters, and maintenance yards through a variety of energy-saving measures.
	Increase the amount of electricity used from renewable sources.

Table 6: Strategies of transit agencies to reduce GHG emissions (Source: Current Practices in Greenhouse Gas Emissions Savings from Transit: The National Academies Press, Transit Cooperative Research Program, 2010)

Some transit agencies have specific policies in place or are developing policies to reduce GHG emissions. They can be the important drivers to incorporate GHG emissions in decision making. The example policies and initiatives include the following:

- Sustainability policies and programs
- Alternative fuel policies
- Environmental management systems that incorporate GHG policies and reduction strategies
- Climate action plan
- Efforts to comply with state or regional reduction targets
- Joining the APTA (American Public Transportation Association) Sustainability Pilot Program

A handful of transit agencies are helping in pilot APTA's Sustainability Commitment. Signatories to the Commitment will agree to establish goals to reduce GHG emissions. Sample commitments include:
- Reduce your organization's carbon footprint in terms of emissions per passenger mile by ____ percent over baseline by 20__
- Reduce overall carbon emissions of administrative function of organization by ____ percent over baseline
- Reduce electricity use by ____ percent over baseline
- Reduce fuel use per unlinked passenger trip by ____ percent over baseline by 20__
- Reduce VMT per capita in your community by ____ percent over baseline by 20__

Agencies had actively engaged in discussions with regional stakeholders on climate change issues, which include the following:
- participating in the drafting of city, regional, and state climate action plans and GHG inventories
- Discussing regional transportation plans with MPOs
- Discussing GHG policies and measurement tools with state, regional and local governments

4.1.1 Transit Sustainability Guideline

In 2011, APTA's Sustainable Urban Design Standards Working Group and Climate Change Working Group published a **Transit Sustainability Guideline – Framework for Approaching Sustainability and Overview of Best Practices**. This Recommended Practice introduces guidelines for designing and operating sustainable transit that both reduces a community's environmental footprint from transportation and enhances its quality of life by making travel more enjoyable, affordable and timely.
These guidelines cover a wide spectrum of sustainability in regard to transit. The objectives are as the following:

- Improving mobility via enjoyable transit services.

- Creating livable communities through facilitating more environmentally friendly forms of mobility, such as walking, biking, and public transit, and increasing the number of routine destinations that are safely and comfortably accessible through these modes.
- Reducing per capita automobile vehicle miles traveled (VMT).
- Reducing stress, loss of productivity, traffic deaths and injuries, and related health-care costs caused by automobile travel.
- Reducing passenger transportation-generated CO2 and other greenhouse gases.
- Reducing passenger transportation-caused ambient hazards such as noise, pollution, and vibration.

The framework and guidelines introduced in the document are designed to lead to the realization of the above sustainability objectives.
No matter what mode of transit service, they all follow similar sequence of creating, operating and maintaining with four basic elements include: System Route and Transit Mode/Mode; Infrastructure and Facilities; Rolling Stock and Fleet; Operation and Maintenance.
Planning, designing, constructing, and operating a transit system have direct and lasting impact to livability, environmental quality, and economic prosperity of a community. The document defined five sustainability indicators for the industry.

- **Smart land use and livable neighborhood.** The impact of transit agencies' planning, development and operations policies and programs to local and regional land use, mobility and placemaking.
- **Materials and construction/operations optimization.** Material selection, construction and fabrication of transit system physical components. Also includes policies and programs that promote sustainable operations.
- **Energy and resources efficiency.** Power, fuel and water consumption.
- **Quality of ambient environment and health.** Positive riding experience, system cleanliness, sense of safety and security, ambience, placemaking, easy access and navigation.
- **Emissions and pollution control.** Emissions and discharge related to fuel, chemical use, solid waste management, wasterwater, stormwater, and other sources of pollution.

Each transit elements has its unique potential to maximize opportunities for implementing sustainability that can be measure within the five sustainability indicators. The potential can be shown as the following:

		Transit Element			
		System Route, Transit Mode and Node (Section 2)	Infrastructure and Facilities (Section 3)	Rolling Stock/Fleet (Section 4)	Operations and Maintenance (Section 5)
Sustainability Indicator	Smart land use and livable neighborhood	***	**	**	*
	Materials and construction/ operations optimization	*	***	***	***
	Energy and resource efficiency	**	**	**	**
	Quality of ambient environment and health	***	***	***	***
	Emissions and pollution control	*	**	**	***

Implementation opportunity: * Less, ** More, ***Most.

Table 7: Opportunities for Implementing Sustainability Measures

Detailed measures and actions under each transit element are explained in the document. It is summarized as the following:

Transit Element	Sustainability Indicator	Measures
System Route, transit mode and node	Smart land use and livable neighborhood	Partner with planning agencies to create transit-supportive land-use policies (14 actions)
		Promote partnership for transit-oriented development (5 actions)
		Make livable neighborhoods a centerpiece of system planning (9 actions)
		Integrate transit alignments and nodes into neighborhoods through use of appropriate scale (3 actions)
		Encourage intermodal connections and transfers, including non-motorized access (5 actions)
		Optimize parking and reduce long-term automobile dependence (8 actions)

		Engage stakeholders early on in the design and integration process (5 actions)
	Energy and resource efficiency	Consider energy consumption in mode choice (2 actions)
		Design alignment to optimize energy use (2 actions)
		Develop partnership for renewable energy (3 actions)
	Quality of ambient environment and health	Promote healthy modes of transportation (2 actions)
	Emissions and pollution control	Evaluate long-term impact of modal choices
		Design to minimize noise and vibration (5 actions)
Infrastructure	Smart Land use and livable neighborhoods	Integrate transit facilities with neighborhood design along system route (6 actions)
	Materials and construction/operations optimization	Design for service life, durability and flexibility (4 actions)
		Design for material applicability and low maintenance (3 actions)
		Select materials with low embodied energy (i.e. local, recycled, recyclable) (6 actions)
		Incorporate innovative sustainable construction practices (7 actions)
	Energy and resource efficiency	Energy harvesting (7 actions)
		Energy conservation and recovery (11 actions)
		On-site generation (4 actions)
		Consider innovative approaches to energy usage (2 actions)
		Partner with local power utility (4 actions)

	Quality of ambient environment and health	Enhance security and safety (friendly, safe and secure for all demographics) (10 actions)
		Provide inviting spaces (11 actions)
		Provide a comfortable experience (6 actions)
		Implement high-quality wayfinding systems (where and when) (11 actions)
	Emissions and pollution control	Mitigate contaminated areas and brownfields (1 action)
		Control hazardous materials, water effluent and air pollution (5 actions)
		Design for water efficiency and reuse (10 actions)
		Establish greenhouse gas monitoring on facilities (2 actions)
		Implement waste management and recycling procedures (other guidelines and standards) (6 actions)
Rolling stock/fleet	Smart land use and livable neighborhood	Consider vehicle choice in system planning (3 actions)
		Design vehicle and fleet capacities to match transit network size (7 actions)
		Design vehicle with neighborhood and geography in mind (7 actions)
	Materials and construction/operation optimization	Incorporate environmentally preferable materials (14 actions)
		Consider bus-specific preferred materials (one action)
		Consider rail-specific vehicle design and preferred materials (4 actions)

	Energy and resource efficiency	Integrate vehicle design and related systems (2 actions)
		Consider alternate fuels and energy consumption (4 actions)
		Consider operation during design (12 actions)
	Quality of ambient environment and health	Design for pleasant riding (10 actions)
		Enhance bus-specific riding experience (5 actions)
		Enhance the rail-specific riding experience (2 actions)
	Emissions and pollution control	Measure and reduce greenhouse gas emissions from vehicle operation (2 actions)
		Reduce diesel use from fleet operation (one action)
Operations and maintenance	Smart land use and livable neighborhood	Consider livable neighborhood measure for service planning and scheduling (6 actions)
		Optimize type and siting of fueling and maintenance facilities (one action)
	Materials and construction/operations optimization	Policies, programs and organizational management (31 actions)
		Green procurement for maintenance and upgrades (9 actions)
		Paints, solvents and cleaners (4 actions)
		Refrigerants, oils, engine coolant and batteries (2 actions)
	Energy and resource efficiency	Implement energy and water conservation procedures for operations and maintenance (7 actions)

		Improve energy efficiency of operations and lower peak demand (12 actions)
		Use renewable energy resources (2 actions)
	Quality of ambient environment and health	Provide clean and attractive vehicles, stations and transit nodes (6 actions)
		Ensure friendly and courteous service (5 actions)
		Plan for crowd control and monitor riding comfort (10 actions)
		Consider innovative health and safety devices and programs (2 actions)
	Emissions and pollution control	Implement pollution reduction strategies (eliminate, reduce reuse and recycle) (13 actions)
		Enhance facility performance and longevity (3 actions)
		Manage wastewater (3 actions)

Table 8: Guideline of sustainable development for transit agencies

The actions under each category are comprehensive and explicit. The actions can be as simple as “clean tunnels for improved air quality” or “Put sustainability on the agenda of regular staff meetings”. The Guideline provides a practical tool for transit agencies to implement measures and actions that can help achieve their goals on environment, climate change and other sustainable aspects.

4.1.2 Guidelines for climate action plan

Transit has a unique role in climate change planning. Transit agencies have focused on automobile-based strategies such as low-carbon fuels and battery and engine technologies while disregarding the direct and indirect emission reductions attributable to transit, statewide regional Climate Action Plan (CAP) approaches to the transportation sector have undervalued the ability of transit to reduce regional GH emissions. The **Guidelines for Climate Action Planning** was designed to help transit agencies reverse this trend.
While the reasons for engaging in climate action planning can be many, they essentially fall into one of two categories: “you have to” or “you want to”. The first one is externally driven and

refers to the “policy mandates.” For example, the San Francisco Metropolitan Transportation Authority (SFMTA) is undertaking a CAP as a result of adoption of citywide goals for GHG emission reductions. The latter one is internally driven and refers to the “policy direction”. There are many compelling reasons for agency to engage in CAP including demonstrating the environment benefits of transit, improving cost-effectiveness, supporting internal sustainability efforts, demonstrating leadership, and preparing for the effects of climate change.
The scope of an agency’s CAP is primarily determined by the scope of the organization’s operational authority and jurisdictional boundaries. The differences in agency authority and jurisdiction can be illustrated as the following:

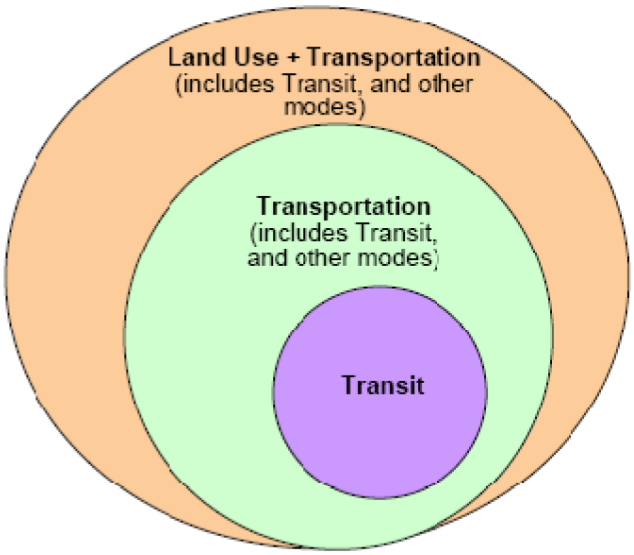

Fig 20: What Authority Does the Agency Have?

Considering this diversity within the industry, there are two basic scales at which transit agencies can undertake:

- Reducing emissions from their own internal operations and facilities, and
- Reducing emissions from the transportation sector at a regional scale through agency operation and regionally coordinated transportation and/or land use strategies.

For most of transit agencies, besides setting targets for reducing their own institutional emissions, they can influence wider range of policy decisions through the interaction with other actors, e.g. regional target setting or other climate planning, land use and development. The planning process can focus on demonstrating the role that transit can play in helping to deliver emission reductions and identifying the resources, partnerships and supporting policies needed to achieve these goals.
In order to that, the partnership are essential. Transit agencies need to identify and engage stakeholders at the beginning of the planning process. These stakeholders will ensure that the CAP strategies are designed and implemented to achieve success.
Another aspect received more and more attention, or we call it the third scoping is the effect of greenhouse gas emission and climate change on the transit. For example, see level rise can

pose threats to infrastructure in low-lying areas. Or changing weather patterns and more intense storm could affect power supply or route availability. The development of climate adaptation plan is necessary in the long run.
The document was structured on a four-step process that is a Plan-Do-Check-Act framework. These steps are to be pursued in a cycle.

Fig 21: The Plan-Do-Check-Act Cycle

The first two strategic planning and options analysis, will result in developing a CAP. The second two, implementation and monitoring and improvement, will ensure that the CAP achieves long-term success. The elements that can make up each stage are as the following:

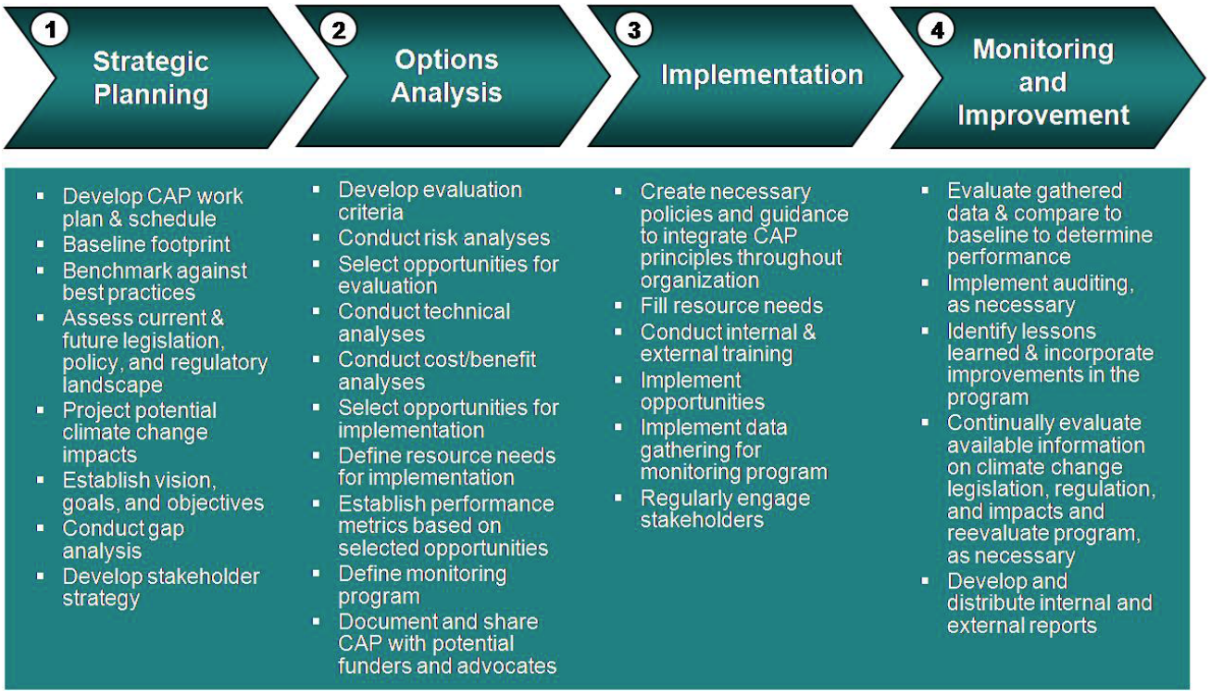

Fig 22: Four Phases of Climate Action Planning

Strategic Planning: build vision to address climate change, ensuring that the vision supports the agency's overall mission. This phase also includes baselining. Developing GHG inventories and baselines will provide the foundation for identifying what it will take to achieve goals and objectives.

One of the keys to the success is to engage stakeholders throughout the CAP process. Internal stakeholders include employees of the transit agency or agencies that develop the plan. External stakeholders include 1) regional partners that implement, regulate or fund programs and projects, e.g. metropolitan planning organizations (MPOs), state and city department of transportation, other transit agencies, state or local housing and development authorities, environmental regulators and water managements districts; and 2) advocates that include NGO, academics and the general public.

The objectives for the CAP should be quantitative and measurable with a preset date of compliance. They should clearly describe an intended outcome and support the achievement of the goals by specifying how the goals will be accomplished.

Taking San Francisco Municipal Transportation Authority (SFMTA) as an example. It set a series of targets across a range of strategies in order to meet a mandated target for emission reductions from the transportation sector. SFMTA has an ambitious GHG reduction goal, 20% of citywide transportation emissions below 1990 levels. The SFMTA established a tracking procedure based upon a set of indicator targets as illustrated in the following. It has target numbers with specific implementation year wherever possible.

Evaluation Category	Indicators *(local or regional transportation targets)*
Operations	• Increase in ridership *(mode share of 30%)* • Reduction in auto/non-transit VMTs *(10% reduction per capita by 2035)* • Reduced need for off-street parking • Conversion of on-street parking to transit, bicycle and pedestrian uses • Reduction in road maintenance • Shorter commute times *(all modes)*
Vehicles	• Reduce transit fleet vehicle emissions *(zero emissions by 2020)* • Increase in number of green vehicle registrations
Facilities	• Increase in energy efficiency and renewable energy *(respectively, 107 MW and 50 MW citywide)* • Provision of infrastructure to support transit and non-transit electric vehicles
Solid Waste and Recycling	• Optimization of waste reduction *(100% diversion by 2020)*
Employee Travel Demand	• Reduction in total VMTs *(at least10% reduction by 2035)*
Construction and Capital Projects	• Diversion of construction and demolition waste from landfills *(100% diversion by 2020)*

Table 9: Examples of Evaluation Categories and Indicator Targets

Options Analysis: Feasibility and suitability phase. Strategies identified as being potentially valuable are evaluated against feasibility factors to determine whether they have a strong business case and will be supported by stakeholders.

Step 1: define criteria: The first step is to consider how to screen, evaluate and prioritize strategies. Some of the key criteria to consider at this stage might include the following:

Evaluation Criteria	Considerations
Primary	
GHG emissions reduction benefit	• GHG per vehicle mile, revenue mile or passenger mile
Technical feasibility	• Certainty of technical advances • Technology readiness • Ease of implementation
Costs: first and life cycle	• Upfront and life cycle capital costs • Long-term O&M costs
Secondary	
Co-benefits	• Cost savings • Reduced energy demand • Reduced criteria pollutant emissions • Public relations • Land use multiplier • Travel choices • Long-term O&M savings
Risks: adaptation and cost	• Climate resilience/adaptation • Certainty of cost estimates
Customer satisfaction (and other key agency criteria)	• Passenger crowding • Passenger comfort (temperature) • Passenger safety and security

Table 10: Examples of Evaluation Criteria and Considerations

Step 2: Identify potential strategies: Assemble a master list of potential GHG reduction strategies.
Step 3: Screen strategies: Assess all the potential GHG emission reduction strategies using the evaluation criteria.

A graphical tools can be used to illustrate how the strategies perform. Following graph illustrate the potential strategies under consideration by Bay Area Rapid Transit (BART) with three parameters, technical feasibility (X-axis), first cost (Y-axis) and GHG reduction (size of circle).

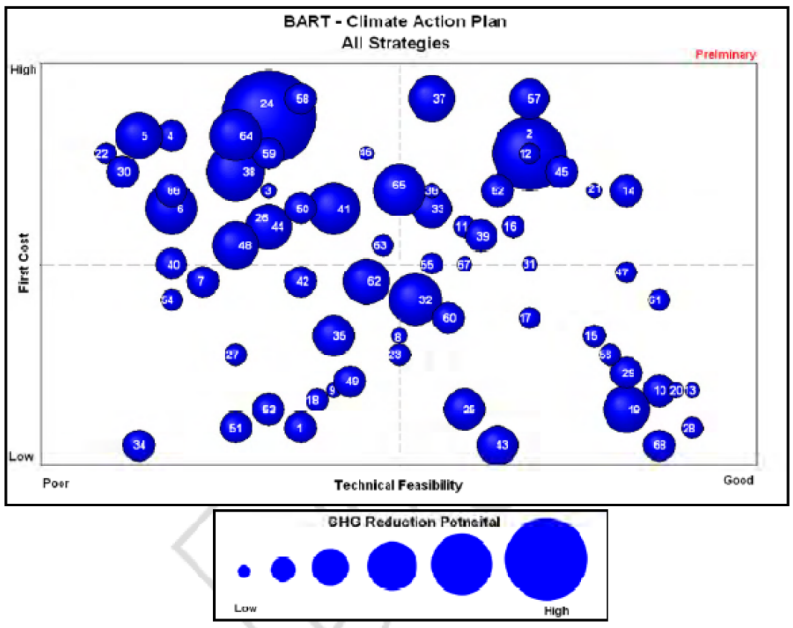

Fig 23: A Visual Way to Evaluate Strategies

Step 4: Detailed strategy development: Refine strategies to better understand their technical feasibility, costs and benefits, including the set of supporting actions that may be needed to implement a strategies.
Step 5: Identify recommended strategies and implementation program: Select top priority strategies that will support the plan's targets and goals. The recommendation should consider short-term strategies that are feasible and can be advanced for funding and implementation right away, as well as medium- and long-term investments that are strategically important but need further research and support.

Implementation: Acting on CAP and putting into place the initiatives and associated data-gathering programs to evaluate performance over time. Following steps are helpful to consider: 1) Create necessary policies and guidance to integrate CAP principles into agency behavior; 2) Fill resource needs; 3) Conduct internal and external training; 4) Implement opportunities; 5) Implement data gathering for monitoring and evaluation program; and 6) Regularly engage stakeholders.

Monitoring and improvement: Establishing feedback loops to provide routine and systematic assess and improve performance. Actions might include: 1) lessons learned and after-action reviews; 2) internal and external reporting; and 3) management review and recalibration.
The guidance presented a number of reasons why agencies should undertake climate action planning, and laid out a framework for approaching such planning. It shows the transit agencies how to identify opportunities for cost savings through resources conservation or investments in more energy-efficient technologies.

4.2 Los Angeles: 50 years of air quality improvements

In April 2016, the American Lung Association (ALA) release its annual State of the Air (SOTA) REPORT, a comprehensive analysis of two of the most prevalent forms of the air pollution-ozone pollution and particle pollution. Not surprisingly, Los Angeles continues to suffer the worst ozone pollution of all US cities and ranks fourth for “year-round particle pollution” and ninth for “short-term particle pollution”. However, what the ranking don’t reflect is the transformation Los Angeles has undergone in improving air pollution levels in the past 50 years. After World War II, economic growth, population growth, rapid suburbanization, and the closing of some public transit systems led to more reliance on personal vehicles for transportation. The number of cars and trucks in the United States increased dramatically, as did the number of highways. One result of the rapid increase of motor vehicles was air pollution, especially in cities, that had serious impacts on public health and the environment. In Donora, Pennsylvania an atmospheric inversion trapped pollutants and killed 20 people (Schenls 1949). In London, in 1952, some 4,000 died in the most famous of all smog disasters. The explosion of a shipload of ammonium nitrate in Texas City, Texas in 1947, was also widely regarded as a related environmental disaster. New York City suffered several smog episodes in 1948, 1963, and 1966 when 168 people died. But it was the West Coast and in particular, Los Angeles, which focused the world’s attention on the “smog” problem. In Smogtown: The Lung-Burning History of Pollution in Los Angeles, journalists Chip Jacobs and William J. Kelly document the rise of this tenacious phenomenon and the various, often-bungled attempts to eradicate it. Jacobs and Kelly date the beginning of Los Angeles' 65-year campaign against smog to July 8, 1943, the day the city was suddenly blanketed in a "harsh, pea-soup London fog." Drivers were blinded. Eyes and throats burned. Rumors spread that the Japanese had launched a chemical attack. The "fume-beast," to use the authors' term, retreated the following day, but it would soon inhabit the city more or less permanently. Smog was at first thought a mere nuisance—visibility reduced, movie shots delayed—as well as a nagging source of civic embarrassment and aesthetic displeasure. But then crops began to wither, residents suffered headaches and nausea, and children struggled to breathe and stay on task at school. The public grew fretful, increasingly so as doctors reported empirical evidence that smog worsened health.

Actually, Los Angeles had started regulating air pollutants, including those from petroleum, as early as 1904 and had some of the strictest laws in the world by 1947. Some $20 million had been spent by local industry but the problem was growing steadily worse. It was obvious that the old smoke abatement remedies were not working, so in 1947, pressured by the Chamber of Commerce and other groups, the city brought in researchers from the Stanford Research Institute. They found that the smog was “a complex mixture of gases, solid particles, and liquid droplets” that reacted photolytically in a bewildering pattern. The source was the 10,500 tons per day of gasoline being burned in the Los Angeles basin (Sawyer 1951). Like most western cities, petroleum and natural gas played a more important role than in eastern cities creating a new set of environmental problems. The quest to confront the murk began with the familiar blundering toward a diagnosis that just about every knotty social issue entails. In fact, science would eventually reveal that the automobile was overwhelmingly the primary contributor. Concrete science was soon to arrive, however. Arie

Haagen-Smit, a Dutch scientist who studied pineapples at the California Institute of Technology, suspected the culprit was oxidation, the process by which metal rusts, and captured smog in a test tube to conduct some experiments. Haagen-Smit concluded that Los Angeles' type of haze, now known as "photochemical smog," forms when nitrogen oxides, mainly from automobile exhaust, react with hydrocarbons, mainly from the incomplete combustion of fossil fuels, in the presence of sunlight to create ozone and other toxic smog constituents. But what nature exacerbates, man has created. An enormous driving population—with roughly 11 million registered cars, Los Angeles has more vehicles per capita than any other city—and scarce options for public transportation have not helped matters. Nor have the region's poorly planned freeways.
The reasons smog exists are arguably the very reasons it has proved so difficult to conquer—a dilemma common to many entrenched social problems. Is it realistic to ask suburbanites who live in developments located miles from centers of employment, and without practical means of mass transit, to stop driving their cars? Does it make sense to expect that politicians, answering to constituents who demand jobs and a solid economy, will tighten the reins on activity at the diesel-spewing ports?

Still, necessity is the mother of legislation, and L.A.'s response, for both good and ill, is more broadly relevant. The city's long reign as the country's top air polluter ultimately forced California to become a bellwether in confronting the issue. As early as 1959, the California Department of Public Health developed the first statewide air-quality standards. In 1967, with the passage of the Federal Air Quality Act, the state lobbied for and received a waiver that allowed it to set and enforce emissions thresholds more rigorous than federal levels. That same year, then-Gov. Ronald Reagan founded the California Air Resources Board, which in its lifetime has instituted a host of significant reforms. In the 1990s, for example, it set new standards, the strictest in the nation, for low-emissions vehicles and cleaner-burning gasoline. During the tenure of progressive Gov. Jerry Brown, the state saw the introduction of the country's first carpool lanes, the first law mandating smog checks for cars, and regulations that required automakers to develop emissions controls. At city and regional levels, in 1945, the City of Los Angeles established the Bureau of Smoke Control in its health department. On October 14, 1947, the Los Angeles County Board of Supervisors established the Los Angeles Country Air Pollution Control District. In 1976, South Coast Air Quality Management District (SCAQMD) were established.

Regional government plays an important role on setting criteria, providing guidance, coordinating and supervising local governments on transportation development that help them meet air quality/climate change targets. There are two important agencies and their respective policies worth mentioning.
South Coast Air Quality Management District is a government agency responsible for the air quality management at greater Los Angeles Region. Its **Air Quality Management Plan** is a regional blueprint for achieving air quality standards and healthful air. Taking 2016 AQMP as an example, it represents a thorough analysis of existing and potential regulatory control options, includes available, proven and cost-effective strategies, and seek to achieve multiple goals in partnership with other entities promoting reductions in greenhouse gases and toxic risk, as well as efficiencies in energy use, transportation, and goods movement.

As required by federal and state law, The Southern California Association of Governments (SCAG), the Metropolitan Planning Organization (MPO) for Southern California, is responsible for ensuring that the regional transportation plan, program, and projects supportive of the goals and objectives of AQMPs/SIPs. SCAG is also required to develop demographic projects and a regional transportation strategy and control measure for the South Coast AQMP/SIP. As MPO, SCAG develops the **Regional Transportation Plan (RTP)/Sustainable Communities Strategy (SCS)** every four years. As mentioned in the previous section, RTP/SCS is a long-range regional transportation plan that provides for the development and integrated management and operation of transportation systems and facilities that will function as an intermodal transportation network for the region.

Metro Countywide Sustainability Planning Policy & Implementation Plan

Since 2008, Metro has conducted a number of studies and planning efforts under the Sustainability Program. The **Metro Countywide Sustainability Planning Policy** is a complement to Metro's efforts to improve air quality and increase transportation choices that have been underway for more than two decades.
The purpose of the Countywide Sustainability Planning Policy is a guide to:

- More fully integrate sustainability into the agency's planning functions.
- Complement and provide a framework for building upon federal, state, regional and local sustainability policies and plans, and
- Foster collaboration and inspire partnership that will lead to more sustainable communities.

The Policy is based on the three themes of "Connect, Create, and Conserve." The themes are the summation of the principles and priorities shown in the following Figure.

Fig 24: Principles and Priorities

The Policy is based on a planning framework that organizes guidance and strategies into two elements: universal and place-based.

Universal Policies

The universal policies have relevance in many locations throughout the county, regardless of accessibility. The Policy summarized the universal policies in the following chart:

POLICY TOPIC	UNIVERSAL POLICY (UP)
Implementation of SCAG Regional Transportation Plan/ Sustainable Communities Strategy (RTP/SCS)	UP I: Promote regional compliance with state climate change law by supporting SCAG's efforts to implement the regionally-adopted, land-use and transportation vision in the Regional Transportation Plan/Sustainable Communities Strategy (outlined below), and encourage local jurisdictions to adopt supportive local policies. (Metro does not have jurisdiction over land-use, but can advance regionally adopted land-use strategies through incentive programs, like TOD planning grants, and supportive transportation investments). a) Support SCAG's efforts to advance the following regionally adopted land-use strategies: i) Focus growth in areas well served by transit (also referred to as High-Quality Transit Areas). ii) Focus growth along main streets, downtowns, and other appropriate infill locations iii) Shift development from single-family towards multi-family residential development to reflect recent market trends, and iv) Promote supportive land use implementation activities, including Compass Blueprint Demonstration projects, which are planning efforts led by local jurisdictions and funded by SCAG b) Support SCAG's efforts to advance the following regionally adopted transportation strategies i) Continue investments to improve the transportation system through 2035 as reflected in the plans of the County Transportation Commissions ii) Implement regional funding strategy to triple the resources available for Active Transportation, as compared to the 2008 Regional Transportation Plan iii) Emphasize and provide additional resources for transportation demand management strategies to reduce solo driving, including carpooling, transit, active transportation, and flexible work schedules iv) Emphasize and provide additional strategies to support improved transportation systems management, including Express Lanes, tolling, and signal synchronization v) Maintain a focus on efficient goods movement to support the growth of the regional economy vi) Advance financial policies that emphasize system preservation to address deferred maintenance and that consider new revenue sources and innovative financing techniques to transition the fuel tax-based system to a more direct, user fee approach. UP II: Draw from the recommendations included in the RTP/SCS to implement appropriate transportation mitigation measures for all projects.
Green Design	UP III: Implement and encourage local incorporation of green design techniques that minimize the environmental impact of transportation projects and/or support local urban greening; consider requiring green design techniques as a condition of funding when these techniques can be implemented with little to no additional cost to project sponsors (i.e. native landscaping).
Vehicle Technology	UP IV: Facilitate the early adoption of zero and near-zero emission vehicles (fleet services, transit vehicles, clean trucks, passenger vehicles) and promote supportive regional and local policies.

Local Access	UP VI: Encourage and support land-use policies and transportation projects that seek to reduce trip lengths by reconnecting the street grid, increasing the mix of land-uses, providing mid-block crossings, incorporating neighborhood traffic calming, reducing set-backs, and breaking up superblocks in new or (re)development projects, among other strategies.
Performance Measurement	UP VII: Pursue alternatives and/or supplements to the use of level of service (LOS) and delay metrics that prioritize mobility for the single occupancy automobile, for project evaluation and encourage regional and local agencies to consider a broader range of metrics to assess multimodal impacts.
System Productivity	UP VIII: Encourage through regional planning, funding policies, infrastructure investments, and promotion of supportive local policies (including parking management policies, road pricing, first/last mile investments, transit preferential treatments, and other demand management and systems management policies/projects) strategies that seek to optimize transit service by increasing its competitiveness with automobiles. UP IX: Incorporate traffic operations system elements into all new highway projects to effectively operate the regions freeway system and coordinate with local transportation management systems. This may include installing equipment along freeways to monitor and manage traffic flows through detection, surveillance, communication, and control equipment, such as loop detectors, CCTV cameras, message signs, and ramp meters and/or promoting highway corridor level operational improvements such as integrated corridor management, congestion pricing, decision support systems, traveler information services, etc. UP X: Support through policy and project development greater utilization of transportation systems management tools that combine traffic engineering measures and traffic operation controls to better manage congestion on surface streets, optimize person throughput, and promote safe and efficient travel for all users of the roadway.
Complete Streets	UP XI: Consistent with state law, explore opportunities through policy and project development to increase access for all users by making streets more "complete" and promote complete streets at the local level through partnerships and incentive programs.
Transit-Oriented Development	UP XII: Pursue opportunities to realize appropriately-scaled, transit-oriented development in rail and bus corridors as part of corridor studies, project development, incentive programs, and the promotion of supportive local policies (TOD Ordinances, land use and zoning changes, General Plan updates, etc).
Virtual Access	UP XIII: Leverage project development to facilitate the early adoption of emerging technologies that complement or even replace conventional travel modes through virtual access, and promote supportive regional and local policies (telecommute programs).

Table 11: Summary of Universal Policies

Place-based Policies

Los Angeles Country has 88 cities. Its size and diversity mean that “one size fits all” approach would not work. “Place types” are used to find solutions that appropriate for each area. It allows planners to categorize a large number of places based on shared characteristics. These characteristics of “accessibility” include net residential density and job centrality. Generally speaking, four clusters are being identified as illustrated below.

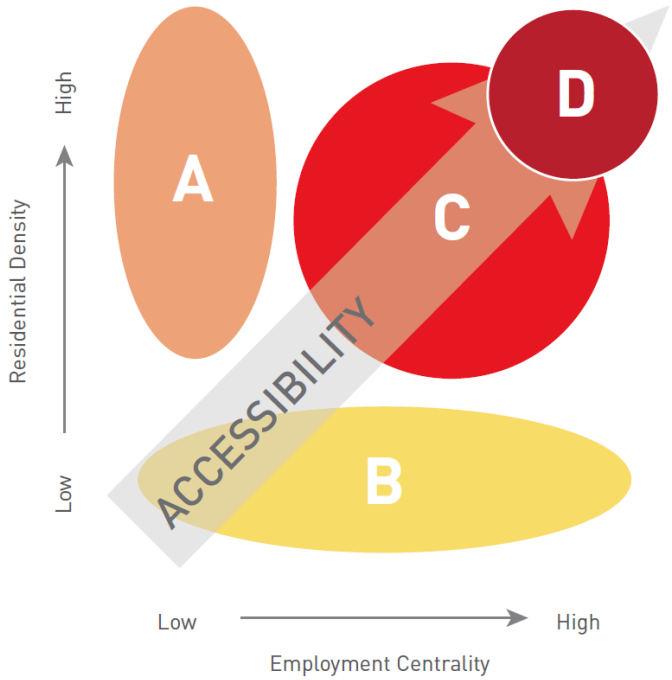

Fig 25: Accessibility Clusters

Different policies are developed for different clusters as the following:
Cluster A: moderate to high residential density with low job centrality. Short trip to local retail and services. Long commutes to work. Low rate of transit ridership. Highest carpool share.

POLICY TOPICS	CLUSTER A: PLACE-BASED POLICIES
Sustainable Transportation	A I: Support use of green modes through development and sponsorship of facilities and services promoting safe active transportation, rideshare, transit, and low impact vehicles.
Local Government Planning	A II: Support local governments in planning and development activities that result in Transit-Oriented Development at select locations and neighborhood-oriented development, focusing on mixed use centers.
Transit Services (Metro, Municipal and Local Transit Providers)	A III: Provide and encourage transit services reflecting area densities and design characteristics, focusing on commute and lifeline services to employment centers, key corridors, and feeder services.
Street Operations	A IV: Implement, encourage and sponsor projects that create safe, attractive, and efficient conditions for active transportation, transit-use, and slow speed vehicles (i.e. roadway design for lower vehicle speeds, installing bicycle parking in the public right-of-way, etc). Encourage integrated trips with transit and active modes. A V: In project development and sponsorship, prioritize efficiency projects that seek to better utilize existing capacity by all modes (i.e. signal timing, complete streets) over increasing capacity.

Table 12: Metro's activities in Cluster A

Cluster B: low housing density. Suburban/Rural communities. Automobile travel is the major means of local mobility. ; Special-Use Areas-Large industrial zones, ports and airports, and open space areas. High job centrality, almost no housing. Mobility needs focusing on goods movement.

Suburban/Rural Communities:

POLICY TOPICS	CLUSTER B: PLACE-BASED POLICIES FOR SUBURBAN/RURAL COMMUNITIES
Sustainable Transportation	B I: Support use of active transportation for local trips and motorized green modes (rideshare, transit, clean fuel vehicles) for longer-distance trips through development and sponsorship of facilities and services.
Local Government Planning	B II: Work with local governments to identify specific transportation needs that can be met with green modes as well as opportunities to improve efficiency and safety of both goods movement and passenger travel. B III: Where greater development is desired, encourage cities to undertake planning exercises in advance of road capacity enhancements to determine the most effective strategies for limiting congestion and providing the transportation choices communities' desire.
Transit Services (Metro, Municipal and Local Transit Providers)	B IV: Provide and encourage transit services reflecting area densities and design characteristics, focusing on lifeline services and commute services to employment centers subregional transportation hubs, and feeder services. Encourage integrated trips with Active Modes.
Street Operations	B V: Implement, encourage, and sponsor projects that create safe, attractive, and efficient conditions for active transportation and transit use (i.e. roadway design for lower vehicle speeds, installing bicycle parking in the public right-of-way, etc) and encourage integrated trips with transit and active modes. B VI: In project development and sponsorship, prioritize efficiency projects that seek to better utilize existing capacity by all modes (i.e. signal timing, complete streets) over increasing capacity.

Special-Use Areas:

POLICY TOPICS	CLUSTER B: PLACE-BASED POLICIES FOR SPECIAL USE AREAS (INDUSTRIAL AREAS AND GOODS MOVEMENT CORRIDORS)
Sustainable Transportation	B VII: Support use of motorized green modes (clean fuel vehicles) through development and sponsorship of facilities and services.
Local Government Planning	B VIII: Work with local governments to identify specific transportation needs that can be met with green modes as well as opportunities to improve efficiency and safety of both goods movement and passenger travel. B IX: Where greater development is desired, encourage cities to undertake planning exercises in advance of road capacity enhancements to determine the most effective strategies for limiting congestion and maximizing the efficiency of freight movement.
Transit Services (Metro, Municipal and Local Transit Providers)	B X: Provide and encourage transit services reflecting area densities and design characteristics, focusing on commute services to employment centers and subregional transportation hubs, and feeder services to fixed-guideway transit corridors.
Street Operations	B XI: Implement, encourage, and sponsor projects that give priority to goods movement through designated routes and corridors, while creating safe and efficient conditions for active transportation and transit use to address mobility conflicts in areas adjacent to population centers and nearby communities. B XII: In project development and sponsorship, prioritize efficiency projects that seek to better utilize existing capacity over increasing capacity.

Table 13: Metro's activities in Cluster B

Cluster: Sub-regional centers/neighborhoods/districts. Nearby employment center and high enough residential densities. Relatively short trip lengths, active transportation and transit use possible for a wide range of activities.

POLICY TOPICS	CLUSTER C: PLACE-BASED POLICIES
Sustainable Transportation	C I: Provide mobility options to support car-free and one-car living through development and sponsorship of facilities and services promoting high levels of active transportation and transit use for all types of trips as well as carshare and rideshare.
Local Government Planning	C II: Support local governments in planning and development activities to create transit supportive densities and design features, with a focus on mixed use corridors and districts.
Transit Services (Metro, Municipal and Local Transit Providers)	C III: Provide and encourage local transit coverage, frequency, and reliability within close proximity to homes and businesses and with short headways or timed transfers, all-day; connect local service to high-quality transit investments (Bus Rapid Transit, Light and Heavy Rail) that provide access to destinations across LA County, Southern California, and the State.
Street Operations	C IV: Implement, encourage, and sponsor projects that give priority to transit and active modes except on key segments of through routes and goods movement corridors. C V: Implement, encourage, and sponsor projects that seek to increase the share of transit services operating in exclusive rights of way.

Table 14: Metro's activities in Cluster C

Cluster D: regional centers with concentrated economic, entertainment, and cultural activity. Full range of horizontally- and vertically- mixed land uses with high capacity transit stops and corridors. High levels of congestion.

POLICY TOPICS	CLUSTER D PLACE-BASED POLICY
Sustainable Transportation	D I: Provide mobility options to support car-free and one-car living through development and sponsorship of facilities and services promoting very high levels of active transportation and transit use for all types of trips.
Local Government Planning	D II: Support local governments in planning and development activities resulting in transit supportive densities and design features throughout Cluster D areas.
Transit Services (Metro, Municipal and Local Transit Providers)	D III: Provide and encourage local transit coverage, frequency, and reliability within close proximity to homes and businesses and with short headways or timed transfers, all-day (and potentially night owl service); connect local service to high-quality transit investments (Bus Rapid Transit, Light and Heavy Rail) that provide access to destinations across LA County, Southern California and the State. Encourage appropriate bicycle parking at stations to improve first-last mile connections to transit.
Street Operations	D IV: Implement, encourage, and sponsor projects that give priority to transit and active modes, except on key segments of through routes and goods movement corridors. D V: Implement, encourage, and sponsor projects that seek to increase the share of transit services operating in exclusive right of way.

Table 15: Metro's activities in Cluster D

The policy includes a performance evaluation component that will track progress toward achieving Metro's sustainability and priorities. It has a set of metrics that are monitored annually (e.g. collision and fatalities; and VMT), and another set that are monitored less frequently (e.g. percentage of housing and jobs near transit on a five-year basis).

The **Implementation Plan** is used to provide direction for implementing the countrywide Sustainability Planning Policy. It is focused on Metro actions, but at the same integrate sustainability into the agency's planning functions and foster collaboration and inspire partnerships.

COUNTYWIDE SUSTAINABILITY PLANNING POLICY IMPLEMENTATION PLAN	INITIATION TIMEFRAME	PARTICIPANTS
1. Performance Measurement and Monitoring		
1.1 Develop/Refine Sustainability Assessment Tools to evaluate the sustainability of projects and plans.	0-2 year	Countywide Planning
1.2 Include sustainability performance metrics in the Sustainability section of the Short Range Transportation Plan.	0-1 year	Countywide Planning
1.3 Evaluate and report on progress toward achieving sustainability policies and priorities by developing an annual report on the program and countywide performance metrics.	Annual	Countywide Planning
1.4 Include sustainability performance metrics in the Sustainability section of the Long Range Transportation Plan.	Next Cycle	Countywide Planning
1.5 Conduct before and after studies of projects funded through the Call for Projects to quantify impact.	Next Cycle	Countywide Planning, Highway Program
2. Integration of Sustainability Principles into Metro's Planning Functions		
2.1 Strengthen Call for Projects link to Metro's sustainability commitments.	0-1 years	Countywide Planning, Highway Program
2.2 Continue to offer the Transit-Oriented Development Planning Grant Program and provide related technical support and resources to cities and the county, including a model TOD ordinance, to encourage local land use changes that provide transit and sustainability benefits.	0-2 years	Countywide Planning
2.3 Per Board Direction, continue development of an Active Transportation and Design Policy that will advance the Context Sensitivity, Green Modes and Healthy Neighborhoods policy priorities.	0-2 years	Countywide Planning
2.4 Organize staff webinars and briefings, as needed, to highlight trends and promote continuous learning within Countywide Planning, as well as between departments, on sustainability issues.	Ongoing	Countywide Planning, other Departments as applicable
2.5 Per Board Direction, develop a Countywide Safe Routes to School initiative to promote active transportation among school-age children.	1-3 years	Countywide Planning
2.6 Per Board Direction, develop safe routes to transit programs that target families as well as youth, senior, and low-income populations.	1-4 years	Countywide Planning
3. Pilot Projects and Community Partnerships		
3.1 Subject to management and board approval, develop a Sustainable Transportation Demonstration Program to support city partners in implementing innovative capital or operations improvements that apply guidance from the policy. Seek funding from SCAG, AQMD, State Strategic Growth Council, and federal/state grants.	0-2 years	Countywide Planning
3.2 Per Board Resolution, partner with the Department of Public Health and Tree People to develop a Systemwide Urban Greening Plan to improve placemaking, increase environmental stewardship, and create livable streets around transit stations with funds awarded by the State Strategic Growth Council.	0-2 years	Countywide Planning

4. Collaboration / Outreach / Education		
4.1 External: Disseminate information on the policy, associated strategies, and tools to regional stakeholders and the greater public.	0-2 years	Countywide Planning
4.2 Internal: Disseminate information on the policy, associated strategies, and tools for inter- and intra-department coordination and collaboration.	0-2 years	Countywide Planning
4.3 Organize forums and workshops to promote and inform cities, industry professionals, and other stakeholders of best practices in the areas of active transportation, transportation demand management, and other sustainability topics.	Ongoing	Countywide Planning
5. Regional Planning and Policy Development		
5.1 Partner with SCAG to conduct a First-Last Mile Strategic Plan to explore opportunities to increase ridership through access improvements adjacent to transit stops.	0-2	Countywide Planning
5.2 Serve on advisory committees to develop regional policies and plans that seek to implement the 2012 Regional Transportation Plan/Sustainable Communities Strategy	0-4	Countywide Planning
5.3 Continue efforts to coordinate a Countywide Zero-Emissions Truck Collaborative to accelerate market adoption of zero and near-zero vehicles in Los Angeles County.	0-2	Highway Program, Countywide Planning
5.4 Provide leadership for the development of the 2016 Regional Transportation Plan/ Sustainable Communities Strategy by working with SCAG and engaging other County Transportation Commissions to share best practices, advance innovation, and develop coalitions to advocate for greater federal and state funding.	0-4	CEO's Office, Countywide Planning
6. Funding		
6.1 Seek federal, state, and local funds to implement planning guidance and strategies to advance both Metro's sustainability goals and those of the RTP/SCS.	0-4	Countywide Planning
7. Policy Updates		
7.1 Review and consider updates to the policy at least every five years.		Metro Board, Countywide Planning

Table 16: Summary of Implementation Plan

As an authority dedicated to the sustainability of Los Angeles county's people, environment and economy, Metro faces the enormous task ensuring that transportation investments adequately serve a 4.700 square mile are with almost 10 million residents. Metro's Countrywide Sustainability Planning Policy & Implementation Plan uses an innovative approach to reduce congestion and vehicle miles traveled. Addressing actions to improve mobility, the policy emphasized the benefits of "bundling" strategies together. A range of activities from new rail investments to safety programs demonstrate Metro's commitment to action across the spectrum of transportation initiatives.

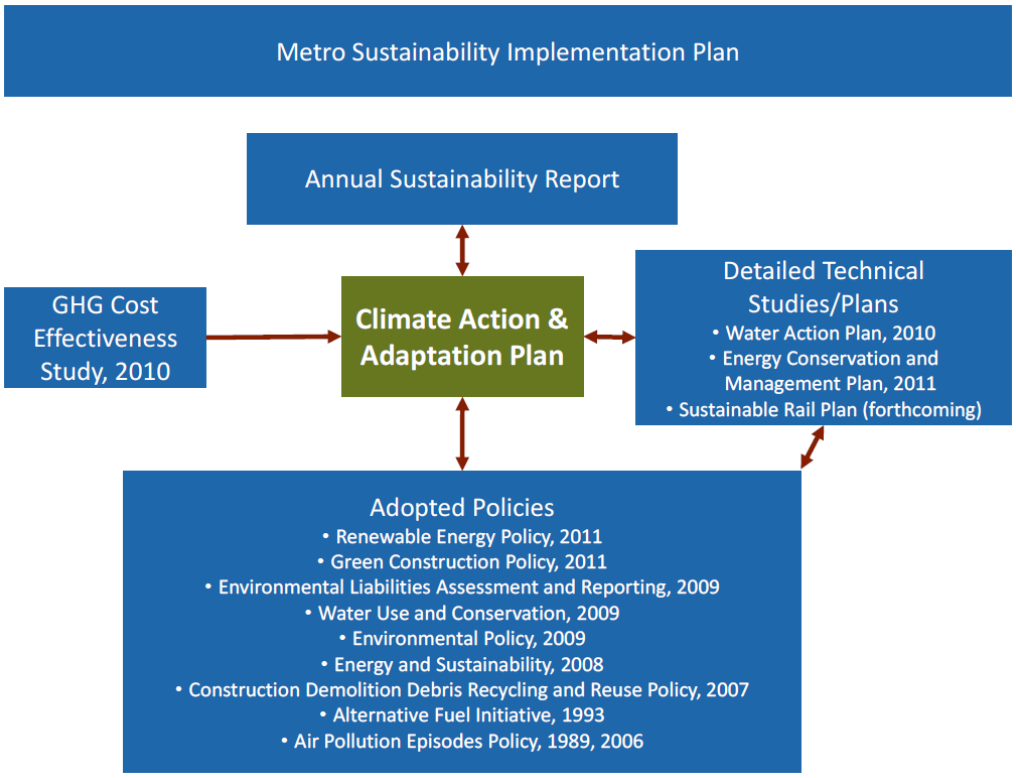

Fig 26: Relationship of the Climate Action and Adaptation Plan to Other Sustainability Initiatives

Since the first edition of Metro Sustainability Implementation Plan in 2008, a series of policies were issued that support the agency's sustainability agenda. Two of related documents mentioned in the above graphic will be introduced in the following.

On August 13, 2007, the Federal Transit Administration (FTA) developed an International Organization for Standardization (ISO) 1400l-based Environmental Management System (EMS). It is a toolbox of management techniques to minimize harm to the environment.

In April 2009, Los Angeles Country Metropolitan Transportation Authority (LACMTA, the Metro), as one of the pilots of EMS program, adopted the **Environmental Policy**. The Policy provides guidance in carrying out the agency's ongoing commitment to provide multi-modal public transit services that greatly improve the quality of the environment in the communities it serves; and its commitment to planning and constructing projects, operating and maintaining facilities and vehicles, and procuring products and services consistent with state and federal laws and regulation and in a manner that protects human health and the environment but not neglecting the efficient delivery of quality public transit services within its financial ability.

The purpose of the policy is to provide guidance in 1) identifying potential environmental impacts generated and developing mitigation measures; 2) operating and maintaining Metro vehicles and facilities to minimize negative impacts on the environment; 3) reducing consumption of natural resources; 4) reducing or eliminating the use of hazardous materials; 5) increasing the amount of recycling and use of recycled projects; and 6) reducing and/or diverting the amount of solid waste going to landfills.

The Policy include a set of 14 commitments that the Metro would follow. Some of the key commitment are as the following:

- Comply with all environmental, federal, state and local laws and regulations;
- Restore the environment by providing mitigation and corrective action and by monitoring to ensure that environmental commitments are implemented;
- Improve ability to manage and account for environmental liabilities and risk;
- Avoid environmental degradation by minimizing releases to air, water and land;
- Encourage and support development of standards that encourage public transit use and environmental protection;
- Ensure that the planning, design, construction and operation of our facilities and services consider environmental protection and sustainable features.

As a result, Metro's Red and Purple Line rail yard recently became the first major rail maintenance facility in the nation to receive ISO 14001 Certification for its environmental management system.

Thanks to a range of legislative, regulative and many other significant reasons, the air quality in Los Angeles has improved dramatically. The city also recognized that fighting air pollution is an ongoing battle. A joint effort of federal, State, regional, local governments and all other stakeholders is the key to the success.

4.3 Portland: Climate Action Champion

The city of Portland, Oregon is often recognized as one of the most environmentally conscious cities in the world. Portland's overarching climate objective is to achieve a 40 percent reduction in carbon emissions by 2030 and 80 percent reduction by 2050 (compared to 1990 levels). Portland became the first local government in the U.S. to adopt a plan for reducing carbon emission, called the Carbon Dioxide Reduction Strategy, and followed eight years later by the joint 2001 Multnomah County-City of Portland Local Action Plan on Global Warming, and then the 2008 Climate Action Plan. These plans supported ambitious carbon-reduction efforts, like public transit expansions and green building policies, which promise to benefit the region's long-term economic, social and environmental prosperity.

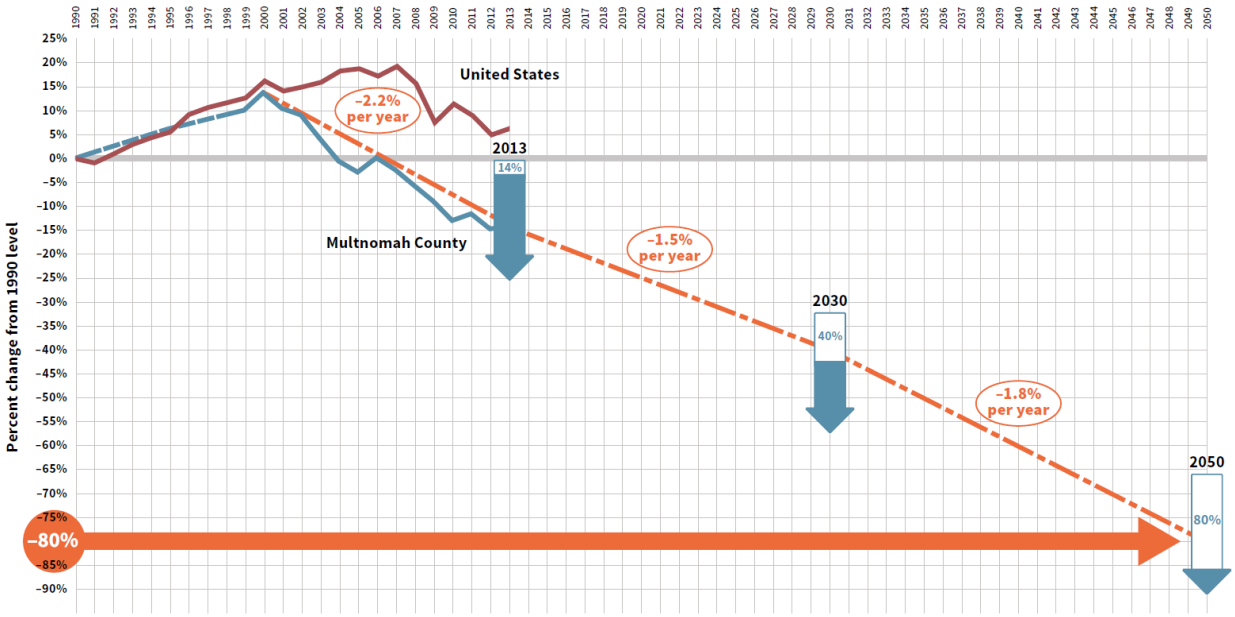

Fig 27: Carbon emission trend and reduction goals.

City of Portland and Multnomah County jointly released its latest Climate Action Plan-local strategies to address climate change in June 2015. In its vision to 2050, there are four major areas being listed include prosperous, connected, healthy and resilient, and equitable. For connected, the future is as the following:

- Access to active transportation options has never been better, including frequent service transit to the city's many employment centers.
- Pedestrians, bicyclists and transit are prominent throughout Portland's vibrant community centers, bustling corridors and diverse neighborhoods.
- Vehicles are highly efficient and run on low-carbon electricity and renewable fuels.

In order to reach the ambitious goals, every sector and every individual must do their part. The projections are as the following:

	1990	2013	Percent Change from 1990	2030	Percent Change from 1990	2050	Percent Change from 1990
Building energy	5,512,000	4,772,000	–13%	3,707,000	–33%	1,112,000	–80%
Transportation	2,979,000	2,830,000	–5%	1,661,000	–44%	655,000	–78%
Waste disposal	498,000	93,000	–81%	40,000	–92%	10,000	–98%
Total	**8,989,460**	**7,695,000**	**–14.4%**	**5,408,000**	**–40%**	**1,777,000**	**–80%**

Table 18: Composition of carbon emission (in metric tons CO2e)

	1990	2013	Percent Change from 1990	2030	Percent Change from 2013	2050	Percent Change from 2013
Population	584,000	766,000	31%	923,000	20%	1,148,000	50%
Per person carbon emissions (metric tons)	15	10	–35%	6	–42%	2	–85%
Natural gas (therms per person)	390	350	–10%	300	–14%	140	–61%
Electricity (kWh per person)	13,000	11,000	–15%	8,630	–20%	4,130	–62%
Passenger miles per day per person	17	17	–1%	12	–29%	6	–64%

Table 19: Budget for a low-carbon future.

For the past years, Portland City and Multnomah Country has made tremendous progress. Those related to transportation include: 1) Since 1990, the Portland region has added and expanded four major rail lines and the Portland Streetcar, as well as over 260 miles of bikeways; 2) About six percent of Portlanders bike to work, nine times the national average, with over 12,000 more people bike commuting today compared to 1990; 3) Transit ridership has almost doubled over the past 20 years, and TriMet provided 100 million rides in 2003.
Since 2000 when local emissions hit highest levels, Multnomah County's emissions have declined. Among other factors, the reductions are due to a combination of: 1) Improved efficiency in buildings, appliances and vehicles, 2) A shift to lower-carbon energy sources, 3) More walking, biking and transit, and 4) Reduced methane emissions from landfills and more recycling.

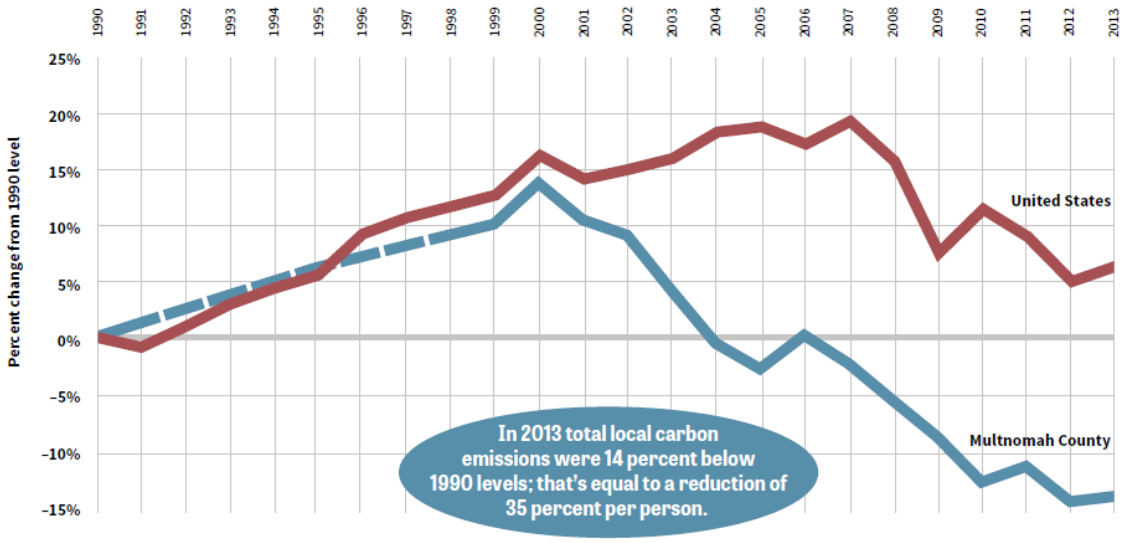

Fig 28: Community carbon emissions (1990-2013).

Transportation of goods and people accounts for nearly 40 percent of Multnomah county carbon emissions. Three factors strongly influence carbon emissions from transportation include: 1) over urban form and shape of the community, including where jobs and housing are located, the presence of parks and open spaces and the location of stores and services; 2) How people and goods move around (e.g., on foot, by bicycle, bus, car or truck); and 3) the fuels used to power transit, cars and trucks (e.g., electricity, biofuels, diesel, gasoline).
The Climate Action Plan identifies twenty 2030 objectives and more than one hundred actions to be completed or significantly underway in the next five years. Under urban form and transportation section, the 2030 objectives and actions (partial, completed by 2020) include:

- 4. Create vibrant neighborhoods where *80* percent of residents can easily walk or bicycle to meet all basic daily, no-work needs and have safe pedestrian or bicycle access to transit. Reduce daily per capita vehicle miles traveled by *30* percent from 2008 levels.
    - 4A: Multimodal Transportation Funding-support a new state multimodal transportation funding source for transit, bicycle and pedestrian services and facilities.
    - 4B: State Transportation Funding-support adoption of a road usage and fuel efficiency charge as long –term replacement for declining gas tax revenue.
    - 4C: City Transportation Funding-Establish a stable funding source adequate to maintain existing system and to invest in transportation capital projects.
    - 4E: Urban Growth Boundary-continue to advocate for growth within the existing Urban Growth Boundary.
    - 4G: 2018 Regional Transportation Plan (RTP)
        - Establish a method for projecting the lifecycle carbon emissions of land use and transportation investment.
        - Align regional mode share targets with carbon reduction targets.
    - Regional Transportation Demand Modal-Refine the regional travel demand model to improve projections of vehicle demand and non-auto mode share.
    - TriMet Service Enhancement Planning-Participate in TriMet's Service Enhancement planning project by providing technical assistance and detailed knowledge of local community development conditions and needs.
    - 4J: Decision Making-Develop and use a transparent and inclusive decision-making framework to be used for infrastructure, transportation, land use, and community development, etc.
    - 4L: Portland Transportation System Plan-In the update of Portland's Transportation System Plan, incorporate:
        - Transportation-related carbon reduction and vehicle-mile-traveled reduction targets.
        - A policy that supports criteria on climate, equity, economic benefit, health, safety and cost effectiveness for project evaluation, development and funding decisions and for performance monitoring.

        - Improved city and regional level of service standards to reflect bicycle, pedestrian and transit needs and urban congestion thresholds.
    - 4M: Citywide Mode Share Targets-Adopt mode share target that are consistent across City bureaus and plans.
    - 4N: Planning Scenario Evaluation-Include estimates of carbon emissions in evaluations of major planning scenarios, Comprehensive Plan and Transportation System Plan decision.
    - 4O: Healthy Connected Neighborhoods- Continue to support development of neighborhoods with walkable and bikeable access and connections to services, nature, transit and destinations.
    - 4Q: Affordable Housing Access to Transit-Use regulatory and voluntary tools to promote affordable and accessible Housing along existing and planned high capacity transit.
    - 4S: Active Transportation-continue sidewalk and bikeway construction.
    - 4T: Bike Sharing-Implement a large-scale public bike sharing program.
    - 4U: Bike Facilities-invest in a network of protected bike facilities to support growing bicycle mode share and provide access to key destinations.
    - 4V: Separated Bike Facilities-Explore establishing separated bikeway facilities, particularly on high-traffic streets.
    - 4W: Neighborhood Greenways-Seek funding to continue building 15 miles per year.
    - 4X: Transit Coverage and Efficiency-Explore joint projects with TriMet to improve transit efficiency, reliability and service.
    - 4Y: Improve Street Connections-Identify impediments to street and sidewalk connections through private development citywide.
    - 4AA: Street Design-Adopt context sensitive street design standards for residential streets.
    - 4BB: Transportation Demand Management-Development and implement comprehensive, culturally appropriate, transportation demand management programs.
        - Integrate TDM standards into Comprehensive Plan code changes for institutional and commercial development
        - Encourage major employers with non-office work shift
        - Promote alternatives to personal vehicle parking, such as car sharing, bike sharing and financial incentives
        - Make data available to improve real-time information
    - 4CC: Portland Parking Strategy-Link parking requirements to mode share targets. Develop parking management policies and programs.
    - 4EE: Car Sharing-Partner with car sharing companies to increase access to vehicles to all communities.

- Improve the efficiency of freight movement within and through the Portland metropolitan area.
- Increase the fuel efficiency of passenger vehicles to 40 miles per gallon and manage the road system to minimize emissions.
- Reduce lifecycle carbon emissions of transportation fuels by 20 percent.

After the Climate Action Plan is in place, the government will develop annual **Climate Action Progress Report** that include the implementation details for all actions. A rating system is used to show where the progress of the action stands, whether it's completed, on track or need more efforts.

	Blue: The action is completed.
	Green: The action is on track for completion by 2020.
	Yellow: The action is in progress, but may face significant obstacles to showing achievement by 2020.
	Red: The action has not yet been started or little progress has been made toward achieving it.

Table 20: Rating System in Climate Action Progress Report

Taking 4L, Portland Transportation System Plan is an example, its progress and status are as the following:

PROGRESS	ACTION TITLE AND DESCRIPTION	STATUS
	4L **Portland Transportation System Plan** — In the update of Portland's Transportation System Plan, incorporate: a) Transportation-related carbon reduction and vehicle-miles-traveled reduction targets. b) A policy that supports criteria on climate, equity, economic benefit, health, safety and cost effectiveness for project evaluation, development and funding decisions and for performance monitoring. c) Improved City and regional level of service standards to reflect bicycle, pedestrian and transit needs and urban congestion thresholds.	In December 2016, City Council adopted the performance objectives for vehicle-miles traveled per capita and transportation-related carbon emissions from the Portland Plan. In June 2016 City Council adopted the Comprehensive Plan goals and policies that support evaluating the multiple outcomes listed in the action item. 2017 TSP work will consider additional performance objectives for consistency with the Regional Transportation Functional Plan (RTFP) and Comprehensive Plan goals
	4M **Citywide Mode Share Targets** — Adopt mode share	2016 City Council adopted daily and commute non-single occupancy vehicle mode share

Fig 29: Example of Progress, Action and Description

As we can see, it is on track and the status include the progress made in 2016 and next steps of work in 2017 and beyond by specific agency/organization.

Guided by Portland Climate Action Plan and Progress Report, government agencies, related organizations as well as the public all share the same vision, clear of goals for each milestone, understand the roles and responsibilities of each other, and have tools to measure the progress

to make necessary adjustment. We can say that Portland is on track to achieve its goals on climate change.

Since 1990, Portland has welcomed 33 percent more people and 24 percent more jobs while carbon emissions have fallen 41 percent on a per person basis. This trajectory demonstrates that it is possible to achieve significant carbon emission reductions while growing the economy and population.

5 Recommendations:

We have to admit that the public transportation system in the US is still not well developed and sufficiently being used compared to other countries, like China. Passenger transportation is still dominated by passenger vehicles (including cars, trucks, vans, and motorcycles), which account for 86% of passenger-miles traveled. The remaining 14% was handled by planes, trains, and buses. In top 15 cities by number of commuters, only New York (56%), San Francisco (33%), Chicago (27%), Philadelphia (26%) and Los Angeles (11%) have the mode share of transit larger than 10%. Others are all around 2-4%. The mode share of biking is as low as 1% to 2%.

But we also recognize the efforts from different levels of government and other stakeholders on tackling with the challenges from air quality and climate change. The leadership from the federal government, the guidance from State government, and the proactive actions from local agencies provide a systematic approach to promote the sustainable development of public transportation system.

Based on the summarization of policies, guidelines and action plans from federal, state and local levels, we have following recommendations to China.

1. **Set up Quantitative air pollution and GHG reduction target.**
   The target in the government policy or Climate Action Plan needs to be as quantitative as possible. The governments have to set up specific goals for GHG and air pollution reduction. In order for the government to be able to evaluate the targets of metropolitan and/or local government, as well as measure the achievements at the end of the plan implementation, it is important for policy makers to develop quantitative goals in the policy and carbon abatement potential for each individual project. For example, California has set statewide targets for GHG emission reductions for years of 2020, 2030 and 2050. Senate Bill 375 further allowed California ARB to set targets for various regions in California. As a result, all Regional Transportation Plans (RTPs) must show that the region will be able to meet the ARB targets. In the RTP guidelines, State government also recommends technical tools to be used by regional government to make sure the plan is complied with federal and state requirements identified, for evaluating alternative strategies. For example, Travel Demand Models (TDM), California Statewide Travel Demand Model (CSTDM), Visualization Techniques & Sketch Modeling of Scenarios, and EMFAC Model, etc.

2. **Collaborate and actively engage with stakeholders and the public.**
   A transportation policy is usually internally developed by engineers and researchers in the field and approved by related government agencies. But the impact of a transportation policy can range from upper level government agencies to general public. So, it should be a collaborative process, led by responsible agency like MPO, and other key stakeholders in the transportation system. It is very important for the development of polices to be conducted both in coordination and consultation with interested

parties. Coordination is the cooperative development of policies, plans, programs and schedules among agencies and entities in order to achieve general consistency. Consultation means that one or more parties confer with other identified parties in accordance with the established process and, prior to taking actions, consider the view of the other parties and periodically informs them about actions taken.

The policies also need to have extensive public participation process. The required development processes should be designed to foster involvement by all interested parties, such as walking and bicycling representatives, public advocates, transportation advocates, neighborhood and community group, environment advocates and general public, etc. through a proactive public participation process.

3. **Actively integrate transportation with land use.**
   It is commonly agreed that integrating transportation, land use and housing, in the planning process is vital to reduce regional GHG emissions from cars. But the mechanism by which these plans can be integrated is a challenge faced by many countries. As mentioned before, California passed the Sustainable Communities and Climate Protection Act, Senate Bill (SB) 375 in 2008. This law requires MPOs to develop a Sustainable Communities Strategy (SCS) as part of RTP, which identifies policies and strategies to reduce greenhouse gas emissions from passenger vehicles to targets set by the California ARB.

   State government requires that the contents of Policy, Action, Financial, and Sustainable Communities Strategy elements of RTP shall be consistent with one another. That means transportation investments and the forecasted development pattern in the SCS should be complementary and not contradictory.

4. **Develop Long term plan.**
   In 2008, California Legislature passed and Governor Schwarzenegger signed into law Senate Bill (SB) 375 that required MPOs throughout California to improve their long-term Regional Transportation Plan (RTP). The plans represent a shift in long-term planning away from simply a list of transportation projects and toward a strategy for sustainable growth. That's what the 'California Transportation Plan 2040 – Integrating California's Transportation Future' is for. While the CTP 2040 was published just a year ago, the preparation work for CTP 2050 has already begun. 'The Future of Mobility' White Paper highlights current research about key trends and emerging technologies and services, and documents their impacts on California's transportation ecosystem. The results from the White Paper will help to inform and guide policy makers and modelers developing appropriate policies for the next generation.

   Long term Plan might not have specific actions that governments and transportation operators can take in short time. But it provides vision and direction that can help each agency to develop their step-by-step plan. It also provides an opportunity for cross-sector collaboration, like land use, biking/walking, and new technologies, etc.

5. **Consider climate adaptation.**
   The Climate Action Plan should include actions to slow the effects of climate change by reducing carbon emissions (known as “climate mitigation”) as well as actions to prepare for the impacts we will experience (“climate preparation” or “adaptation”). Scientific studies have predicted the impacts of climate change include sea-level rise, storm surge, flooding, pavement deterioration, additional heating and cooling requirements, and many other factors. In Portland’s CAP, it is said that successful climate change preparation must (1) reduce climate-related vulnerabilities for residents and business, and (2) respond to and recover from the impacts when they do occur.

6. **Take Future technology into Consideration at early stage.**
   Transportation system has been evolving rapidly during the past few years. The market is producing new technologies before we even realize their need. These technologies might have deep impact on public transportation system in the short or long term. As government agencies, or transit operators, we need to think ahead to prepare for the potential changes. For example, Caltrans is asking UC Berkeley to draft a Future of Mobility White Paper to discuss the emerging technologies and its implication. The report analyses shared mobility options like carsharing, bikesharing, microtransit, and ride sourcing/transportation network companies. It also includes new technologies like connected and automated vehicles, Information and Communications Technology, Electric vehicles and charging infrastructure, 3D printing, blockchain, mobile apps, and hyperloop, etc. All these technologies might end up changing the future transportation scenario.