- 400 jobs
- Located in the San Joaquin Valley Air Pollution Control District's (SJVAPCD) jurisdiction
- Analysis year 2009

Table 7: Commercial Project Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric Tons/Year CO_2e	Demographic Data	
Area-source emissions	464	Residents	0
Mobile-source emissions	13,889	Jobs	400
Indirect emissions (from CCAR Protocol)	1,477		
Total operational emissions	**15,830**	Service population	400
Operational emissions/SP	**39.6**		

Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).

Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

Specific Plan

If used traditionally with default trip rates and lengths, rather than project-specific (Traffic Analysis Zone-specific) trip rates and lengths, URBEMIS does not work well for specific plan or general plan-sized projects with multiple land use types proposed. However, in all instances, projects of these sizes (several hundred or thousand acres) would be accompanied by a traffic study. Thus, for large planning-level projects, URBEMIS can be used as a calculation tool to easily obtain project-specific mobile-source emissions. The user should follow the steps discussed above; wherein he/she overwrites the default ITE trip rates for each land use type with that needed to make total VMT match that contained in the traffic study. The URBEMIS interface is a simple calculator to combine the traffic study and EMFAC emissions factors for mobile-source CO_2.

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Project Attributes:

- 985 acres
- Total dwelling units: 5,634
- Commercial/Mixed Use: 429 ksf
- Educational: 2,565 ksf
- 14,648 residents
- 3,743 jobs
- Located in Sacramento County (SMAQMD jurisdiction)
- Analysis year 2009

Table 8: Specific Plan Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric Tons/Year CO_2e	Demographic Data	
Area-source emissions	23,273	Residents	14,648
Mobile-source emissions	73,691	Jobs	3,743
Indirect emissions (from CCAR Protocol)	32,744		
Total operational emissions	**129,708**	Service population	18,391
Operational emissions/SP	**7.1**		

Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).

Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

The specific plan example, when compared to the residential or commercial examples, illustrates the benefit of a mixed-use development when you look at CO_2e emissions per resident or job (service population) metric (see definition of service population below in discussion of Normalization/Service Population Metric). Though this particular specific plan is not an example of a true jobs/housing balance, the trend is clear: accommodating residents and jobs in a project is more efficient than residents or jobs alone.

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Stationary- and Area-Source Project Types

GHG emissions from stationary or area sources that require a permit to operate from the air district also contain both direct and indirect sources of emissions. Examples of these types of sources would be fossil fuel power plants, cement plants, landfills, wastewater treatment plants, gas stations, dry cleaners and industrial boilers. All air districts have established procedures and methodologies for projects subject to air district permits to calculate their regulated pollutants. It is anticipated that these same procedures and methodologies could be extended to estimate a permitted facility's GHG calculations. For stationary and area sources that do not require air district permits, the same methodologies used for permitted sources could be used in addition to URBEMIS and CCAR GRP to calculate GHG emissions from these facilities.

Wastewater Treatment Facilities

Direct GHG emissions associated with a proposed waste water treatment plant can be calculated using AP-42 emission factors from Chapter 4.3.5 Evaporative Loss Sources: Waste Water-Greenhouse Gases and the CCAR methodology. In general, most wastewater operations recover CH_4 for energy, or use a flare to convert the CH_4 to CO_2. There are many types of wastewater treatment processes and the potential for GHG emissions from different types of plants varies substantially. There is not one standard set of emission factors that could be used to quantify GHG emissions for a state

"average" treatment plant. Thus, research will need to be conducted on a case-by-case basis to determine the "Fraction Anaerobically Digested" which is a function of the type of treatment process. Indirect emissions from these facilities can be calculated using the CCAR energy use protocols and URBEMIS model for transportation emissions.

Solid Waste Disposal Facilities

Air districts will have emission estimate methodologies established for methane emissions at permitted landfills. In addition, EPA's Landfill Gas Emissions Model (LandGem) and the CCAR methodology could also be used to quantify GHG emissions from landfill off gassing; however, this model requires substantial detail be input. The model uses a decomposition rate equation, where the rate of decay is dependent on the quantity of waste in place and the rate of change over time. This modeling tool is free to the public, but substantial project detail about the operation of the landfill is needed to run the model. Indirect emissions from these facilities can be calculated using the CCAR energy use protocols and URBEMIS model for transportation emissions.

Construction Emissions

GHG emissions would occur during project construction, over a finite time. In addition, a project could result in the loss of GHG sequestration opportunity due primarily to the vegetation removed for construction. URBEMIS should be used to quantify the mass of CO_2 that would occur during the construction of a project for land development projects. Some construction projects would occur over an extended period (up to 20–30 years on a planning horizon for general plan buildout, or 5–10 years to construct a dam, for example). OFFROAD emission factors are contained in URBEMIS for CO_2 emissions from construction equipment. For other types of construction projects, such as roadway construction projects or levee improvement projects, SMAQMD's spreadsheet modeling tool, the Road Construction Emissions Model (RoadMod), should be used. This tool is currently being updated to include CO_2 emissions factors from OFFROAD.

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The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of-life of construction materials would be speculative at the CEQA analysis level. The emissions disclosed will be from construction equipment and worker commutes during the duration of construction activities. Thus, the mass emissions in units of metric tons CO_2e/year should be reported in the environmental document as new emissions.

General Plans

In the short-term, URBEMIS can be used as a calculation tool to model GHG emissions from proposed general plans, but only if data from the traffic study is incorporated into model input. The same methodology applied above in the specific plan example applies to general plans. The CCAR GRP can be used to approximate indirect emissions from

increased energy consumption associated with the proposed plan area. The same models and methodologies discussed previously for wastewater, water supply and solid waste would be used to estimate indirect emissions resulting from buildout of the general plan.

In the longer-term, more complex modeling tools are needed, which would integrate GHG emission sources from land use interaction, such as I-PLACE^{3}S or CTG Energetics' Sustainable Communities Custom Model attempt to do. These models are not currently available to the public and only have applicability in certain areas of the state. It is important that a tool with statewide applicability be used to allow for consistency in project treatment, consideration, and approval under CEQA.

Scenarios

At the general plan level, the baseline used for analyzing most environmental impacts of a general plan update is typically no different from the baseline for other projects. The baseline for most impacts represents the existing conditions, normally on the date the Notice of Preparation is released. Several comparative scenarios could be relevant, depending on the exact methodological approach and significance criteria used for GHG assessment:

- Existing Conditions. The GHG emissions associated with the existing, on-the-ground conditions within the planning area.

- 1990 conditions. The GHG emissions associated with the general plan area in 1990. This is relevant due to the state's AB 32 GHG emission reduction goals' benchmark year of 1990. The GHG-efficiency of 1990 development patterns could be compared to that of the general plan buildout.

- Buildout of the Existing General Plan. The GHG emissions associated with buildout of the existing general plan (without the subject update). This is the no project alternative for the purposes of general plan CEQA analysis.

- Buildout of the Updated General Plan. The GHG emissions associated with buildout of the general plan, as proposed as a part of the subject update. This would include analysis of any changes included as a part of the general plan update for the existing developed portions of the planning area. Many communities include redevelopment and revitalization strategies as a part of the general plan update. The general plan EIR can include assumptions regarding what level and type of land use change could be facilitated by infill and redevelopment. Many jurisdictions wish to provide future projects consistent with these land use change assumptions with some environmental review streamlining. In addition, many communities include transit expansions, pedestrian/bicycle pathway improvements, multi-modal facility construction, travel demand policies, energy efficiency policies, or other measures that could apply to the existing developed area, just as they may apply to any new growth

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areas. Such policies could affect the overall GHG emissions of the built out general plan area.

- Increment between Buildout of Updated General Plan and Existing General Plan Area. There are many important considerations associated with the characterization of the impact of the General Plan update. The actual GHG emissions impact could be described as the difference between buildout under the existing and proposed land use plan (No-Build Alternative). However, the courts have held that an EIR should also analyze the difference between the proposed General Plan and the existing environment (*Environmental Planning & Information Council v. County of El Dorado* (EPIC) (1982) 131 Cal.App.3d 350). At the General Plan level, over the course of buildout, some new land uses are introduced, which could potentially add operational GHG emissions and potentially remove existing sequestration potential. Some properties become vacant and are not redeveloped. Other properties become vacant and then are redeveloped. Communities cannot pretend to understand fully in advance each component of land use change. The programmatic document is the preferred method of environmental analysis. Through this programmatic framework, communities develop buildout assumptions as a part of the General Plan that are normally used as a basis of environmental analysis. For certain aspects of the impact analysis, it becomes important not just to understand how much "new stuff" could be accommodated under the updated General Plan, but also the altered interactions between both "new" and "existing" land uses within the planning area. As addressed elsewhere, there are tools available for use in understanding land use/transportation interactions at the General Plan level. Without the GHG targets established by AB 32, a simple mass comparison of existing conditions to General Plan buildout might be appropriate.

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However, within the current legal context, the GHG efficiency of the updated General Plan becomes the focus of analysis. Some options in this regard include:

- Estimate the GHG emissions associated with all the land uses included within the planning area upon buildout of the General Plan using no project specific information (regional, countywide, or statewide defaults). Estimate GHG emissions using project specific information from the transportation engineer, transportation demand policies, community design elements, energy efficiency requirements, wastewater treatment and other public infrastructure design changes, and other components. Compare these two calculations. Is the second calculation reduced by the percent needed to meet AB 32 goals compared to the first calculation?

- Estimate the GHG emissions associated with the 1990 planning area and the per-capita or per-service population GHG associated with the 1990 planning area. (Many communities are establishing GHG inventories using different tools). Estimate the GHG emissions associated with buildout of the proposed General Plan update and the resulting per-capita or per-service population GHG

emissions. Compare the two calculations. Is the General Plan buildout per-capita or per-service population level greater than the 1990 estimate?

Example General Plan Update: Proposed new growth area

Project Attributes:

- 10,050 single family dwelling units
- 652 multi-family dwelling units
- 136 acres parks
- 2,047 ksf commercial (regional shopping center)
- 2,113 ksf office
- 383 acres industrial park
- 31,293 new residents
- 4,945 new jobs
- Located in Stanislaus County (SJVAPCD jurisdiction)
- Analysis year 2025

Table 9: General Plan Example GHG Emissions Estimates

URBEMIS Output (Project Specific)	Metric CO_2e Tons/Year	Demographic Data	
Construction emissions	12,083*	Residents	31,293
Area-source emissions	45,708		
Mobile-source emissions	263,954	Jobs	4,945
Indirect emissions (from CCAR Protocol)	78,385		
Total operational emissions	**388,046**	Service population	36,238
Operational emissions/SP	**10.7**		

* Approximately 241,656 metric tons CO_2e total at general plan buildout (assumes 20-year buildout period). Construction emissions were not included in total operational emissions.
Notes:
CO_2e = carbon dioxide equivalent; CCAR = California Climate Action Registry; SP = service population (see definition of service population below in discussion of Normalization/Service Population Metric).
Sources: EDAW 2007, ARB 2007b, CCAR 2007, CEC 2000

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Due to the programmatic level of analysis that often occurs at the general plan level, and potential for many relevant GHG emission quantities, it could be preferable to use a qualitative approach. Such an analysis could address the presence of GHG-reducing policy language in the general plan.

Three possible tiers of approaches to addressing GHG mitigation strategies, either as general plan policy, general plan EIR mitigation measures, or both, include:

- Forward planning
- Project toolbox
- Defer to GHG reductions plan

The three basic approaches are described below.

1. Bring reduction strategies into the plan itself. The most effective way for local jurisdictions to achieve GHG emissions reductions in the medium- and long-term is through land use and transportation policies that are built directly into the community planning document. This involves creating land use diagrams and circulation diagrams, along with corresponding descriptive standards, that enable and encourage alternatives to travel and goods movement via cars and trucks. The land use and circulation diagrams provide a general framework for a community where people can conduct their everyday business without necessarily using their cars. The overall community layout expressed as a part of the land use and circulation diagrams is accompanied by a policy and regulatory scheme designed to achieve this community layout. Impact fees, public agency spending, regulations, administrative procedures, incentives, and other techniques are designed to facilitate land use change consistent with the communities' overall vision, as expressed in policy and in the land use diagram. There are many widely used design principles that can be depicted in land use and circulation diagrams and implemented according to narrative objectives, standards, and policies:

- Connectivity. A finely-connected transportation network shortens trip lengths and creates the framework for a community where homes and destinations can be placed close in proximity and along direct routes. A hierarchical or circuitous transportation network can increase trip lengths and create obstacles for walking, bicycling, and transit access. This policy language would likely be found in the Circulation Element.

- Compactness. Compact development, by its nature, can increase the efficiency of infrastructure provision and enable travel modes other than the car. If communities can place the same level of activity in a smaller space, GHG emissions would be reduced concurrently with VMT and avoid unnecessary conversion of open space. This policy language would likely be found in the Land Use Element.

- Diversity. Multiple land use types mixed in proximity around central "nodes" of higher-activity land uses can accommodate travel through means other than a car. The character and overall design of this land use mix is, of course, different from community to community. This policy language would likely be found in the Land Use Element.

- Facilities. Pedestrian, bicycle, and public transportation improvements, planning, and programming are sometimes an afterthought. To get a more GHG-efficient mode share, safe and convenient bike lanes, pedestrian pathways, transit shelters, and other facilities are required to be planned along with the vehicular travel network. This policy language would likely be found in the Circulation Element.

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- Redevelopment. One way to avoid GHG emissions is to facilitate more efficient and economic use of the lands in already-developed portions of a community. Reinvestment in existing neighborhoods and retrofit of existing buildings is appreciably more GHG efficient than greenfield development, and can even result in a net reduction in GHG emissions. This policy language would likely be found in the Conservation or Land Use Element.

- Housing and Employment. Most communities assess current and future economic prospects along with long-range land use planning. Part of the objective for many communities is to encourage the coalescence of a labor force with locally available and appropriate job opportunities. This concept is best known as "jobs-housing balance." This policy language would likely be found in the Housing Element.

- Planning Level Versus Project Level. For transportation-related GHG emissions that local governments can mitigate through land use entitlement authority, the overall community land use strategy and the overall transportation network are the most fruitful areas of focus. The reduction capacity of project-specific mitigation measures is greatly limited if supportive land use and transportation policies are lacking at the community planning level. The regional economic context, of course, provides an important backdrop for land use and transportation policy to address GHG emissions. Within this context, the general plan is the readily available tool for local governments to establish such land use and transportation strategies. This policy language would likely be found in the Land Use and Circulation Elements.

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- Shipping Mode Shift. Locate shipping-intensive land uses in areas with rail access. Some modes of shipping are more GHG-intensive than others. Rail, for example, requires only about 15 to 25 percent of the energy used by trucks to ship freight equivalent distances and involves reduced transportation-related GHG emissions. Cities and counties have little direct control over the method of shipment that any business may choose. Nevertheless, as a part of the general planning process, cities and counties can address constraints on the use of rail for transporting goods. This policy language would likely be found in the Land Use and Circulation Elements.

2. Provide a "toolbox" of strategies after the project site has been selected. In addition to the examples of design principles that are built into the community planning process, communities can offer project applicants a range of tools to reduce GHG emissions. Mitigation strategies are elaborated in detail in Chapter 9.

3. Defer to General Plan implementation measure. Develop and implement a GHG Emissions Reduction Plan. Another option for local governments would be development of an implementation measure as a part of the general plan that outlines an enforceable GHG reduction program. Perhaps the most well known example of this approach is the result of California's Attorney General settlement of the lawsuit brought against San

Bernardino County. The County has agreed to create a 1990 GHG inventory and develop measures to reduce such emissions according to the state's overall goals. Other communities have pursued similar programs (i.e., the City of San Diego, Marin County). Along with the inventories, targets, and example reduction measures, these programs would include quantitative standards for new development; targets for reductions from retrofitting existing development; targets for government operations; fee and spending program for GHG reduction programs; monitoring and reporting; and other elements. The local government itself should serve as a model for GHG reduction plan implementation, by inventorying emissions from government operations and achieving emission reductions in accordance with the plan's standards. An optional climate change element could be added to contain goals, policies, and this implementation strategy, or this could belong in an optional air quality element.

Other Project Types

Air District Rules, Regulations and Air Quality Plans

Air district air quality plans, rules and regulations could have the potential to increase or decrease GHG emissions within their respective jurisdiction. In general, air district air quality plans, rules and regulations act to reduce ozone precursors, criteria air pollutant and toxic air contaminant emissions, which would almost always act to reduce GHG emissions simultaneously. However, this may not always be the case.

Air Quality Plans

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Air districts will have to include GHG emissions analysis as part of their criteria air pollutant and toxic air contaminant air pollutant analysis when considering the adoption of air quality plans and their subsequent rules and regulations needed to implement the plans. Multiple models and methodologies will be needed to accomplish this analysis.

Regional Transportation Plans

Regional transportation plans would also need to be evaluated on a case-by-case basis to determine if a net increase or decrease in GHG emissions would occur. Complex interactions between the roadway network, operating conditions, alternative transportation availability (such as public transit, bicycle pathways, and pedestrian infrastructure), and many other independent parameters specific to a region should be considered. Regional transportation models exist to estimate vehicular emissions associated with regional transportation plans, which includes the ability to estimate GHG emissions.

Normalization/Service Population Metric

The above methodology would provide an estimate of the mass GHG emissions generated by a proposed project, which could be compared to a mass emission threshold. EDAW developed a methodology that would measure a project's overall GHG efficiency

in order to determine if a project is more efficient than the existing statewide average for per capita GHG emissions. The following steps could be employed to estimate the GHG-"efficiency," which may be more directly correlated to the project's ability to help obtain objectives outlined in AB 32, although it relies on establishment of an efficiency-based significance threshold. The subcommittee believes this methodology may eventually be appropriate to evaluate the long-term GHG emissions from a project in the context of meeting AB 32 goals. However, this methodology will need substantially more work and is not considered viable for the interim guidance presented in this white paper.

- Divide the total operational GHG emissions by the Service Population (SP) supported by the project (where SP is defined as the sum of the number of residents and the number of jobs supported by the project). This value should be compared to that of the projected statewide GHG emissions inventory from the applicable end-use sectors (electricity generation, residential, commercial/institutional, and mobile-source) in 1990 divided by the projected statewide SP for the year 2020 (i.e., AB 32 requirements), to determine if the project would conflict with legislative goals.

    - If the project's operational GHG/SP falls below AB 32 requirements, then the project's GHG emissions are less than cumulatively considerable.

    - If the project's operational GHG/SP exceed AB 32 requirements (a substantial contribution), then the project's GHG emissions would conflict with legislative requirements, and the impact would be cumulatively considerable and mitigation would be required where feasible.

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- New stationary and area sources/facilities: calculate GHG emissions using the CCAR GRP. All GHG emissions associated with new stationary or area sources should be treated as a net increase in emissions, and if deemed significant, should be mitigated where feasible.

- Road or levee construction projects or other construction-only projects: calculate GHG emissions using the RoadMod, which will be updated to contain GHG emission factors from EMFAC and OFFROAD. All construction-generated GHG emissions should be treated as a net increase, and if deemed significant, should be mitigated to the extent feasible.

- Air District rulemaking or air quality management plan-type projects should be evaluated on a case-by-case basis for secondary impacts of increased GHG emissions generation. In most cases, the types of projects that act to reduce regional air pollution simultaneously act to reduce GHG emissions, and would be beneficial, but should be evaluated for secondary effects from GHG emissions.

- Regional transportation plans should also be evaluated on a case-by-case basis for potential to either reduce or increase GHG emissions from the transportation sector. EMFAC can be utilized to determine the net change in GHG emissions

associated with projected vehicle VMT and from operating speed changes associated with additional or alleviated congestion.

To achieve the goals of AB 32, which are tied to GHG emission rates of specific benchmark years (i.e., 1990), California would have to achieve a lower rate of emissions per unit of population and per unit of economic activity than it has now. Further, in order to accommodate future population and economic growth, the state would have to achieve an even lower rate of emissions per unit than was generated in 1990. (The goal to achieve 1990 quantities of GHG emissions by 2020 means that this will need to be accomplished in light of 30 years of population and economic growth in place beyond 1990.) Thus, future planning efforts that would not encourage new development to achieve its fair share of reductions in GHG emissions would conflict with the spirit of the policy decisions contained in AB 32, thus impeding California's ability to comply with the mandate.

Thus, if a statewide context for GHG emissions were pursued, any net increase in GHG emissions within state boundaries would be considered "new" emissions. For example, a land development project, such as a specific plan, does not necessarily create "new" emitters of GHG, but would theoretically accommodate a greater number of residents in the state. Some of the residents that move to the project could already be California residents, while some may be from out of state (or would 'take the place' of in-state residents who 'vacate' their current residences to move to the new project). Some may also be associated with new births over deaths (net population growth) in the state. The out-of-state residents would be contributing new emissions in a statewide context, but would not necessarily be generating new emissions in a global context. Given the California context established by AB 32, the project would need to accommodate an increase in population in a manner that would not inhibit the state's ability to achieve the goals of lower total mass of emissions.

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The average net influx of new residents to California is approximately 1.4 percent per year (this value represents the net increase in population, including the net contribution from births and deaths). With population growth, California also anticipates economic growth. Average statewide employment has grown by approximately 1.1 percent over the last 15 years. The average percentage of population employed over the last 15 years is 46 percent. Population is expected to continue growing at a projected rate of approximately 1.5 percent per year through 2050. Long-range employment projection data is not available from the California Department of Finance (DOF) and can be extrapolated in different ways (e.g., linear extrapolation by percentage rate of change, percentage of population employed, mathematical series expansion, more complex extrapolation based on further research of demographic projections such as age distribution). Further study would be needed to refine accurate employment projections from the present to 2050. For developing this framework, employment is assumed to have a constant proportionate relationship with the state's population. The projected number of jobs is assumed to be roughly 46 percent of the projected population.

In light of the statewide context established by California law, consistency is most important for evaluating GHG emissions from projects. Thus, URBEMIS and the CCAR GRP are the recommended tools for quantification of GHG emissions from most project types in the short term. Over the long term, more sophisticated models that integrate the relationship between GHG emissions and land use, transportation, energy, water, waste, and other resources, and have similar application statewide would have better application to the problem, but may not currently be as accessible or as easily operable. I-PLACE^{3}S and CTG Energetics' Sustainable Communities Model (SCM) are two examples of such models that contain emission factors for GHGs, which could be refined to have applicability statewide and made available to CEQA practitioners. Other models are likely to be developed, given the importance of this issue.

Short-Term and Long-Term Methodologies

The following tools can be used to quantify a project's GHG emissions until tools that are more comprehensive become available statewide:

1. Land development projects: URBEMIS 2007 v. 9.2 and the CCAR GRP v. 2.2 (short-term); further development of I-PLACE^{3}S or CTG's Sustainable Communities Model (long-term).
2. New stationary and area sources/facilities: AP-42 Chapter 4.3, LandGem v. 3.02, and/or CCAR GRP v. 2.2.
3. Road or levee construction projects or other construction-only projects: RoadMod/OFFROAD 2007.

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Ideally, I-PLACE^{3}S or CTG's Sustainable Communities Model would be expanded to apply to all regions of the state. These types of models use an integrated approach, which is the best approach for reasonably approximating the emissions that result from interaction between land uses, but neither is available to the public and would create consistency problems in reporting emissions from projects across the state if these were used today. However, a similar model with statewide applicability will likely be developed due to the importance of the issue.Table 10 Summary of Modeling Tools for Estimating GHG Emissions and Project Applicability

Table 10: Summary of Modeling Tools for GHG Emissions

Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
URBEMIS 2007	*Public domain -Download (www.urbemis.com) free of charge*	*Land development and construction projects (construction, mobile- and area-source emissions)*	*Local*	*Fairly Easy*	*Land use information, construction and operational data and assumptions (e.g., jurisdiction, acres of land use type, year of operation, etc.)*	*Mobile-source Construction & Operational CO_2 (lb/day or tons/year)*	*-Recommended for land use development and construction projects -Also recommended for net change in land use (zoning changes)*	*-Does not quantify indirect emissions from energy consumption or other GHGs (except methane from mobile-sources) -Free, available to public, and applicable statewide -Widely used for assessment of other air quality impacts*
California Climate Action Registry General Reporting Protocol v. 2.2	*Public guidance document*	*Indirect emissions from land development projects, stationary- and area-source facilities regulated under AB 32*	*State*	*Easy*	*Energy consumption*	*CO_2e (Metric tons/year)*	*-Recommended for indirect emissions from energy consumption for land use development projects, and for new stationary- or area- sources to be regulated*	*-Contains emission factors for CH_4 and N_2O in addition to CO_2 -Does not contain emission factors broken down by utility provider (statewide average grid only)*
Clean Air and Climate Projection (CACP) Software	*Public agencies (members of ICLEI, NACAA, or similar)*	*Local governments used for emissions inventories*	*Local*	*N/A*	*Energy usage, waste generation/disposal transportation*	*CO_2e (tons/year)*	*-Recommended for inventories of local government entities activities (must be a member of affiliated agency or group)*	*-Not available to public*
CTG Sustainable Communities Model	*Custom model*	*Land development*	*Regional, scalable*	*N/A*	*Land use information, operational (mobile, energy, economic, infrastructure) assumptions*	*CO_2e (tons/year)*	*-An integrated and comprehensive modeling tool, but cannot obtain*	*-Not available to public*

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Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
I-PLACE^{3}S	*Access fee through local COG* *Only available for eight California counties*	*Land use change*	*Regional, scalable*	*Fairly Easy*	*Parcel information*	*CO_2 (lb/day or tons/year)*	*-Recommended for land use development projects and land use changes* *-Especially good for general plans*	*-Not freely available to public* *-Not applicable statewide* *-Actually provides insight into land use interaction* *-Can include very specific project attributes* *-Trip rates are from behavioral survey data, instead of ITE*
EMFAC 2007	*Public domain*	*On-road mobile-sources*	*Statewide, regional*	*Fairly Easy*	*Vehicle fleet information*	*CO_2 (grams/mile)*	*-Not recommended for most projects (URBEMIS preferred)* *-Could be used for certain Air District Rulemaking applications*	*-Can compare emissions based on speed-distribution* *-Emission factors contained in URBEMIS* *-Not a stand-alone model*
OFFROAD 2007	*Public domain*	*Off-road mobile sources (construction equipment)*	*Statewide, regional*	*Fairly Easy*	*Construction fleet information*	*CO_2 (lb/day)*	*-Not recommended (URBEMIS preferred)* *-could be used for certain Air District Rulemaking applications (re: construction equipment)*	*-Emission factors contained in URBEMIS*
RoadMod (to be updated to include CO_2)	*Public domain*	*Off-road and on-road mobile sources (construction equipment and material haul trucks)*	*Statewide*	*Easy*	*Construction information*	*CO_2 (lb/day or tons/project)*	*-Recommended for construction-only projects (linear in nature; i.e., levees, roads, pipelines)*	*-To be updated to support emissions factors from OFFROAD 2007*

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Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
DTIM	*Public domain*	*On-road mobile-sources*	*Statewide, regional*	*Difficult (consists of a series of three programs and requires input files from traffic and emissions modeling)*	*-EMFAC files -Traffic model output files (e.g., link, interzonal, and trip end data) -User options file -Optional files*	*CO_2 (tons/year)*	*-Not recommended*	*-Not updated to support EMFAC 2007 emission factors -Input files include output files from regional transportation models which more accurately reflect VMT*
Southeast Climate Change Partnership Spreadsheet Model (UK)	*Public domain http://www.climatesoutheast.org.uk/*	*UK Local government/ agencies/ organizations used for emissions inventories*	*Local, county, regional*	*Fairly easy*	*Energy usage, waste generation/disposal, transportation*	*CO_2 (tonnes/year)*	*-Not recommended for use in California, but could be a valuable source for building an applicable spreadsheet model*	*-Applicability for UK, but could be updated with CA-specific emission factors*
EPA AP-42; Evaporation Loss Sources Chapter 4.3.5	*Public reference document*	*GHG emissions from waste water treatment facilities*	*Facility level*	*Easy equation; substantial research needed to use*	*Biochemical oxygen demand (BOD) loading, Fraction anaerobically digested*	*CH4 (lb/year)*	*-Recommended for Publicly owned treatment works (POTW) projects*	*-Substantial research needed to determine the "fraction anaerobically digested" parameter, which is dependent on the type of treatment plant/process*
LandGem v. 3.02	*Public domain http://www.epa.gov/ttn/catc/dir1/landgem-v302.xls*	*GHG emissions from anaerobic decomposition associated with landfills*	*Facility Level*	*Moderate*	*Solid waste processing, year of analysis, lifetime of waste in place*	*CO_2, CH_4 (Mega grams/year)*	*-Recommended for landfill emissions*	*-Emission rates change dependent on years of decomposition, waste in place rates of change. -Complex decomposition rate equation, but good first approximation*

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Method/Tool Description	Availability	Applicability	Scope	Ease of Use	Data Input (Requirements and Guidance)	Data Output	Recommendation Comments	Advantages/ Disadvantages
CARROT	*Registry members*	*Stationary source emissions, vehicle fleet mobile sources*	*Facility level*	*Moderate*	*Facility-specific information*	*All GHGs*	*-Recommended for reporting facilities under AB 32 and for indirect emissions from energy consumption (CCAR Protocol)*	*-Estimates all GHGs and normalizes to CO_2e -Not publicly available*

Notes:
GHG = greenhouse gas; AB = assembly bill; CO_2e = carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; COG = council of governments ; ITE = Institute of Transportation Engineers; CCAR = California Climate Action Registry
Source: Data compiled by EDAW and the California Air Pollution Control Officers Association in 2007

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Exhibit G

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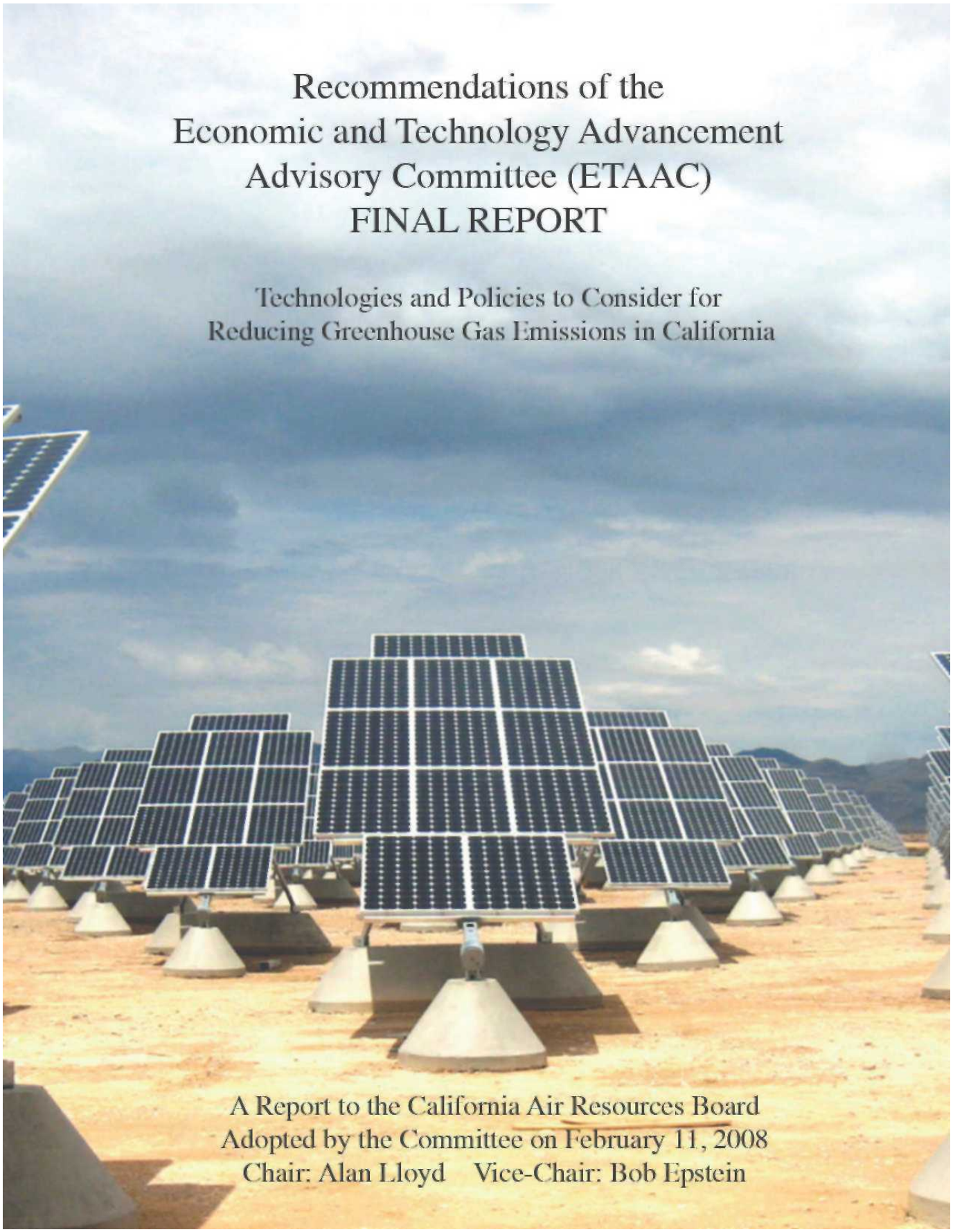
Exhibit G


Recommendations of the
Economic and Technology Advancement
Advisory Committee (ETAAC)
FINAL REPORT
Technologies and Policies to Consider for
Reducing Greenhouse Gas Emissions in California
A Report to the California Air Resources Board
Adopted by the Committee on February 11, 2008
Chair: Alan Lloyd Vice-Chair: Bob Epstein

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cont.

The statements and conclusions in this Report are those of the Committee and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

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Recommendation of the
Economic and Technology Advancement and Advisory Committee (ETAAC)
February 14, 2008

To: Chair Mary Nichols and
Members of the California Air Resources Board (CARB)
From: Members of the ETAAC Committee

We are very pleased to present to you our policy and technology recommendations for reducing greenhouse gas emissions in California. Our report includes 55 specific recommendations for greenhouse gas reduction strategies in the areas of finance; transportation; industrial commercial and residential end users; electricity and natural gas; agriculture; forestry; and water policy. As requested by CARB, we also examined the Market Advisory Committee's Report from the perspective of how particular market mechanisms can stimulate early action, promote innovation and establish clear price signals.

Climate change threatens California's environment and economy. We must move California from its current level of 14 tons of carbon-dioxide equivalent per person down to 10 tons/person by 2020. As requested by CARB, we also looked towards an 80 percent reduction by 2050, which would require a level of 1.5 tons/person by 2050. To achieve these significant reductions will require more efficient use of energy, the virtual elimination of all GHG emissions from the state's energy infrastructure and a substantially different mix of transportation systems and fuels. A key part of the committee's task is to expand the scope of technical and economic solutions available for consideration.

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There are also opportunities for California's economy, environment and citizens. Developing cleaner energy and transportation systems will give California a chance to improve the security of fuel supplies, address stubborn air pollution concerns, and develop more livable communities. In many cases, these solutions provide important co-benefits by addressing difficult and long-standing problems, including the achievement of Environmental Justice objectives.

We hope this report provides a wide and diverse range of alternatives that will inform policymakers in their efforts to meet both the economic and environmental goals of AB 32. Our specific policy recommendations are all based on the following policy strategies and technology opportunities that are outlined in Chapter 1 of our report:

Major Strategies:

- Accelerate GHG Emission Reductions
- Balance a Portfolio of Economic and Technology Policies
- Create Innovative Public Funding to Complement Private Investment
- Foster International and Domestic Partnerships
- Leadership Across State Agencies

Major Opportunities

- Accelerate Efficiency Measures
- Remove Carbon From Energy Sources
- Rethink Transportation to Lower Demand and Carbon Emissions
- Reduce GHG Emissions from Industry, Agriculture, Forestry and Water
- Capture Cleantech Employment, Economic, Health and Environmental Justice Co-Benefits

After CARB convened ETAAC in January 2007, we conducted 9 public meetings across the state. Over 200 members of the public provided comments in writing or in person. Our committee was composed of people from a wide cross-section of California's business, academic, government and non-profit communities. As expected, members hold differing opinions and unique perspectives on the topics covered in the report. However, members are united in the effort to develop recommendations that will help meet the emission targets of AB 32 and also yield the co-benefits of cleaner air, health benefits, new industries and job growth here in California. It is our hope that the knowledge and products created in response to AB 32 can strengthen both the California economy and the state's international leadership on environmental issues.

This final ETAAC report reflects consensus views when consensus was reached, and reflects a range of differing points-of-views when there was general support that fell short of a consensus. Each recommendation may not necessarily reflect the views of every ETAAC member.

Thank you for the opportunity to serve the State of California.

Respectfully submitted,

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ETAAC FINAL REPORT
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APPENDICES

Acknowledgements

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The Committee would like to acknowledge the following individuals who helped with the Committee's work (in alphabetical order):

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The Committee also appreciates the many individuals and members of the public who submitted public comments, commented on the draft reports, or spoke at the Committee meetings.

Technical Writer: Peter Asmus

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The Chair would like to acknowledge the generous financial support of the Energy Foundation, Environmental Entrepreneurs and the William and Flora Hewlett Foundation.

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1. INTRODUCTION AND EXECUTIVE SUMMARY

I. The Challenge and The Opportunity

Global climate change presents California with serious challenges to the health of its people and ecosystems and the vitality of its economy. Properly implemented, the solutions to climate change can also present enormous opportunities. The California Legislature and Governor Schwarzenegger approved AB 32, the California Global Warming Solutions Act of 2006, which requires the state to cut total greenhouse gas (GHG) emissions such as carbon dioxide (CO_2) by 25 percent by 2020 (compared to "business as usual" economic activity.)

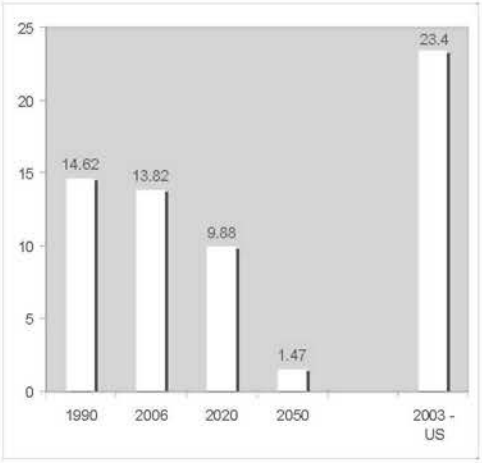

Figure 1-1: California Per Capita CO_2-Equivalent (tons per person)

Prior to the passage of AB 32, Governor Schwarzenegger issued a 2005 Executive Order that set an even more ambitious climate change response program: an 80 percent GHG emission reduction by 2050. Other nations and states are now adopting this aggressive reduction target in light of recent scientific findings that suggest the world may soon be reaching a tipping point on climate change impacts. Given California's expected population growth, this 2050 reduction target creates great challenges for the state, as it requires a 90 percent per capita reduction in GHG emissions (see Figure 1-1). Meeting this target will require a sense of urgency for vastly more efficient use of energy and the virtual elimination of all GHG emissions from the state's energy infrastructure.

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Despite these seemingly daunting challenges, California's climate change policies can benefit the state's economy, environment, and residents. Developing cleaner energy and transportation systems will give California a chance to improve the security of fuel supplies, address stubborn air pollution concerns, and develop better designed communities and buildings. The development of better methods of moving people and goods throughout the state is another opportunity to improve economic efficiency and reduce pollution and congestion in the implementation of our climate change response program. In many cases, these solutions provide important co-benefits by addressing difficult and long-standing problems. Among them is the inequitable distribution of the environmental costs associated with California's electric power and transportation infrastructure.

Continuing California's long-standing tradition of innovation on environmental issues, AB 32 has given the California Air Resources Board (CARB) a leadership role in forging new approaches to diminishing the state's carbon footprint working with other state agencies. Existing California programs have demonstrated that major air pollution reductions can be achieved through economic and technological advancements. For example, new electric power plants in California now emit 90 percent less ozone and particulate forming Nitrogen Oxides (NOx) than they did two decades ago due to technology-forcing regulations. Strict technology-forcing standards have also resulted in California's greenest new passenger cars emitting 99

percent less Volatile Organic Compounds (VOC) and NOx than vehicles did in 1970. Policies supporting aggressive energy efficiency upgrades, as well as higher energy prices and a transition toward a service-oriented economy, have all helped California keep its per capita electricity consumption flat for the past few decades. California has achieved this feat, in part, through a balanced portfolio of policies, performance standards and market-based incentives. These State policies addressed important market failures: pollution externalities; market barriers to private sector Research, Development & Demonstration (RD&D); misplaced financial incentives; and imperfect information for energy consumers. As California turns its attention to combating global climate change, new State policies designed to surmount these and other market failures must expand in scope and creativity.

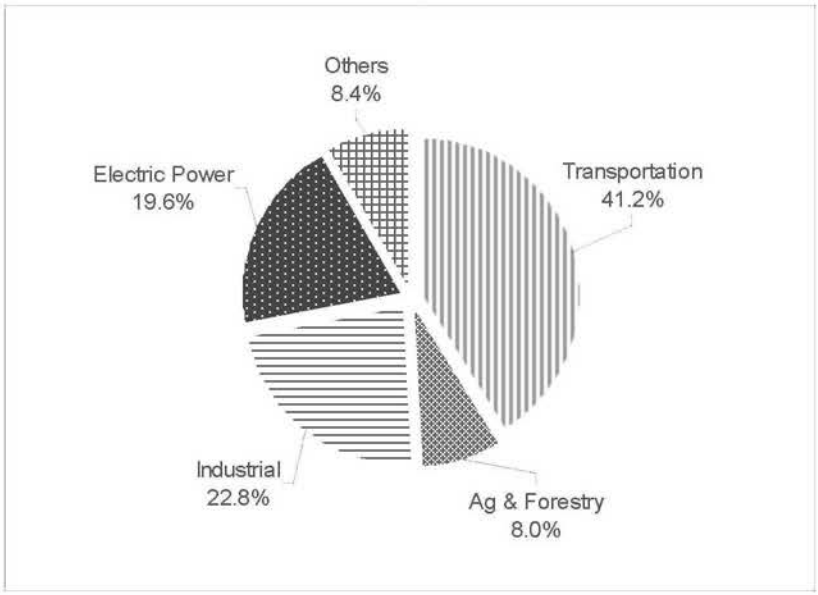

Figure 1-2: Carbon Emissions by Sector

13-123 cont.

As shown above in Figure 1-2, GHG emissions result from many activities ranging from transportation to manufacturing to agriculture. Policies implemented under AB 32 and the Governor's Executive Order for 2050 must address all sectors of California's economy so that all significant sources of GHG emissions participate in both the challenges and opportunities afforded by this critical piece of state legislation. This broad-scaled approach is the most likely to create a level playing field, and address new alternative energy sources and fuels that could be used in multiple sectors. For example, policies need to recognize that electricity and biofuels will likely compete with more traditional transportation fuels in the future; therefore, policies that address only the electric sector or only the petroleum refining sector are unlikely to achieve the goals of AB 32.

The initial AB 32 target of reducing California's GHG emissions back to 1990 levels by 2020 is the critical first step toward reducing emissions and placing the state on a trajectory to meet long-term GHG reduction goals. The long-term reduction goals for 2050 and beyond are equally important and will require fundamental changes in consumer behavior, in energy use, and in the infrastructure that supports virtually all economic activity. In some cases, the state will encounter tradeoffs between the actions necessary to bring about the wide scale transformation of a carbon-free economy with those that may bring about the lowest cost emission reductions in

the short term. This report identifies recommendations to achieve both short-term and long-term goals. Balanced and innovative approaches are clearly needed.

II. Major Strategies and Opportunities

AB 32 instructs CARB to create the Economic and Technology Advancement Advisory Committee (ETAAC) and instructs ETAAC to do the following:

> *"Advise on activities that will facilitate investment in and implementation of technological research and development opportunities including, but not limited to, identifying new technologies, research, demonstration projects, funding opportunities, developing state, national, and international partnerships and technology transfer opportunities, and identifying and assessing research and advanced technology investment and incentive opportunities that will assist in the reduction of greenhouse gas emissions. The committee may also advise the CARB on state, regional, national, and international economic and technological developments related to greenhouse gas emission reductions."*

ETAAC has identified five major strategies for promoting economic and technology advancement. The Committee believes these policy approaches are key to California's success in tackling the climate change challenge. ETAAC has also identified five key areas of opportunity, places where the state must focus its attention and resources to deliver the GHG emission reductions and ancillary benefits needed for climate success. A general description of each of these strategies and opportunities follows. A map of how each recommendation in the report reflects these major themes is included in a chart at the end of this introductory chapter.

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Strategy #1: Accelerate GHG Emission Reductions

AB 32 establishes a fixed timeframe for California to achieve a 25 percent reduction in GHG emissions relative to current levels. This 2020 timeframe is useful because it provides business and policy makers specific targets for long-term planning. However, the competing interests of many different stakeholders -- including industry, labor, environmentalists, land owners, and others -- has led to a regulatory system for project approval that can be complex, time-consuming, costly, and often litigious. Gridlock would not serve California as it looks to future solutions to the climate change conundrum. ETAAC has identified areas (for example the deployment of advanced large scale renewable energy – section 5.III.D and methane digesters – Chapter 6.II.A, etc.) where the project approval process could be improved without compromising environmental integrity. To successfully complete this task, however, will require addressing the special interests that created the existing system to begin with. Leadership and skill to help design politically acceptable compromises will be needed.

There is an urgent need for investments in GHG emission reductions before the AB32 implementing regulations begin taking effect in 2012 because some investments in particular technologies may preclude other choices that would lead to even greater GHG emission reductions. In many cases, delaying these investments will also delay the total benefit of actions that could be taken today to reduce GHG emissions.

Lingering regulatory uncertainty has stymied some potential investments. These "early actions" by the private sector could proceed at a faster pace if the potential economic benefits of early actions were made explicit. The actual economic value of "credits" for early action depends on market and regulatory decisions that may not occur immediately. If ownership and quantification of these "early action" credits were more clearly defined, increased investment in GHG emission reduction projects could begin to flow, leaving California in a much better position to cost effectively meet the AB 32 GHG emission reduction targets.

Strategy #2: Balance a Portfolio of Economic and Technology Policies

Placing a price on carbon and other GHG emissions is a critical step towards responding to the climate change threat as it allows private markets to incorporate the value of reducing these emissions into their everyday business decisions. One potential option is a market based "cap and trade" system which establishes a cap on allowable GHG emissions that would ratchet down over time. A declining cap can send the right price signals to shape the behavior of consumers when purchasing products and services. It would also shape business decisions on what products to manufacture and how to manufacture them. Establishing a price for carbon and other GHG emissions can efficiently tilt decision-making toward cleaner alternatives. This cap and trade approach (complemented by technology-forcing performance standards) avoids the danger of having government or other centralized decision-makers choose specific technologies, thereby limiting the flexibility to allow other options to emerge on a level playing field.

If markets were perfect, such a cap and trade system would bring enough new technologies into the market and stimulate the necessary industrial RD&D to solve the climate change challenge in a cost effective manner. As the Market Advisory Committee notes, however, placing a price on GHG emissions addresses only one of many market failures that impede solutions to climate change. Additional market barriers and co-benefits would not be addressed if a cap and trade system were the only state policy employed to implement AB 32. Complementary policies will be needed to spur innovation, overcome traditional market barriers (e.g., lack of information available to energy consumers, different incentives for landlords and tenants to conserve energy, different costs of investment financing between individuals, corporations and the state government, etc.) and address distributional impacts from possible higher prices for goods and services in a carbon-constrained world. Investing revenues from any allowance auctions in low and zero carbon technology development and deployment will greatly increase the benefit of putting a price on carbon. Performance standards (i.e. emissions per kilowatt-hour, per mile traveled, per units produced, etc.) also have a proven history of success and need to continue to be part of California's strategy. In complying with a performance standard, a regulated entity should have the choice to use a mix of technologies that brings the entity into compliance on an equivalent basis with a particular performance standard. In addition, California can consider revenue-neutral fee shifting to reward the purchase of lower carbon products (see Chapters 2.III.E and 3.IV.G).

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These complementary economic and technology development strategies form the core of ETAAC's policy recommendations found in this report. Many of the strategies outlined in the following pages of this report would be much more effective with appropriate price signals that

flow from a declining cap on GHG emissions combined with near and long-term development of low and zero carbon alternatives. A well conceived diverse portfolio featuring both market-based policies and regulatory measures will be more efficient and less costly than relying exclusively on options from either category of potential solutions on their own.

Government policy should not attempt to pick technology winners. Rather, performance-based programs—whether market-based, command-and-control, or incentive oriented—should be the normal course of business. ETAAC makes a number of recommendations based on the need to help emerging technologies move through demonstration phases to achieve full commercial viability (see Chapters 2.II.B and 4.III.I). For instance, policies shaping development and demonstration of innovative technologies may differ from those focused on introducing technologies into the marketplace on a commercial scale. The best approach may be to support new technologies to the point where they can stand-alone within a market structure characterized by performance standards and carbon prices that become a part of everyday decision-making by consumers and businesses. Full performance battery electric and fuel cell vehicles, for example, are two major zero tailpipe emission technologies currently under development. While both technologies will require significant government involvement to become fully commercialized, ETAAC does not advise selecting one or the other as the preferred future technology. In the shorter term, plug-in hybrids using clean electricity as part of their vehicle fuel may compete with other vehicle technologies using lower carbon advanced vehicle fuels. Thus, standards, policies, and incentives should be aimed towards establishing a level playing field and lowering barriers to technologies that can then compete based on price, efficiency, emissions, convenience, and other factors.

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Flexibility in program design and implementation will be necessary to minimize the negative economic impacts that might result from AB 32 implementation and to recognize the need to phase-in new, low-and zero carbon technologies into the state's economy. Preserving flexibility for changing circumstances in the future is yet another important goal embedded in the work of ETAAC. Electric power generation stations and other forms of capital intensive infrastructure being planned today may become the primary energy sources for advanced vehicles of the future. The crossover and spillover effects of today's investment decisions will present significant challenges and opportunities for both energy and transportation sectors.

Strategy #3: Create Innovative Public Funding to Complement Private Investment

One result of the lack of a clear price for GHG emissions today is the inadequate level of RD&D for new low and zero carbon technologies. Companies invest much less in RD&D than is socially optimal because they expect a high return on their capital investments, they may not capture all the benefits of RD&D investments, and because RD&D is an inherently risky undertaking. Stimulating innovation in new technologies is the goal of RD&D. Broadly speaking, there are two ways to foster innovation: by funding RD&D directly or by requiring improved performance in the marketplace. In the energy sector, where new technologies are often very capital intensive and integrated into complex production systems, a balanced approach that uses both methods is clearly desirable.

The policies created to support AB 32 will galvanize significant private sector investment in

California, but this expected investment will not be enough to reach all areas necessary to achieve the overall GHG emission reduction goals. ETAAC reviewed areas where public financing, possibly leveraged with private capital, can stimulate innovation and accelerate adoption of cleaner products. ETAAC has identified the technology demonstration/pre-commercialization phase in a product's life cycle as a critical stage for this type of investment. If California decides to adopt a cap and trade system that includes the auction of emission allowances, ETAAC proposes that a California Carbon Trust – discussed in greater detail in Chapter 2.II.A – can direct investments in RD&D and finance technology pilot projects in disadvantaged communities and throughout the State of California. Often, these projects offer co-benefits such as improved air quality or employment. Investments from the California Carbon Trust can fill RD&D funding gaps by leveraging the capabilities of universities, State agencies, non-profits and other pioneering research leaders throughout the state.

If auction revenues from a carbon cap and trade system are large enough, they can also be used to reduce the negative impacts of some of the more distortionary elements of California's current taxation system. In addition, these revenues could provide resources for GHG emission reductions. This represents another potentially important policy option because it could improve the economic efficiency of the overall California economy. Alternatively, these revenues could address Environmental Justice issues by assisting communities or industries that are disproportionately affected by climate change or by climate change mitigation programs. Any such assistance should not eliminate the incentive created by placing a price on carbon, but instead should help with short-term transitions to a more competitive, low-carbon economy.

California does have several hundred million dollars worth of existing incentive fund programs underwriting RD&D and related research activities (outlined in Appendix III). They typically serve specific functions. At present, none of them specifically target GHG emission reductions and they also are not currently coordinated to achieve the maximum amount of co-benefits. ETAAC recommends that the State of California make an affirmative commitment to RD&D programs geared toward GHG emission abatement (see Chapter 2.II.B), and examine how to best integrate these climate change priorities and existing State funded programs with existing environmental and energy policy goals. The State should also consider creating a new organization to house these and other programs. By not just supporting, but actively promoting clean energy innovation, California has the opportunity to seed the marketplace with promising new technologies that may provide critical tools to achieve AB 32's reduction targets. This seeding effort will also bring to market solutions necessary to meet the 2050 goal of a carbon-free economy. This will also drive new investment dollars to California and better enable our state to attract and nurture the most promising clean energy start-up businesses.

13-123 cont.

Strategy #4: Foster International and Domestic Partnerships

California should learn from the European Union and others in the international community that have already moved forward on the implementation of policies designed to respond to global climate change. California can learn from both policies that have worked and those that have not. Success on the climate change front domestically can benefit greatly from partnerships between the public and private sector (see Chapter 4.III.H), between State and local governments, between the State and Federal government, and between the State and other

nations. Broad deployment of clean technology will generally drive down costs and lead to subsequent generations of innovation. California must leverage agreements with western U.S. states, Canadian provinces, the European Union, the United Kingdom and other countries and coordinate with Federal programs (such as the recently signed "Energy Independence and Security Act" – H.R. 6) if AB 32 is to accomplish its expressed intent. Achieving genuine success on climate change will also require the transfer of clean technology to developing nations, including China, India, Mexico and Latin America. Exporting both information on public policy solutions and the benefits of a strong Cleantech industry is one example recommended by ETAAC (see Chapter 2.II.B); partnering with other states, the Federal government, and other nations on low and zero tailpipe emission vehicles is another (see Chapter 3.IV.E).

Within the state, leveraging and coordinating RD&D efforts of State and Federal labs, private research institutes, universities and non-profit organizations is a major opportunity for California to garner cost-effective emissions reductions and co-benefits. CARB has initiated two projects that will offer stakeholders consolidated documents illuminating climate research efforts and priorities in California. The California Climate Research, Development, Demonstration, and Deployment (RDD&D) catalog will present climate-related research and commercialization efforts underway in California in a publicly available, searchable database. The California Climate RDD&D Road Map will delineate each State agency's research priorities in support of AB 32's climate change response goals. The catalogue and road map were initiated in October 2007 and will be completed by April 2008. A coordinated effort would ensure that market and policy signals reach and influence RDD&D being funded at these innovation centers (see Chapter 2.II.B). Such an effort may facilitate policy initiatives that reflect real technological progress and may help individual innovations achieve the necessary scale more quickly. This could be accomplished by a new entity charged with coordinating low and zero carbon research efforts, or it could be accomplished by an existing private or public entity. The CPUC recently acknowledged a similar need and opened a proceeding to consider creating a "California Institute for Climate Solutions" to be administered within California universities.

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Strategy #5: Leadership Across State Agencies

There must be effective leadership across all State agencies to reduce GHG emissions from their own governmental operations and from the stakeholders they oversee and/or regulate. Just as all sectors of the state's economy need to participate in the opportunities and challenges of meeting California's GHG emission reduction goals, all State agencies must also participate (with Cal/EPA playing a key government coordination role). This sort of coordination will also be important for planning efforts to adapt to the climate change effects that could still potentially occur even if atmospheric GHG levels are stabilized to avoid the most severe negative impacts (see Chapters 3.IV.H and 5.VI.K).

Many new technologies and practices to lower GHG emissions will also have co-benefits such as less air pollution or lower water consumption. But some will also lead to higher costs and may even exacerbate other policy challenges. It will be necessary for California to identify and manage tradeoffs that will occur as it addresses climate change. Tradeoffs among different public policy objectives should be integrated across all State agency decisions -- those associated directly with AB 32 as well as other air pollution regulations, infrastructure development, and so

forth. Such reciprocity is needed to avoid an unbalanced set of regulatory and project decisions that would result in missed opportunities to help meet climate change goals and integrate these goals into other State programs. SB 85, approved in August 2007, calls for an annual Report Card summarizing progress from all State agencies (section 12892). ETAAC strongly supports this Report Card as a way of providing regular feedback. If possible, these Report Cards should be strengthened with independent, third party verification.

Opportunity #1: Accelerate Efficiency Measures

The most cost-effective GHG emission reduction opportunities continue to be investments in energy efficiency. Whether it is more efficient buildings, appliances or motor vehicles, initial up-front investment is rewarded - often very quickly - with reduced energy use and lower overall costs. While California has led the nation in building and appliance efficiency, the State has significant opportunities to do much more. In some cases, further technological innovation is needed to create more efficient products. In other cases, faster adoption of existing and emerging technology needs to be encouraged (see Chapters 3.IV.E, 3.IV.F, 4.III.F;,5.II.A, 5.II.B).

ETAAC believes that new types of financing will likely increase the development and adoption of energy efficient technologies and practices. Consequently, financing policies that can be implemented through utilities or municipalities to increase efficiency are recommended (see Chapter 2.III.F, G). The potential use of auction proceeds to help finance efficiency upgrades to lower energy bills in historically disadvantaged communities is another opportunity to achieve efficiency, while also meeting AB 32's Environmental Justice goals.

13-123 cont.

Energy efficiency opportunities exist in all the sectors considered in this report. ETAAC recommends that the State, in considering these opportunities, ensure the proposed programs and measures are coordinated to avoid overlaps, duplication, and double-counting.

Opportunity #2: Remove Carbon from Energy Sources

California's future sources of electricity, transportation fuels and heating fuels will need to be zero or near-zero carbon by 2050. Renewable energy technologies such as wind, solar, and others offer the technical potential to generate all of California's electricity, but there are a number of technical and implementation challenges that will not be simple to overcome. ETAAC examined the opportunity of how to quickly scale up these sources of renewable energy, (such as wind, solar, and geothermal steam) both on-site distributed generation and central utility-scale power plants. ETAAC also identified barriers that must be overcome (See Chapter 5.III.C) to achieve an increase in renewable energy or carbon-free equivalent to 33 percent.. In addition, biomass sources, if coupled with carbon sequestration, could produce renewable energy supplies and permanently remove carbon from the atmosphere provided that there are no net adverse air quality effects from growing and using the biomass (see Chapters 6.II.A, 6.II.C, 6.II.D ad 7.IV.A).

Electricity storage has the potential to enable higher penetrations of renewable energy in California's power supply portfolio. Technologies such as pumped hydro storage, compressed air, thermal storage, batteries, or hydrogen can transform intermittent renewable generation into

a reliable resource for energy planning (see Chapter 5.IV.F). Electricity storage in the form of plug-in electric vehicles has the potential to both reduce reliance on fossil fuels in the transport sector and allow for even greater utilization of existing and future renewable electricity generation (see Chapter 5.IV.G).

In the AB 32 timeframe, ETAAC believes fossil fuels, including natural gas, can play an important role for both power generation and heating. Over the long term, fossil fuels such as natural gas are most likely to play a valuable role for traditional uses and as a feedstock for vehicle energy supplies if carbon can be separated and permanently stored. Large scale deployment of low carbon, zero carbon and even negative carbon biomass energy will likely require methods to permanently sequester carbon. California should continue to partner with other states, Federal agencies and international partners to encourage RD&D to find cost-effective and safe methods of sequestering CO_2 streams from power generation (see Chapters 5.V.I).

Opportunity #3: Rethink Transportation to Lower Demand and Carbon Emissions

Transportation by far accounts for the largest fraction of GHG emissions in California, roughly 40 percent of the state's total inventory. In order to meet 2050 GHG goals, the transportation sector will need to accomplish a dramatic transition to new low and zero carbon technologies.

ETAAC recommends that California build upon existing State programs to reduce air pollution and "decarbonize" the state's transportation system. These existing programs include the Pavley – Schwarzenegger vehicle GHG emission regulations, the Low Carbon Fuel Standard, the Low/Zero Emission Vehicle program and the Zero-Emission Bus program. California should also initiate a near-term program to reduce GHG emissions from Heavy-Duty Vehicles (HDV). The infrastructure to deploy technologies emerging from these State programs must also be based on low or zero emission fuel supplies.

13-123 cont.

In addition to transportation technology itself, it is time to rethink current methods of mobility for both freight and people. California's growth in motor vehicle purchases and State investments in road infrastructure occurred largely during a period in time when transportation fuels were inexpensive. This is no longer the case. Decreasing Vehicle Miles Traveled (VMT) is critical to meeting AB 32 GHG emission reduction goals. Reducing this growth will also yield important co-benefits such as diminishing the time lost in traffic congestion and the corresponding improved quality of life. Putting a price on carbon is one way to help reduce vehicle use and congestion. Yet these approaches are limited in scope. They must be complemented by pricing for other currently unpriced transportation costs, alternative transit options, such as electric rail, and urban and suburban designs that provide better and affordable alternatives to the internal combustion engine (see Chapter 3.III). Local government land use planning decisions will need to be coordinated with state-wide priorities to encourage transit-oriented residential and commercial development (see Chapter 3.III.A). Without such coordination, overall VMT will climb due to current population growth rates. This is just one of many ways in which local governments are a key partner with the State in complying with AB 32.

California's freight systems will need a similarly dramatic overhaul. California's coastal ports and Central Valley freeways have become increasingly congested. Alternative modes of goods movement have become both a necessity and an opportunity to reduce GHG emissions and other criteria air pollutants.

Opportunity #4: Reduce GHG Emissions from Industry, Agriculture, Forestry and Water

Forest, agricultural and industrial practices also emit GHG emissions due to energy consumption and other activities. Significant opportunities exist to reduce these GHG emissions through established best practices such as the expanded and judicious use of combined heat and power in industry (see Chapter 4.II.C). In addition, both the agriculture and forestry sectors hold the long term potential to sequester carbon in biomass and soil (see Chapter 6.II.E, 6.II.F and Chapter 7.IV.B).

Water use in California is extremely energy intensive. Today, more than 19 percent of electricity, 30 percent of natural gas not used for electricity generation, and 88 million gallons of diesel fuel per year are used to treat, deliver and heat water in California each year. Policies and technologies that increase the efficiency of the state's water delivery systems and reduce end-use will produce multiple benefits. Less demand for water resources translates into reduced emissions of CO_2 and other air pollutants since less energy is used to pump, treat and move water. Other economic and environmental benefits also flow from water efficiency (see Chapter 8.II.A and 8.II.B). There is also an opportunity to capitalize on carbon-sequestering benefits of soil and biomass and reduce end-use water demand by providing incentives for sustainable practices, including the application of compost (see Chapter 4.IV.L and 4.IV.N). **13-123 cont.**

Opportunity #5: Capture Cleantech Employment, Economic, Health, and Environmental Justice Co-Benefits

Many policies designed to combat climate change can also bring about substantial economic, health and environmental co-benefits for the State of California. For example, climate policies can stimulate the Cleantech industry in California providing both economic growth and jobs.

The Cleantech industry encompasses everything from alternative energy generation to wastewater treatment to more resource-efficient industrial processes. Although each of these industries is unique, they all share a common thread: they rely upon new and innovative technology to create products and services that compete favorably on price and performance while reducing our collective environmental footprint. Given its legacy of entrepreneurism and clean energy innovation, California is well positioned to attract venture capital investments in Cleantech companies. In 2007, California led the nation in Cleantech venture capital with $1.78 billion, representing 48 percent of total U.S. Cleantech investments of $3.67 billion. This represents a 50 percent growth over 2006 in venture investments in California companies.

Cleantech represents a new export opportunity, too. Cleantech products will increasingly be needed worldwide to address climate change and other challenges associated with the decreasing availability of water and other natural resources. Furthermore, Cleantech is spurring new employment opportunities in such fields as solar energy and energy efficiency device

installation. ETAAC proposes State supported training programs to encourage the development of these kinds of green-collar jobs (Chapter 2.III.D).

At present, the State of California is doing little to encourage the manufacturing of Cleantech products within state borders. In fact, it is quite possible that many Cleantech companies will locate their manufacturing operations out-of-state, while keeping their corporate headquarters and RD&D facilities in California. (This trend is already underway.) The State should consider a variety of policy recommendations to make it more economically attractive to both invent *and* manufacture solutions to climate change in California. Such incentives would allow California to more fully reap the economic benefits of the rapidly expanding Cleantech industry (Chapter 2.III.C).

Some policies designed to combat climate change can reduce pollutants affecting local public health. Ground level ozone and black carbon (a type of fine particulate mostly from diesel combustion) contribute to both climate change[1] and major public health problems that exist in California.[2] Assessing existing regulations for public health pollutants such as ozone and fine particulate regulations were outside the scope of the ETAAC report. Nevertheless, ETAAC acknowledges the importance of existing programs to achieve public health standards and welcomes innovations that would further these goals while also meeting AB 32's GHG emission reduction targets. In addition, ETAAC has identified a number of opportunities to reduce CO_2 and other GHG emissions along with reducing ozone and fine particulates.

In evaluating potential policy and technological fixes to comply with the challenges of AB 32, ETAAC recognized the need to develop solutions that avoid imposing undue compliance or increased pollution burdens on disadvantaged communities suffering from historic pollution levels. Instead, ETAAC has explored how AB 32 could create new economic opportunity for these same communities. Many recommendations were designed in part to specifically reduce pollution burden in Environmental Justice areas (see Chapter 2.II.A). In all cases, further evaluation such as cumulative impacts assessment need to occur when specific implementation measures are developed by CARB or other agencies or organizations to ensure Environmental Justice benefits and avoid disadvantages.

13-123 cont.

III. Summary Message

California has a prime opportunity as it seeks to meet the challenges embodied in AB 32. By acting sooner rather than later, California can lower the costs of transitioning to an economy less dependent upon carbon and other GHG emitting energy sources.[3] At the same time, it can reap the rewards of a more sustainable, efficient and competitive economic system. The opportunities linked to AB 32 cut across all sectors examined in this ETAAC report: transportation; industrial/commercial/residential energy use; electricity/natural gas; agriculture; forestry; and water. Renewable energy, alternative fuels, and energy efficiency could create environmental benefits and jobs in all stages of economic development, ranging from RD&D to manufacturing and the rest of product and equipment lifecycles.

Policy makers, industry and consumers must bear in mind that the long-term effects of decisions made today will still be with us in 2020, and in many cases, in 2050 and beyond. Land-use decisions and choices about new electric power generation infrastructure will either help or hinder California's efforts to meet both the 2020 and 2050 GHG emission reduction targets. Development of new kinds of clean vehicles and other transportation technologies over the next decade may dictate whether the state is on a trajectory toward meeting the AB 32 mandates or falling behind the curve on achieving these critical long-range goals.

Californians are ready to respond to the climate change challenge. To meet the timeframe outlined in AB 32, however, California must do the following:

- Continue the state's long-standing commitment to environmental policy and build on the success of existing programs and regulations in order to develop low and zero carbon solutions;
- Establish a clear market price on carbon to provide the incentives for businesses and consumers to reduce their carbon emissions efficiently and California should invest the value of any resulting auction or fee revenues to achieve additional reductions;
- Attract and leverage private capital for productive investments;
- Develop and retain new green collar jobs;
- Adopt polices and measures that facilitate the kind of business and technology innovations that have made California world renowned;
- Develop and maintain a capability to assess and adjust policies and measures over time as new conditions emerge and new technologies are developed. Other parts of the U.S. and the world are also investing in Cleantech and California needs to maintain its leadership position to comply with AB 32;
- Continue partnerships at the State, national, and international level with leaders on climate change mitigation strategies.

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In addition to mitigating the dire impacts of climate change, effective action on AB 32 can also yield the co-benefits of cleaner air, new industries and jobs here in California. The knowledge

and products created in response to AB 32 will strengthen both the California economy and the state's international leadership on environmental issues.

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IV. The Role of ETAAC

ETAAC was created to facilitate the development of new policies and technologies as quickly and economically as possible, including initiatives that reach outside of direct GHG emission regulations. CARB provided several specific areas of focus for ETAAC and requested that the Committee look broadly at issues that relate to CARB, other State agencies and the State Legislature:

- Review and prioritize incentive proposals for industry compliance with AB 32, identifying potential funding sources to underwrite these fiscal incentives;
- Identify the areas where public sector investment is critical to overcoming barriers to achieving the California's climate protection objectives by 2020 and 2050 and discuss whether those investments should be at the local, State or Federal level, or some combination thereof;
- Identify advanced technologies with the greatest GHG emission reduction potential, their commercial status, and the steps necessary to accomplish significant market penetration;
- Identify export opportunities for California businesses that specialize in carbon reduction technologies and services;
- Recommend key demonstration projects for early success and assist CARB in formulating proposals for public/private partnerships and the potential involvement of national and international organizations;
- Review and comment on the findings and recommendations of the Cal/EPA Market Advisory Committee, to the extent that report affects deliberations of ETAAC.

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To meet these objectives, CARB appointed members to the ETAAC in January 2007. Members were selected based on their knowledge and expertise in fields of business, technology research and development, climate change and economics. (Brief biographies of members are listed in Appendix I.) The Committee is chaired by former CARB chairman and former Cal/EPA Secretary Alan Lloyd, Ph D. The Committee vice-Chair is Bob Epstein, Ph D., noted engineer and entrepreneur, and co-founder of Environmental Entrepreneurs.

ETAAC has endeavored to adhere to the following ten general principles while carrying adhering to its mission and tasks:

1. Address near, medium and long-term goals
2. Encourage early action
3. Foster collaboration at all levels of government
4. Encourage public and private research, demonstration and development
5. Leverage California's centers of innovation
6. Establish a level playing field and do not pick winners and losers
7. Maximize public health and socio-economic benefits

8. Address Environmental Justice concerns
9. Participation across all sectors
10. Flexible approaches

This final ETAAC report reflects consensus views when consensus was reached, and reflects a range of differing points-of-views when there was general support that fell short of a consensus. Each recommendation may not necessarily reflect the views of every ETAAC member.

ETAAC met nine times throughout California (see Appendix II) and received presentations by members of California's technology community. Meetings were subject to the Bagley-Keene Open Meeting Act and webcast to allow significant opportunities for public comments and input. ETAAC also received numerous suggestions from the general public for ways to reduce climate change emissions (a summary table of the suggestions received prior to the final drafting of this report is presented in Appendix IV and V). ETAAC has also agreed to develop an Internet website at www.etaac.org to provide access to details of the technologies ETAAC is reviewing as mechanisms to comply with AB 32.

The work of ETAAC is designed to complement ongoing efforts to reduce GHG emissions in California. The recommendations contained in this report do not replace or supersede existing State regulatory programs, or any adopted future policies authorized under AB 32. However, the ETAAC report may facilitate the development of technologies that help meet, or even exceed, the GHG emission reduction goals outlined in AB 32. Comments received by ETAAC regarding the development of specific rules have been collated outside of this report for consideration during the appropriate regulatory development process.

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V. Organization of ETAAC report

Broad participation by all sectors of California's economy will be necessary to achieve the AB 32's reduction targets. This ETAAC report contains a chapter offering economic/financial strategies for climate change solutions that stretch across sectors, followed by one chapter for each of the six specific sectors analyzed from a stand-point of policy and technology strategies and opportunities (transportation, industry/commercial/residential, electricity/natural gas, agriculture, forestry sector, and water). ETAAC's comments on the Market Advisory Committee report also comprise a chapter in this report. Finally, detailed information on energy and transportation technology advances is included in the Appendix IV and V, respectively.

Developing solutions of the scale required by the climate change challenge will be a complex endeavor. It is therefore important to recognize that each of the proposed policies included in this ETAAC report will inevitably interact with one another. Each recommendation put forward by each ETAAC sector subgroup contains critical information on expected GHG emission reductions and an expected timeframe for achieving these reductions when each policy is considered as a stand-alone option. The "timeframe" sections of each policy recommendation are designed to indicate which of these policies can be in place in the near term (in time for the 2012 deadline of AB 32), medium term (in time for the 2020 deadline of AB 32), or long-term (in time for the 2050 deadline under the Governor's Executive Order). ETAAC did not prepare a full scale implementation analysis for these recommendations individually, or as an integrated program (which would depend on the menu of choices selected). ETAAC did, nonetheless, identify major co-benefits and mitigation requirements when such information was known and available. ETAAC believes that the benefits, costs, risks, trade–offs and uncertainties associated with climate change response policies must be made transparent as California moves forward with the implementation of AB 32. In the final analysis, it is vitally important to understand and fully communicate the rich diversity of information included in this ETAAC assessment so that California policy makers and the general public can identify solutions to AB 32 that are fair, balanced, and effective.

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VI. Mapping from Recommendation to Categories, Timeframes and Responsible Parties

Recommendation	Relevant Strategies and Opportunities	Time-frame	Responsible parties
2- FINANCE			
A. Create a California Carbon Trust	Accelerate GHG Emission Reductions; Balance a Portfolio of Economic and Technology Policies; Innovative public finance; Accelerate efficiency; International and Domestic Partnerships	By 2012	CARB Legislature Other
B. Promote Clean Energy Innovation and Commercialization	Balance a Portfolio of Economic and Technology; Innovative public finance; Capture Economic, Health, and Environmental Justice Co-benefits International and Domestic Partnerships	By 2012	CARB CEC CPUC
C. Leveraging AB 32 to Spur California Job Creation and Manufacturing	Capture Economic, Health, and Environmental Justice Co-benefits	By 2012	Legislature CPUC Other
D. Clean Technology Workforce Training Program	Capture Economic, Health, and Environmental Justice Co-benefits	By 2012	Other
E. Fee and Tax Shifting (Feebates)	Balance a Portfolio of Economic and Technology; Accelerate efficiency	By 2012	Legislature Other
F. Municipal Assessment Districts	Innovative public finance; Accelerate efficiency	By 2012	Other
G. On-Bill Financing for Small Business Energy Efficiency Projects	Accelerate efficiency	By 2012	CPUC Other
3. TRANSPORTATION			
A. Planning: Smart Growth and Transit Villages	Accelerate efficiency; Rethink Transportation to Lower Demand and Carbon; Capture Economic, Health, and Environmental Justice Co-benefits	By 2012	CEC Other Cal Trans
B. Pay-As-You-Drive Insurance	Rethink Transportation to Lower Demand and Carbon	By 2012	CARB Legislature Other Cal Trans

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C. Congestion Charges	Balance a Portfolio of Economic and Technology Rethink Transportation to Lower Demand and Carbon	By 2012	Legislature Other Cal Trans
D. Employer-Based Commute Trip Reductions	Rethink Transportation to Lower Demand and Carbon	By 2012	CARB Other
E. New Vehicle Technology Improvements	Accelerate efficiency; Rethink Transportation to Lower Demand and Carbon; Reduce GHG - Industry, Ag, Forestry, Water	By 2020	CARB Other
F. Low GHG Fleet Standards and Procurement Policies	Balance a Portfolio of Economic and Technology; Accelerate efficiency; Rethink Transportation to Lower Demand and Carbon	By 2012 By 2020	CARB Other
G. GHG-based Vehicle Feebates and Registration Fees and Indexed Fuel Taxes	Balance a Portfolio of Economic and Technology; Accelerate efficiency; Rethink Transportation to Lower Demand and Carbon	By 2012	Legislature Other
H. Air Quality Incentives Programs and Standards	Balance a Portfolio of Economic and Technology Capture Economic, Health, and Environmental Justice Co-benefits	By 2012	CARB Legislature Other
I. Create Markets for Green Fuels	Balance a Portfolio of Economic and Technology; Remove Carbon from Energy Sources; Rethink Transportation to Lower Demand and Carbon; Reduce GHG: Industry, ag, forestry, water	By 2012	CARB Other
4 – Industrial, Commercial & Residential Energy Use			
A. Cleantech Tax Incentives	Innovative public finance; Accelerate efficiency	By 2012	Legislature Other
B. Rebates for Load Reduction	Accelerate efficiency; Reduce GHG: Industry, ag, forestry,water	By 2012	Other
C. Improve Policies for Combined Heat and Power Plants	Accelerate efficiency; Reduce GHG Industry, ag, forestry, water	By 2012	CEC CPUC Other
D. Distributed Renewable Energy Generation: Solar PV	Remove Carbon from Energy Sources	By 2020	Legislature CPUC

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			Other
E. Customer Choice of Electric Service Provider	Remove Carbon from Energy Sources	By 2012	Legislature CPUC
F. Building Efficiency Programs and Incentives	Accelerate efficiency	By 2020	CEC Other
G. Combustion Devices: Energy Efficiency	Accelerate efficiency; International and Domestic Partnerships	By 2012	CARB CEC Other
H. Industry - Government Partnerships to Reduce Industrial Energy Intensity	International and Domestic Partnerships; Coordinate Across State Agencies	By 2012	CEC Other CalEPA
I. A Revolving Fund for Technology Demonstration Projects	Innovative public finance; Accelerate efficiency; Reduce GHG Industry, ag, forestry, water	By 2020	No answer
J. Develop Suite of Emission Reduction Protocols for Recycling	Reduce GHG Industry, ag, forestry, water	By 2012	CARB CIWMB
K. Increase Commercial-Sector Recycling	Reduce GHG Industry, ag, forestry, water	By 2012	CARB CIWMB
L. Remove Barriers to Composting	Reduce GHG Industry, ag, forestry, water	By 2012	CARB CIWMB Cal Trans
M. Phase Out Diversion Credit for Greenwaste Alternative Daily Credit	Reduce GHG Industry, ag, forestry, water	By 2012	CARB CIWMB
N. Reduce Agricultural Emissions Through Composting	Reduce GHG Industry, ag, forestry, water	By 2020	CARB CDFA CIWMB
O. Evaluate and Improve Policies for Qualified Waste Conversion Technologies	Reduce GHG Industry, ag, forestry, water	By 2012	Other
5. ELECTRICITY AND NATURAL GAS			
A. Energy Efficiency Program Coordination	Accelerate efficiency	By 2012	CARB CPUC
B. Aggressive LED Energy Efficiency Programs	Accelerate efficiency	By 2012	CARB CEC CPUC
C. Take Steps Necessary to Achieve an Increase in Renewable Energy to 33	Balance a Portfolio of Economic and Technology	By 2020	CARB CEC

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Percent by 2020 to Reduce GHG Emissions	Remove Carbon from Energy Sources		CPUC Other
D. Competitive Renewable Energy Zones	Accelerate GHG Emission Reductions; Remove Carbon from Energy Sources	By 2012	CEC CPUC Other
E. Renewable Energy Technology Assessments	Remove Carbon from Energy Sources	By 2012	CEC CPUC Other
F. Electricity Storage as an Enabling Technology for Renewable Energy	Remove Carbon from Energy Sources; Coordinate Across State Agencies	By 2012	CEC CPUC Other
G. Plug-in Electric Drive Vehicles as Storage Devices	Remove Carbon from Energy Sources; Rethink Transportation to Lower Demand and Carbon	By 2020	CARB
H. Smart Grid as Enabling Technology for Renewables and Clean Vehicles	Accelerate efficiency; Remove Carbon from Energy Sources	By 2012	Legislature CPUC
I. Carbon Capture and Sequestration in Geological Formations	Remove Carbon from Energy Sources	By 2020	Other
J. Low and Zero Carbon Electricity Generation Plan	Balance a Portfolio of Economic and Technology; Remove Carbon from Energy Sources	By 2012	CARB CEC CPUC Other
K. Unifying Standards for Climate-Related Programs	Balance a Portfolio of Economic and Technology; Coordinate Across State Agencies;	By 2020	CARB CEC CPUC
6. AGRICULTURE			
A - Manure to Energy Facilities	Remove Carbon from Energy Sources; Reduce GHG Industry, ag, forestry, water	By 2012 By 2020	CARB CEC CPUC Other CDFA CalEPA
B - Enteric Fermentation	Reduce GHG Industry, ag, forestry, water	By 2020 By 2050	Other CDFA
C - Agricultural Biomass Utilization	Remove Carbon from Energy Sources; Reduce GHG Industry, ag, forestry, water	By 2020 By 2050	CARB CEC CPUC CDFA CalEPA SWRCB
D - Dedicated Bio-Fuels Crops	Remove Carbon from Energy Sources	By 2012 By 2020	CARB CEC CDFA

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			CalEPA SWRCB
E - Soil Carbon and Sequestration	Reduce GHG Industry, ag, forestry, water	By 2012 By 2020 By 2050	CEC CDFA SWRCB USDA/NRCS
F - Riparian Restoration and Farmscape Sequestration	Reduce GHG Industry, ag, forestry, water	By 2012 By 2020 By 2050	CDFA USDA/NRCS
G - Fertilizer Use and Water Management Efficiency	Accelerate efficiency; Reduce GHG Industry, ag, forestry, water	By 2012 By 2020 By 2050	CEC CDFA SWRCB USDA/NRCS
7. FORESTRY			
A - Link Forest Fuels Management and Biomass Utilization	Remove Carbon from Energy Sources; Reduce GHG Industry, ag, forestry, water	By 2012	CARB Other CDF
B. Reforestation and Forest Management for Enhanced Carbon Storage	Reduce GHG Industry, ag, forestry, water	By 2012	CARB Other CalEPA CDF
C - Urban Forests for Climate Benefits	Remove Carbon from Energy Sources; Reduce GHG Industry, ag, forestry, water	By 2012	Other CDF Cal Trans
D. Endorse "California Climate Solutions" Program	Capture Economic, Health, and Environmental Justice Co-benefits	By 2012	CARB Other
8. WATER POLICY			
A. Establish a Loading Order for Water	Accelerate efficiency Reduce GHG Industry, ag, forestry, water Coordinate Across State Agencies	By 2012	Legislature CPUC Other SWRCB DWR
B. Establish a Public Goods Charge for Funding Water Improvements	Accelerate efficiency Reduce GHG Industry, ag, forest, water	By 2012	Legislature CPUC SWRCB

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[1] IPCC, Fourth Assessment Report (AR4), Working Group 1 Report *The Physical Science Basis*, Summary for Policymakers, 2007.
[2] *The California Almanac of Emissions and Air Quality*, 2007 Edition.
[3] Stern Review, Cabinet Office - HM Treasury (2006).

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3. TRANSPORTATION SECTOR

I. Introduction

Transportation accounts for over 40 percent of all anthropogenic greenhouse gas (GHG) emissions produced in California, making it the largest source of these climate change gases in the state. These substantial sources of carbon dioxide (CO_2) and other GHG emissions are divided among different segments of the state's transportation infrastructure (see Figure 3-1 below). California's transportation sector impacts on global climate change are clearly dominated by gasoline to fuel the state's large fleet of motor vehicles (See Figure 3-2 below.) These GHG emissions flowing from various modes of travel and goods movement are a function of: (1) motor vehicle technologies;[1] (2) carbon intensity of transportation fuels; (3) overall transportation activity levels.

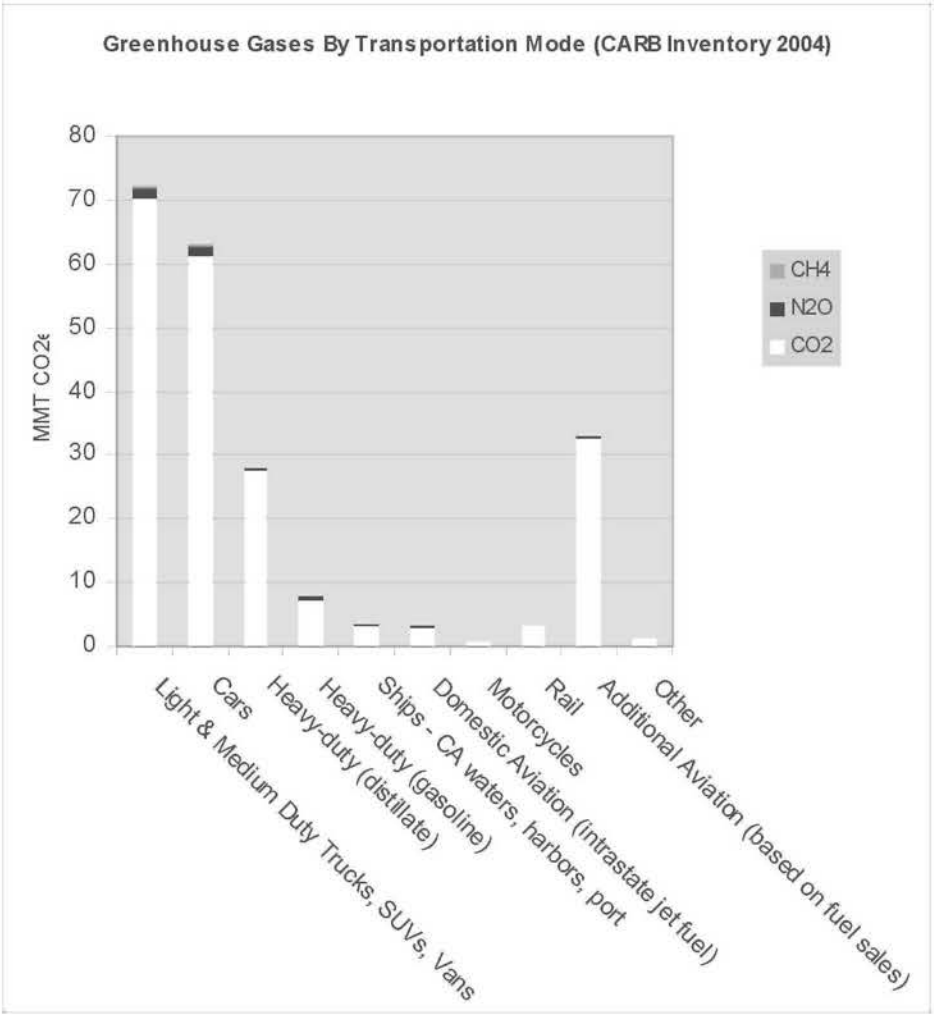

Figure 3-1: Greenhouse Gases by Transportation Mode (CARB Inventory for 2004)[2]

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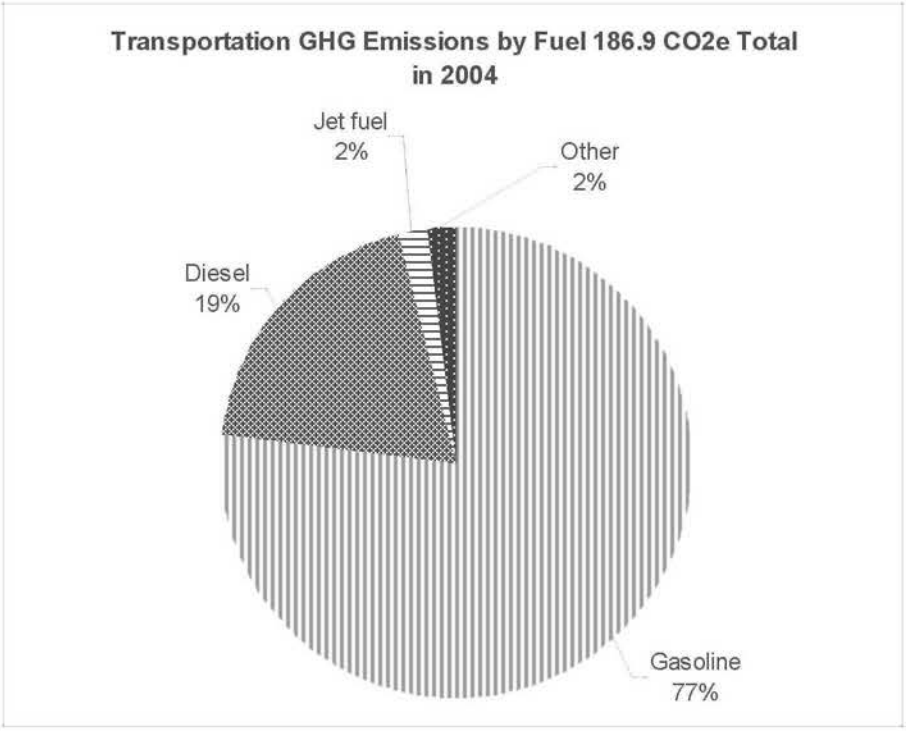

Figure 3-2: California Greenhouse Gas Emissions by Fuel Type (CARB 2004 Inventory)

Achieving California's AB 32 climate change goals will require addressing all three of these aspects of the transportation system. Some policies to address these three primary challenges in the transportation sector are already in place or are currently being developed (see tables 3-1 and 3-2, below). It is clear that ultimately solutions to global climate change will require setting a price on carbon as well as new and far-reaching motor vehicle and fuel technology standards. The ETAAC transportation sector subgroup recommends additional measures to achieve the following public policy goals:

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- Conserving energy by lowering aggregate passenger and freight motor vehicle miles traveled (VMT);
- Substantially lowering GHG emissions released per VMT;
- Lowering the impact of fuels and technologies on California's major transportation sector carbon footprint.

According to the California Department of Transportation (CalTrans), the number of vehicles in California is increasing at a proportionately faster rate than the state's population. There are many reasons why. Among them are rising standards of living -- which boosts vehicle ownership and global trade -- and increasing freight movement throughout California. The state's VMT figures also continue to rise, in part, due to longer commute distances. But expansions in non-work trips are playing an even larger role. Average on-road fuel economy has been declining, primarily because traditional family cars are being replaced with less efficient light-duty trucks and sport utility vehicles (SUVs). Levels of congestion on California's roads and highways are also up, leading to still further increases in per trip GHG emissions.

California drivers used an estimated 18.1 billion gallons of motor fuel to travel 330 billion miles in 2005 – a 15 percent increase since 1990 -- at an estimated cost of $44 billion.[3] If current growth trends continue, gasoline use and related CO_2 emissions in the transportation sector will grow by approximately 30 percent over the next 20 years. This increase carries a substantial environmental price tag as well as economic penalty: a $13 billion increase in the cost of fueling the transportation system (assuming a cost of $2.40 per gallon of gasoline). Considering that over 50 percent of the petroleum consumed in California is imported, the near total reliance of the transportation sector on this fuel exposes the state's economy to price spikes created by the dynamics of national or international markets. The corresponding outflow of capital from California to countries and regions supplying petroleum reduces the purchasing power and living standard of growing numbers of state citizens.

Forecasts regarding California's transportation fuel consumption need to accommodate a key piece of climate change legislation (AB 1493), which will reduce the GHG emissions from new automobiles by about 30 percent by 2016.[4] With this law in place, California's gasoline consumption is expected to be essentially flat through 2025, but diesel fuel consumption is expected to approximately double over this same period.[5]

There are already several policies intended to decrease transportation GHG emissions, as well as a number of factors that can potentially increase these same emissions. It is imperative for the State to develop and implement these existing policies while considering new policies needed to meet the goals of AB 32. Table 3-1 below summarizes key policies in place or under development in California.

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Table 3-1: Existing Policies Affecting Transportation GHG Emissions

	Standards (Regulations)	**Incentives**	**RD&D**
Mobility (personal travel)	• AB1493 vehicle GHG standards • California Zero Emission Vehicle program • California Zero Emission Bus program	• HOV lane access for hybrid vehicles (limited in numbers) • Incentives for advanced vehicles • Investments in travel alternatives • Federal Tax Credit for hybrids • Moyer Program (ozone precursor and black carbon contributions to climate change)	• State and federal R&D • California Fuel Cell Partnership • Advanced Battery Consortium (DOE) • H_2 Highway (infrastructure deployment with different H_2 generation technologies)

Goods Movement	• New diesel emission requirements (small percentage increase in CO2 and major decrease in black carbon) • Diesel Risk Reduction Program (in-use vehicles via black carbon reductions) • Marine vessel speed reductions • Port expansion*	• Electrification programs for ports and truck stops (and potentially increased use of CNG) • State Emission Reduction Program • Smartway Program	• State and Federal R&D
Air	• Airport expansion plans*		
Fuels	• Low Carbon Fuel Policy	• Low taxes on fuels, compared to world averages*	• State and federal R&D

* Tends to *increase* GHG emissions

In order for California to continue to grow (and for California citizens and businesses to prosper) better options for personal and freight transportation are clearly needed. And yet, to avoid dangerous climate change, the State must reduce its transportation-related GHG emissions. Some of the policies described in this chapter may operate by limiting emissions or setting a more appropriate price on transportation options, while others create new opportunities for travel and freight shipment. All of these approaches are essential complements to the deployment of cleaner vehicles running on cleaner fuels. Thus, it is crucial that the State ensure that low-carbon travel options are expanded. Some of the new opportunities include:

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- Smart Growth plans by local governments to make walking and cycling more feasible.
- Bus Rapid Transit (BRT) systems (which are operating successfully in many cities worldwide.)
- Personal Rapid Transit (PRT) systems (which could help relieve traffic congestion.)
- Smart Cards to ease the use of different transit systems.
- Low speed transit options such neighborhood electric vehicles (EV).
- Transit villages that make bus, rail and perhaps PRT modes preferable ways to travel.
- Electric passenger and freight rail systems that could also offer air quality and congestion benefits (but which require significant investments.)

The ETAAC collected and reviewed a substantial amount of information on technology transportation and other innovations. This material is included in Appendix V. Because research, development and deployment (RD&D) of new technologies in the

transportation sector is advancing rapidly, a website has been established as a resource that contains or point towards many of the reports, presentations, and other documentation (www.etaac.org). Table 3-2 below contains relevant AB 32 Early Action measures already being developed by CARB.[6]

Table 3-2: Measures Contained in CARB's Draft Early Action Plan

Name	**Summary**	**Estimated emission reduction (MMTCO2e)**
Low Carbon Fuel Standard	Require the carbon intensity of transportation fuels to decline 10 percent by 2020.	10-20 by 2020
Smartway Truck Efficiency	Require existing trucks and trailers to be retrofitted with devices that reduce aerodynamic drag.	Up to 6 by 2010 and 20 by 2020
Tire inflation	Require tune-up and oil change technicians to ensure proper tire inflation as part of overall service.	0.54 by 2010 and 0.20 by 2020
Port Electrification	This early action allows docked ships to shut off their auxiliary engines by plugging into shore side electrical outlets or other technologies.	0.5 in 2020
New Passenger Vehicle GHG Standards	GHG Standards for post-2016 model year vehicles	4 by 2020; 27 by 2030
Heavy duty hybrid trucks	Lower GHG Emissions through heavy-duty hybrid trucks	0.5 to 1.7 by 2020
Air conditioning	Restrict HFC-134a sales to consumers	Options range from 0.1 to 2 by 2020

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II. General Policy Recommendations for the Transportation Sector

Enhance Research Development & Demonstration: The ETAAC transportation sector subgroup proposes a California Clean Transportation RD&D Program that substantially increases State investments in low-carbon and zero carbon technologies. These efforts should focus on RD&D to accelerate market adoption of on-road and non-road transportation and goods movement technologies. The end goal should be to achieve greater cost-reductions in technologies that reduce GHG emissions as well as improve durability, reliability, and product life. As motor vehicles are weaned off petroleum fuels, new ways of charging for the use of roadway infrastructure and operations currently underwritten by Federal, State and local gas taxes funds will need to be developed. Many methods for supporting such research exist, including direct grants, solicitations, State procurement policies, and more. AB 118 (Nunez) is a constructive new tool for guiding such RD&D activities, but additional funds may be needed, perhaps generated through auction revenue or other climate change related fees.

Encourage Private and Public Investment: The three key GHG emission reduction strategies identified in the Introduction of this chapter – reduce or shift demand for VMT, boost efficiency, and expand use of low carbon intensity fuels -- could be accelerated if California created financial mechanisms to encourage investment in advanced energy and manufacturing technologies. State and local bonding authority could be used to establish investment funds that are used to encourage development of clean technology companies to build new manufacturing facilities in California and add to the state's employment base. For example, The United Kingdom's (U.K.) Carbon Trust is an independent, not-for-profit company set up by the U.K. government to use public sector revenues to support low-carbon technologies using a private-sector approach.[8] As described in the Chapter 2 (the Financial sector) of this ETAAC report, California could set up something similar in the spirit of the California Institute of Regenerative Medicine.

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It is important to encourage private sector as well as to public sector RD&D. Private research funds are much larger than public funds and they tend to focus on innovations not being supported by the public sector. Clear and consistent public policy decisions and regulations will provide direction that encourages the private sector to make investments, and to direct their research dollars in the most appropriate and strategic areas.

Coordinate Between Levels of Government and the Private Sector: The transition to a low or zero carbon economy in California will require major shifts in virtually all industries. This is particularly important in the transportation sector, where vehicle manufacturers and fuel producers and distributors must be coordinated in a way that still meets customer needs while enabling the development of many new cleaner vehicle technologies. Given the scope of the task facing California, effective collaborations will become increasingly important. Reductions in travel demand will certainly require common goals and strong ties between local, State and Federal agencies. As described below, the California Fuel Cell Partnership is just one of a number of examples of successful public/private partnerships.

California Fuel Cell Partnership:
Example of a Public/Private Demonstration Project

The need for coordination between auto manufacturers, energy providers, government agencies, and fuel cell technology providers is a potential barrier to commercialization of hydrogen fuel cell vehicles. The California Fuel Cell Partnership is a collaboration of 31 members to overcome barriers that would face individual members working to solve these problems alone.

Automotive members provide fuel cell passenger vehicles for demonstration programs where they are tested in real-world driving conditions (several organizations represented by ETAAC member are currently using hydrogen fuel cell vehicles in their fleets). Energy sector members work to build hydrogen infrastructure and fueling stations that are safe, convenient, and fit into the communities where they are located. Fuel cell technology members provide fuel cells for passenger vehicles and transit buses. Government members lay the groundwork for demonstration programs by facilitating the creation of a hydrogen fueling infrastructure. In addition, members collaborate on activities such as first responder training, community outreach, and agreeing on fuel cell related protocols while standards are being developed.

Since 2000, the Partnership has placed 170 light duty vehicles in California, and fuel cell passenger cars and buses have traveled more than a million miles on California's roads and highways. There are currently 25 fueling stations, with others planned. During 2008-2012, the Partnership members will continue to improve vehicle driving range, fuel cell durability, and station access in preparation for commercialization of fuel cell technology. Other important future challenges include making the fuel infrastructure sustainable by producing hydrogen from renewable sources. Yet another challenge is maximizing efficiency through energy stations that produce stationary heat and power in addition to hydrogen vehicle fuels.

Source: http://www.fuelcellpartnership.org

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Increase Consumer Education and Choice: Consumer education on environmentally friendly technologies or habits has worked in California; both the State *Flex Your Power* campaign and Federal *Energy Star* labeling program have proved effective in shrinking energy usage. The State should emphasize the importance of public education and outreach programs for the transportation sector similar to existing efforts like "Spare the Air" to reduce or defer driving on bad air quality days. A much broader public outreach effort is needed, nevertheless, to address global climate change. As a greater range of choices of vehicles and fuels become available, it will become important to provide information to consumers so that they make educated choices to reduce GHG emissions. This information can complement market-based incentives. However, the evidence about the effectiveness of public education campaigns to achieve public polices is lacking.[9] Thus, these programs will require monitoring, evaluation, and adjustment to make sure they are cost-effective.

Green labeling is an important component of the transportation energy consumer education program. One form of green labeling for the transportation sector would label a fuel or vehicle, making the consumer aware of the GHG emissions associated with their purchases.[10] Consumers are then allowed to make an educated and active decision to reduce their carbon footprint if they so choose. CARB is in active discussions regarding such green labeling efforts. At present, motor vehicles sold in California already have a smog index label.[11] GHG emissions information will also become part of this label by 2009. The State Legislature may want to consider further labeling efforts referencing energy use and corresponding emissions of different fuels or the emissions that were produced in making or shipping consumer goods related to transportation.

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Realize Economic, Ecological and Environmental Justice Co-Benefits: It is notable that each one percent reduction in transportation energy consumption (or rate of consumption growth) could add up to $440 million in annual savings. CalTrans calculates that every one percent reduction in GHG emissions from the transportation sector (through decreased VMT, improved vehicle technology or fuels) stops 1.81 million metric tons (MMT) of GHG emissions from being released into the atmosphere. This one percent reduction in energy yields a total statewide GHG emission reduction of 0.5 percent.[12] The decreased cost of purchasing fuels will also result in macro-economic benefits because of a shift of consumers' dollars from purchasing imported oil to purchasing more in-state goods and services. One study of climate change policies in California found that implementing AB 1493 would lower vehicle GHG emissions by 31 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) in 2020 compared to a business-as-usual scenario. This equates to roughly 18 percent of this legislation's GHG emissions reduction goal. At the same time, the law could increase gross state product by about $50 billion (over a 2 percent increase) and create about 22,000 jobs (a 0.1 percent increase) due to this macro-economic effect.[13]

In addition, lowering petroleum imports will create energy security benefits. Rising petroleum imports into the State of California -- and the increasing concentration of oil reserves and production in unstable areas of the world -- raises concerns about both the security of supply as well as the market power of foreign oil producers. Policies that cut

petroleum consumption and imports address these related and pressing problems as well. These benefits are realized through both a reduction in transportation energy consumption and a shift away from petroleum-based fuels.

The GHG emission reduction strategies recommended for the transportation sector are also expected, as a whole, to achieve significant public health and Environmental Justice benefits. Strategies to reduce GHG emissions in the transportation sector lower fuel consumption and generate significant air quality and other environmental benefits through reduced "upstream" emissions from oil refineries and fuel transport. Furthermore, important synergies exist between California's decades-long fight against air pollution and the current effort to respond to global climate change. Many of the State's air quality strategies (e.g., anti-idling regulations, the Zero Emission Vehicle (ZEV) and Zero Emission Bus (ZEB) programs) offer key reductions in GHG emissions. Because many criteria air pollutants such as the black carbon component of particulate matter and ozone also accelerate global climate change, air quality policies yield valuable contributions to AB 32's GHG emission reduction goals.

Other co-benefits materialize from policies to decrease demand for transportation services. Such policies tend to lower traffic congestion, saving time now lost in traffic. They may also lower the number and severity of traffic accidents, reducing the associated property damage, injuries, and mortality. These policies may also yield water quality improvements and other environmental benefits.

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Key Environmental Justice Issues for Transportation

Several important environmental justice concerns are particularly relevant to transportation and deserve special attention as California proceeds to implement its climate change goals. These include:

- *Improve mobility.* Access to affordable, safe, and convenient travel is critical for economic development. Opportunities to improve access while reducing vehicle travel should be the cornerstone of transportation and land use planning.
- *Reduce existing air pollution.* Emissions from transportation vehicles (especially diesel equipment) and the facilities that fuel them (e.g., refineries and distribution networks) disproportionately impact low-income communities and people of color. The state should prioritize GHG reduction policies that yield cost-effective ancillary air pollution reductions in these communities. The development of a low-carbon transportation system, such as low-carbon fuel production, should be focused as much as practicable on delivering net air pollution reductions for impacted communities.
- *Create economic opportunity.* Policies and programs to lower GHG emissions in the state have the potential to generate green collar jobs, and the state should support opportunities to benefit disadvantaged individuals and communities.

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III. Shifting Demand for Mobility and Goods Movement

Vehicle travel is a major contributor to global climate change. Demand for highway travel by US citizens continues to expand due to population increases and growth in per capita transport demand. Between 1980 and 1999, highway route miles increased 1.5 percent while VMT increased 76 percent in the US. The Texas Transportation Institute estimates that in 2003, the 85 largest metropolitan areas experienced 3.7 billion vehicle-hours of delay, resulting in 2.3 billion gallons in wasted fuel and a congestion cost of $63 billion.[14] Traffic volumes are projected to continue growing, too.[15] Convenient and efficient public transportation and transportation demand management (TDM) systems are critical measures to reduce VMT and GHG emissions.

Travel Demand Approaches to GHG Emission Reductions

It is widely accepted that the current costs of driving and road use in the United States are below the efficient levels because many important external costs are ignored.[16] Thus, there are many measures that will both reduce GHG emissions and internalize some of these costs by pricing vehicle travel per mile. Improved planning measures will also lead to reductions in these "externalities." Some travel demand strategies that are likely to have larger or more certain effects include:

- Improved planning such as Smart Growth and Transit Villages;
- Pay-As-You-Drive insurance and road pricing.

ETAAC has also evaluated employer-based commute trip reduction options. Some of these options are more likely to result in significant GHG emission reductions than others.

Other possible approaches to managing passenger and freight vehicle traffic were originally developed as methods to reduce congestion and improve traffic flow. They could reduce GHG emissions from the perspective of reducing time spent idling in traffic with a traditional gasoline or diesel engine (if no additional trips resulted). However, it is unclear whether strategies to reduce traffic congestion – in particular those strategies that make driving faster without providing incentives to use alternate modes of transportation -- will in fact reduce travel overall, in part due to latent travel demand (itself a controversial topic.[17]) While idling can increase GHG emissions in conventional vehicles, high vehicle speeds can also boost GHG emissions due to lower fuel efficiency.

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Improving transit systems is another way to reduce GHG emissions in the transportation sector. Increased funding of public transit systems may be needed so that California residents have more travel options. These systems can be expensive if designed to provide reliable, affordable transit options to low-density neighborhoods, highlighting the importance of Smart Growth.

New approaches to public transit are advancing rapidly, and deserve further study for suitability in California. Some of these feature improved technologies that can be used in

current transit systems, such as electric-hybrid buses and fuel cell buses. Others are more novel approaches that may have greater potential for GHG emission reductions, such as Bus Rapid Transit (BRT) and Personal Rapid Transit (PRT) systems. Due to limited time and resources, and because these approaches are developing rapidly, ETAAC was unable to conclusively evaluate these options. More study of these technologies and approaches are warranted. Each technology or approach is at a different stage of development and may merit a different type of evaluation. For instance, hybrid buses are being deployed today, while PRT will need to be evaluated at the pilot project stage. In conducting studies relevant to California's distinct transit needs, the ongoing research and experience from other parts of the world should be considered. For instance, several BRT systems are now in successful service in cities around the world, while the first modern PRT system is only now being installed at Heathrow airport. This suggests that BRT systems might be closer to deployment here in California than PRT systems. Nevertheless, near-term implementation should not be the only criteria to judge new clean transportation technologies. New technologies and approaches should also be evaluated on projected GHG emission reductions, costs, and associated benefits such as reduced congestion, greater transit access for all communities, and the potential for manufacturing and other employment in California.

This chapter identifies economic and technological innovations for transit systems linked to improved transportation planning and roadway pricing, but does not evaluate and rank specific transportation system technologies. More information can be found in Appendix V.

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A. Planning: Smart Growth and Transit Villages

Planning measures can shift investments in housing and transportation infrastructure in a way that would reduce GHG emissions over the long term by providing desirable and low-GHG transportation options, largely by replacing automobile trips. Partnerships between the State government and regional and local agencies are critical to achieving these goals

Smart Growth is an urban planning and transportation strategy that emphasizes growth near city centers and transit corridors to prevent urban sprawl. This approach promotes mixed-use, infill and transit-oriented development; transit, bicycle and pedestrian-friendly infrastructure; preservation of open space; affordable housing; and other strategies to reduce traffic injuries and improve the livability of urban neighborhoods including non-residential speed limits, roundabouts, "parking maximums, shared parking, flexible zoning for increased densities and mixed uses, innovative strategies for land acquisition and development, and design emphasis on a sense of place."[18]

- *Timeframe*: Implemented by 2012. Emission benefits will continue to increase through the 2020 and 2050 timeframes as new development incorporates these concepts.
- *GHG Reduction Potential*: CalTrans estimates that the average household living in a transit village could emit 2.5 to 3.7 tons less CO_2 annually than a traditional household.[19] These figures are based on a CARB study estimating transit village

household private vehicle mileage reductions of approximately 20 to 30 percent annually.[20]

- *Ease of Implementation:* The obstacles to implementing smart growth policies will vary among regions, but ultimately will require each regional development agency to make reduction of GHG emissions a planning priority. State-level legislation requiring regional transportation agencies to address smart growth and then provide appropriate implementation incentives would enable regions to move closer to sustainability.
- *Co-benefits Mitigation Requirements*: Smart Growth policies play a critical role in reducing GHG emissions while improving the economy. Urban in-fill housing can be an effective tool to prevent creating more suburbs from existing farmland. Proponents point out that smart growth can reduce driving, increase walking, spur transit use, curb obesity *and* promote cleaner air.[21]
- *Responsible Parties:* Land use decisions are made at multiple levels of governance (e.g, building and urban design, local zoning and use separation, regional integration with land use patterns). It is therefore imperative that several interventions and policies occur at different institutional levels. These should be consistent and complementary with Smart Growth priorities.
    - *State Government*: In June 2007, the CEC released *The Role of Land Use in Meeting California's Energy and Climate Change Goals*, a report addressing the need for land use planning to reduce the GHG emissions from the transportation sector.[22] CalTrans has also looked at ways to reduce VMT. One of its programs is the Regional Blueprint Process, which establishes 20-year goals to reduce VMT on a regional basis. The State Resources Agency should amend CEQA guidelines to recognize transportation impact measures that are not biased towards automobiles over other modes of travel. In addition, policies and requirements relating to CEQA, the California Transportation Plan, housing element updates, the California Water Plan, and storm water plans, can all affect local land use planning and development. These State agencies will be critical in providing incentives for linking ongoing State planning processes with local and regional GHG emission reduction strategies.
    - *Land Use Agencies*: Implementation of Smart Growth policies by local agencies to reduce VMT will be particularly important to meet AB 32's GHG emission reductions. California local land use agencies, such as San Diego's SANDAG, provide regional plans for more efficient land use. They can play key roles in implementing smart growth policies and then monitor the progress of these planning practices over time. They can also generate funding for smart growth incentives. Smart Growth blueprints have been completed for the Sacramento, San Francisco Bay Area and Southern California and are under development in other areas including the San Joaquin Valley.

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- *Land Use Advocacy*: Land use agencies such as the Smart Communities Network[23] provide information sharing and best practices for local government and regional planning agencies.
- *Regional Transportation Agencies*: The Metropolitan Transportation Commission (MTC) is an example of a regional transportation agency. MTC is the transportation planning, coordinating and financing agency for the nine-county San Francisco Bay Area. It is responsible for regularly updating the Regional Transportation Plan, a comprehensive blueprint for the development of mass transit, highway, airport, seaport, railroad, bicycle and pedestrian facilities. The latest Plan features Smart Growth development patterns. MTC has developed new policies, funding programs and technical studies to foster smart growth, including transit-oriented development, regional growth planning, station area plans, and parking policies.
- *Developers*: Developers are the integral part of smart growth implementation. Equipped with sustainable practices, developers can build structures that generate fewer GHG emissions due to upfront construction decisions as well as ongoing daily operations.

Problem: Urban sprawl can increase and lock-in high rates of VMT, subsequently increasing GHG emissions and leading to inefficient land use practices. In addition, urban sprawl requires high rates of land consumption, which threatens farmland. Urban sprawl can also lead to inefficient spending of government funds on new infrastructure while leaving existing infrastructure unattended.[24] The low rates of physical activity associated with urban sprawl are also thought to have a negative effect on peoples' health and well-being.[25]

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The current Williamson Act mechanism used to keep farmland in agricultural use and delay housing or commercial development may not provide sufficient incentives for farmland owners to prevent urban sprawl and halt the growth of VMT. A large share of Williamson Act land in San Joaquin County is in non-renewal status, for example. Other states are more proactive than California in supporting smaller family farm operations.

Possible Solutions: The most important vehicle for implementing more smart growth planning is the coordination and provision of consistent incentives in infrastructure planning and development. Tying funding for these activities to Smart Growth goals, including GHG emission reduction goals, will encourage smart growth planning.

One form of Smart Growth is Transit Villages, which are typically mixed-use residential and commercial areas that are designed to maximize access to mass transit systems. They are usually located within one-quarter to one-half mile (0.4 to 0.8 kilometer) of a mass transit station. Bikeways, buses and Personal Rapid Transit systems could broaden the reach of transit oriented development by expanding beyond existing transit corridors and forming networks that reach more destinations. Transit oriented development can reduce VMT by 20-30 percent compared to conventional lower density development. With higher densities, more consideration is needed regarding how neighborhoods share

open space, bike paths, and pedestrian corridors. Other considerations include evaluating how urban dwellers travel within and between different cities. Along with improved transit, pedestrian, and bicycling infrastructure, these Smart Growth housing and land use practices are critical to reducing VMT. More electrified light rail systems are also needed for intra-city travel and as collectors linked to inter-city transit systems.

Incentives to provide residential housing close to employment centers (consistent with the ARB's "Air Quality and Land Use Handbook"), to support transit oriented development, to expand telecommuting, and to use video-conferencing in lieu of air travel, could all dramatically reduce VMT. Mixed-use development where shopping and services are within a comfortable walking distance for residents could also play a major role in cutting GHG emissions from the transportation sector.

Adding GHG emission reductions to the California Environmental Quality Act (CEQA) guidelines is yet another important complimentary policy that will encourage Smart Growth. Such a change to CEQA is already underway. By January 1, 2010, new guidelines to address global climate change will be incorporated into CEQA.[26] Though ETAAC has not been actively engaged in this rulemaking process, ETAAC endorses one specific change to the proposed CEQA guidelines on climate change to encourage Smart Growth. The use of "Level of Service" (LOS) as a measure of environmental impacts for transportation projects under CEQA[27] should be replaced with broader measure of access to goods and services and quality of life. Because the "LOS" matrix values only automobile convenience, projects that may increase access to goods and services and improved quality of life by facilitating other modes of transportation are likely to be rated unfavorably under LOS (see the Appendix V for more information).

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B. Pay-As-You-Drive Insurance

Pay-As-You-Drive or Pay-Per-Mile insurance assesses individualized premiums based upon miles driven instead of the calendar year, providing motorists a new option to save money by driving less and therefore minimizing insurance risk. Pay-As-You-Drive premiums incorporate traditional risk factors such as driving record and vehicle make and model. They also still reflect insurance coverage services selected by the consumer themselves.[28]

- *Timeframe:* Pay-as-you-drive insurance could be implemented quickly, by legislative and regulatory actions that allow insurance companies to implement these programs.
- *GHG Reduction Potential*: Applying the results of studies assessing mileage changes related to fuel prices, researchers have projected that pay-as-you-drive insurance could lead to up to a 12 percent reduction in driving and energy use.[29] Even a more modest benefit of a several percent reduction in driving would achieve significant GHG emission reduction benefits.
- *Ease of Implementation:* There are a range of challenges that insurance companies face related to offering Pay-As-You-Drive insurance, including

regulatory barriers, product start-up costs, explaining to customers the benefits of a new pricing scheme, mileage verification costs, consumer acceptance of at least some monitoring (even if only of mileage), and loss of premium dollars from existing low-mileage customers.[30]

- *Co-benefits Mitigation Requirements*: Government incentives to promote Pay-As-You-Drive insurance appear to be very cost competitive when viewed from the vantage point of reducing air pollution and saving lives. Other government transportation-related expenditures aimed at achieving these objectives are often more costly.[31] A 1 percent reduction in VMT typically lessens total vehicle crashes by about 1.2 percent.[32] Although it is difficult to predict actual congestion alleviation, even a small decrease in driving demand can limit congestion delays.[33]
- *Responsible Parties:* Insurance Companies; transportation agencies; CARB; State Insurance Commissioner.

Problem: At present, automobile insurance premiums do not adequately factor in the number of miles driven by consumers. This subsidy encourages more driving, leading to increased VMT, GHG emissions, and traffic accidents.

Possible Solutions: Convert insurance to a variable priced service that considers risk factors such as driving record. Several key organizations can play a major role in changing current insurance practices so that they account for climate change impacts.

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- *Insurance Companies*: Once insurance companies are allowed to use regular and reliable tools to verify their customers' mileage in California, they will be able to offer such products. Though they face some challenges in implementing this type of insurance, insurance companies in other state have the flexibility of instituting a Pay-As-You-Drive strategy and some have already put forward pilot programs based on this insurance scheme.[34] Since 2004, for example, the General Motors Acceptance Corporation (GMAC) has offered mileage-based discounts to OnStar subscribers located in certain states.[35]
- *Transportation Agencies*: CalTrans is the State agency that is pivotal to alleviating traffic congestion and implementing successful transit systems. CalTrans is likely a critical player in making Pay-As-You-Drive operations successful.
- *State Insurance Commission:* The State Insurance Commission plays a significant role in determining how insurance companies set rates for consumers. In 2006, insurance companies were ordered by this Commission to place more weight on each individual driver's record, rather than his/her zip code. The State Insurance Commission could mandate that insurance companies adjust rates based on how much consumers drive. This is currently given little weight. Smog check mileage records could provide information to verify the mileage provided by consumers.

C. Congestion Charges

Congestion pricing uses electronic transponders in the vehicle, database-linked cameras, and other barrier-free means to charge drivers as they enter heavy traffic congestion zones. This system works well in combination with public transit, and can be used as a source of funding for improved public transit systems. London, Norway, Rome, Singapore, and Stockholm are urban centers where such congestion pricing has already been successfully implemented.

- *Timeframe:* Initial project(s) in place by 2012; with additional potential projects feasible in time for 2020 targets.
- *GHG Reduction Potential*: Exact reductions would depend on the areas covered and specific program design. Potential GHG emissions reductions of one million tons per year or more could be achieved if applied to areas responsible for 10 percent of the state's vehicle GHG gas emissions.[36] The City of San Francisco Climate Action Plan sets a goal of reducing 165,000 tons per year of CO_2 emissions by reducing VMT.[37] The San Francisco County Transportation Authority has identified congestion pricing as a key component of that strategy.[38]
- *Ease of Implementation:* Local planning authorities need legal authority from the State to implement congestion pricing. State support for planning and/or initial set-up of congestion mitigation pricing systems would also be beneficial.
- *Co-benefits Mitigation Requirements*: Reductions of pollutants such as fine particulates and ozone forming pollutants, and reductions in traffic deaths and injuries, are examples of major co-benefits. Revenues can be used for projects to accommodate increased demand for alternatives such as transit, walking, and bicycling. Public hearings and outreach can help focus these improvements to mitigate disadvantages and maximize improved transit and other transportation co-benefits to meet AB 32's Environmental Justice goals.
- *Responsible Parties:* The State Legislature would provide legal authority. Local transportation planning agencies would be responsible for evaluating potential projects, such as areas with existing effective transit systems or the potential for effective transit, with support and coordination from CalTrans and Regional Transportation Agencies as needed.

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Problem: VMT is an important contributor to global climate change, air pollution, and other congestion-related problems.

Possible Solutions: Congestion pricing has the potential to reduce traffic jams, VMT, and GHG emissions. Under congestion pricing, drivers are charged via electronic and other barrier-free options to enter an area of heavy traffic. London reduced GHG emissions from road traffic by 16 percent within its congestion pricing area,[39] lowered traffic, and improved transit and bicycle use.[40] The City of Stockholm is estimated to have reduced CO_2 and particulate emissions by 14 percent, which equates to approximately 100 tons per weekday 24-hour period.[41] Such congestion pricing

programs could offer varying fees based on different tiers that factor in co-benefits. London, for instance, offers exemptions for electric cars.[42] Other factors could be studied during the local planning process for California agencies. Revenues collected under such a program could be used for transit improvements, thus further reducing VMT and traffic congestion. Roadway improvements could also be candidates for this source of funding.

The City of San Francisco is currently seeking to move forward with a congestion charging project covering access to downtown and certain other areas of San Francisco. San Francisco is also conducting a study to be completed by the summer 2008 for a possible second project that would cover traffic hotspots like the downtown area.

The California Legislature should adopt legislation providing local governments with the authority to implement congestion pricing projects after a public review process that includes a local public hearing. CalTrans and Regional Transportation Agencies should examine appropriate opportunities to support and coordinate potential projects within the state.

D. Employer-based Commute Trip Reductions

Employers and their employees can reduce GHG emissions by reducing drive-alone commuting.

- *Timeframe:* Could be implemented by 2012.
- *GHG Reduction Potential:* Varies based on option(s) chosen.
- *Ease of Implementation:* Varies based on option(s) chosen.
- *Co-benefits Mitigation Requirements:* Varies based on option(s) chosen.
- *Responsible Parties:* CARB; employers; employees; and potentially others based on the specific option chosen.

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Problem: Just over one fifth of personal travel is for commuting to work. According to a 2000 US Census and National Household Travel Survey, just over three quarters of these US commuter trips are drive-alone trips. What that translates into is that roughly 17 percent of personal travel is drive-alone commutes that could be minimized through employer-based policies.

Potential Solutions: Several employee trip reduction policies are already in place in California, designed to lower air pollution. Existing employee-based strategies that reduce VMT will reduce more GHG emissions and other air pollutants if they are expanded to cover more employers. Other programs designed to limit or offset other air pollutants such as nitrogen oxides (NOx), volatile organic compounds (VOC), fine particulates (PM), and carbon monoxide (CO), from new land development (e.g. a new shopping mall) could also be expanded to require reductions of GHG emissions. Strategies such as increasing transit usage, and potentially also telecommuting and flexible work schedules, could be promoted either as expanded mandatory programs or as voluntary measures.

However, the cost-effectiveness of these programs is not clear. Policies that lower the per-mile GHG emissions of personal travel will tend to make policies to reduce VMT less cost-effective. (Of course trip reduction policies have other benefits such as lower levels of congestion.) Furthermore, placing a price on all GHG emissions may tend to reduce the need for trip reduction policies. Note that at present, there is *no* price attached to air pollutants. So if one is imposed on GHG emissions, the need for other policies like those discussed below will be less than the need to control air pollution. And in some cases, eliminating commute trips may not reduce GHG emissions as much as it might first appear since the employee who does not commute may use energy in their home office and may make other trips (e.g. for lunch) that they would not have otherwise. ETAAC recommends that the CARB study the cost-effectiveness of all policies it proposes to undertake, incorporating the factors noted below in any analysis.

- *Mandatory programs for both existing and new commute travel*: One existing mandatory program covers both existing employers and one covers new land development, as described below. South Coast Rule 2202 requires employers with over 250 employees (with a few exceptions) to reduce employee trips and provides employers with a menu of how to options. Employers can either reduce emissions, and/or purchase credits for mitigation. Similar rules could be applied to other areas where the potential to reduce drive-alone commuting exists. Parking cash-out programs are another example. Employers are required under state law to allow employees to "cash-out" the value of free parking that is provided at the employer's expense, under certain circumstances. **13-123 cont.**

  Several existing California programs are aimed at reducing air pollutants for new development, including -- but not limited to -- additional employee commute trips. Developers subject to NEPA or CEQA may be required to mitigate air pollution emissions. The State is currently developing standards for addressing GHG emissions under CEQA. Many project developers are integrating evaluations of climate change impacts of their projects on a case-by-case basis. A number of Air Quality Districts have adopted "indirect source rules," which require on-site reductions of some or all of the expected emissions (such as NOx and PM) or paying a mitigation fee (for instance, San Joaquin Valley Rule 9510.) These rules would also reduce GHG emissions if expanded to cover these pollutants, especially in cases where GHG emission reductions are not already required as mitigation under CEQA.

- *Shifting commute trips to other modes of travel:* Other modes of travel include ridesharing, public transit, walking, and bicycling. These modes can be promoted as a compliance option for mandatory programs. Employers can also support these options on a voluntary basis to increase employee-satisfaction and demonstrate environmental stewardship under an Environmental Management System or as a stand-alone measure.

These shifts are not expected to lead to opportunities for additional personal travel by vehicle, or at-home energy use, as this strategy is not intended to affect the type of work schedule.

- *Telecommuting:* With its leading role in promoting information technology, California seems well suited to telecommuting, where employees work from a home-based office. (Telecommuting also includes satellite workplaces that are closer to home). This strategy can become a compliance option for mandatory programs. Like the previous option described above, telecommuting can be promoted on a voluntary basis by employers for identical reasons. Home energy usage could potentially offset travel-based GHG emission reductions. ETAAC did not attempt to quantify these values.

- *Compressed Work Schedules:* Under compressed work-week schedules, employees work a smaller number of longer days, such as a four-day 10 hour work week, or work seven days of 12 hours each over a two week period. Commute travel would be avoided on the day that the employee did not drive to work. Additional personal travel and at-home energy usage complicates the question of whether a net GHG emission benefit should be expected, and if so, whether a measurable impact could be determined.

  However, compressed work schedules are often not cost-effective for California employers because state law requires payment of overtime compensation for work performed by an hourly employee who works in excess of eight hours in a single day or more than 40 hours in a single work week. (This is more restrictive than Federal law, and all other states, where overtime pay is required after 40 hours in a week). As a result, employers have a disincentive to schedule a four-day compressed workweek schedule because the last two hours of each ten-hour workday incur time and a half wage rates. Split shifts for 24 hour operations (12 hours on, 12 hours off) are even more costly. California allows for "alternative schedules," but only under very detailed Industrial Welfare Commission wage orders that are difficult to implement and rarely used. At present only 11,000 out of California's 800,000-plus employers operate under these "alternate schedule" rules.

  Changes to state labor law are contentious and involve issues such as safety, flexibility, cost savings, and politics. ETAAC does not have the expertise or responsibility to consider all these factors and is therefore not able to make any specific recommendations. However, it is clear that CARB should conduct a study examining the following factors: How much would wages be decreased by these changes in labor law? Would lowering wages for hourly workers currently earning daily overtime wages disproportionately impact low-income communities and therefore conflict

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with AB 32's Environmental Justice provisions? Will this measure lead to a change in work schedules without changing behavior? In addition, health and safety concern outcomes should be quantified as well as the probable size of the expected net GHG emissions reduction.

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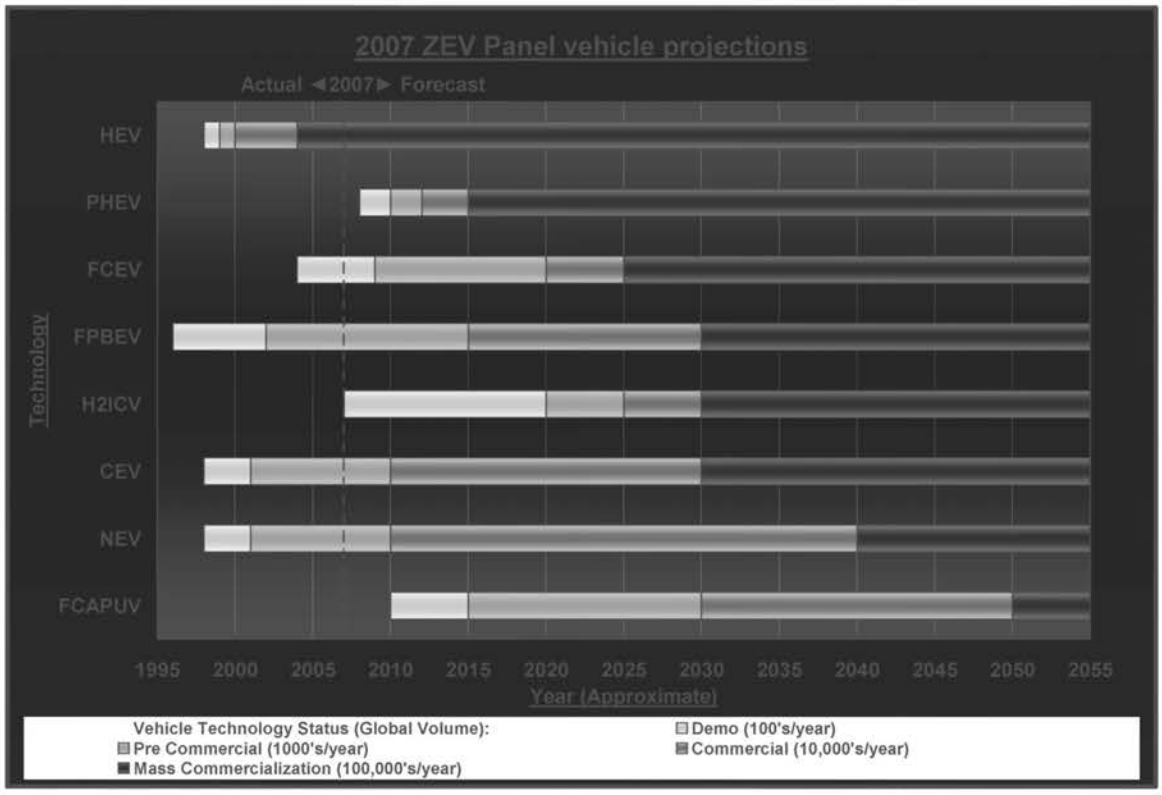
IV. Improving Vehicle GHG Emissions Performance

ETAAC has identified technology-forcing standards and economic incentives as key pathways to low and zero GHG emission vehicles. Like most measures that improve efficiency, these policies may pay for themselves and do not require public sector subsidies.

There are a number of successful programs that the state can build on. CARB's AB 1493 regulations establish a critical, performance-based system for driving low-carbon vehicle technology into the market through 2016. The ZEV program is leading the development of zero tailpipe emission vehicles that are expected to become commercially available around the time that follow-up standards to AB1493 would take place (see projections below). Bridge technologies like plug-in hybrids should be available even before that date. The main priorities of this section is to describe the development of new standards taking advantage of new technology for low and zero tailpipe emissions passenger vehicles and to expand those efforts to include the medium and heavy-duty vehicles. While these efforts are focused on cutting carbon emissions, California should also partner with the Federal government to demonstrate low and zero carbon technologies can also help form the basis for urgently needed improved Federal fuel economy standards.

The section also describes complimentary pricing recommendations that will facilitate compliance with these standards. Incentives to exceed these standards will also be examined. Another key financial incentive for low and zero tailpipe emission vehicles is the "feebate" recommendation described in the Financial Sector Chapter (Chapter 2-E) of this report and below. [43]

13-123 cont.



CEV city electric vehicle
FPBEV full performance battery electric vehicle
FCAPUV fuel cell auxiliary power unit vehicle
FCEV fuel cell electric vehicle
H2ICV hydrogen internal combustion vehicle
HEV hybrid electric vehicle
NEV neighborhood electric vehicle
PHEV plug-in hybrid electric vehicle [44]

13-123 cont.

E. New Vehicle Technology Improvements

While forward thinking when written -- and vitally important for near term AB 32 compliance – AB 1493 does not capture the full potential for GHG emission reductions now technically possible from motor vehicles. For instance, the legislation covers only passenger vehicles and the cost-effectiveness analysis is based on gasoline prices ($1.74 per gallon) that no longer reflect real world conditions. A more comprehensive standard for post-2016 vehicles of all types would net even greater GHG emission reductions and can help foster partnership opportunities nationally and internationally.

- *Timeframe:* In effect by 2020.
- *GHG Reduction Potential*: 4 MMT by 2020; 27 MMT by 2030 for passenger vehicle standards. In particular, new engine, transmission, tire, and aerodynamic designs, idle reduction, and advanced auxiliary power units could ultimately reduce GHG emission from new freight trucks by one third to one half.[45]

- *Ease of Implementation:* Changing vehicle manufacturing lines may be difficult
- *Co-benefits Mitigation Requirements*: Very high co-benefits, including reductions in up-stream refinery emissions and reduced reliance on imported petroleum. A supporting in-state clean fuels infrastructure of would maximize these co-benefits.
- *Responsible Parties:* CARB; auto manufacturers.

Problem: Continued reductions in vehicle GHG emissions will be necessary beyond the 2016 end point of California's first round of passenger vehicle standards to account for currently available technology and future developments. The recent U.K. King Review of low carbon motor vehicles found significant deployment market barriers. These barriers include fixed capital investments in older technology, the need for economies-of-scale to make new technologies economical, and lack of high-priority given to fuel economy in consumer purchases.[46] Since vehicle manufacturing is a global industry, these same barriers affect vehicles available in California. Although the medium and heavy duty transport sector is sensitive to fuel prices, market barriers also exist to developing new technology for this sector.

Possible Solutions: In September 2004, CARB approved regulations to reduce GHG emission reductions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks and will be phased-in from 2009 through 2016 model years. Between 2009 and 2012, these standards will cut GHG emissions by 22 percent compared to the 2002 fleet of passenger vehicles and light duty trucks. Mid-term – during the 2013–2016 time frame – these standards will cut GHG emissions by approximately a 30 percent.

13-123 cont.

CARB intends to present new standards in the fourth quarter of 2012, which would impact the 2017 model year. The ETAAC transportation sector subgroup believes that follow-up technology-forcing performance standards are an immediate priority in order to accomplish the following:

- Take into account the full range of emerging vehicle technologies;
- Partner with other countries in the European Union and elsewhere that are currently developing new standards;
- Provide manufacturers with adequate lead time to introduce cleaner new vehicles.

These standards can also build on the State's ZEV program, which is intended to help drive the development of automotive technology that will limit GHG emissions. A ZEV review panel will assess the status of these technologies, which ETAAC did not attempt to duplicate in this report. Some of these technologies are available today (i.e. hybrids) while others will be available in the mid-term.[47] The timing of the rule adoption process should be flexible enough to accommodate an accelerated schedule, if needed, to provide sufficient lead time for manufacturers to bring new vehicles to market in 2017.

The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the statewide fleet. Assuming that the new standards call for about a 50 percent reduction from pre-AB1493 levels beginning in 2017, CARB staff estimates a reduction potential of 27 percent[48] -- 27 MMT[49] -- in 2030.

Additional decreases would be achieved if new vehicle standards were also applied to the heavy duty trucking sector, which accounts for nearly one-fifth of transportation sector emissions. In particular, new engine, transmission, tire, and aerodynamic designs, idle reduction, and advance auxiliary power units could ultimately reduce GHG emissions from new freight trucks by one third to one half.[50] Although the freight industry is sensitive to fuel prices, technologies that slash fuel consumption have been slow to find their way to market. Comprehensive standards should not delay the planned near-term implementation of Smart Way efficiency improvements contained in CARB's Early Action Plan. Instead, the results should be incorporated into a broader look at driving innovation and the uptake of existing technologies. The Early Action Plan discussion of hybrid technology identifies a number of important Federal and private sector partners, and international coordination can also play a valuable role in this effort. The National Academy of Sciences review of the 21st Century Truck Partnership will provide critical information that ETAAC did not attempt to duplicate in this report, and implementation studies associated with the new federal standards are another source of technical information.

Potential Heavy Duty Vehicle Near Term and Future Technologies

- *Vehicle Technologies*

Accessory Electrification (air conditioning, etc)
Efficiency Improvements (lubricants, brake and bearing drag)
Aerodynamic Drag
Vehicle Mass Reduction
Tire Rolling Resistance
Other Factors (vehicle weight, road speed, logistics, maximum loaded weight restrictions)
Advance Auxiliary Power Units

- *Engine Technologies*

Improved Selective Catalytic Reduction
Engine Friction Reduction
Engine Controls Refinements
Improved Air Handling Efficiency
Low Temperature Combustion
Homogeneous Charge Combustion Ignition/Partial Charge Compression Ignition
Sturman Digital Engine
Post Combustion Heat Recovery
Thermal Management Engine Improvements
Fuel Cell Electrochemical Engines

- *Drive train Technologies*

Continuous Variable Transmission
Automated/Manual Transmission
Hybrid (hydraulic and/or electric)
Electric Drive

13-123 cont.

Sources: International Council on Clean Transportation; and National Academy of Sciences 21st Century Truck Partnership

F. Low Carbon Fleet Standards and Procurement Policies

Performance standards and procurement policies can facilitate implementation of low and zero carbon vehicles.

- *Timeframe*: By 2012, expanding to heavy-duty vehicles by 2020.
- *GHG Reduction Potential*: This recommendation can complement the implementation of AB 1493 standards and post-2016 standards; as well as the ZEV program.
- *Ease of Implementation:* Potential barriers are the need to increase "market pull" for the continued development and implementation of low and zero emission vehicles, helping to mitigate current price premiums for these vehicles. Companion fuel infrastructure policies will be critical to success.
- *Co-Benefits Mitigation Requirements*: Large co-benefits will be achieved from less local air pollution and less reliance on imported petroleum. Increased clean energy supply, including renewable energy sources whenever feasible, will maximize overall emission cuts, including vehicle tailpipe and oil refinery emissions in communities concerned about Environmental Justice.
- *Responsible Parties:* CARB; Federal, State, local and other fleet owners and managers.

13-123 cont.

Problem: The efficiency benefits of new technology are not fully utilized. In addition, new technologies must be demonstrated before they are commercialized.

Possible Solutions: Many local fleets have requirements for the fuel economy of the vehicles they purchase. The first component of this suggested policy is setting standards to require certain fleets to purchase vehicles meeting a GHG emission standard. The standard could be structured as an average over a fleet -- or even across all fleets in a given category -- with a credit trading program.

A performance standard for fleet vehicle procurement would be similar to that of AB 1493, denominated in GHG emissions per mile. However, buyers of new vehicles instead of sellers would be responsible – and would also receive the benefits of more efficient vehicles. Such a standard may be subject to less procedural or jurisdictional challenges than the AB 1493 rule impacting vehicle manufacturers. This policy should be applied to State fleets immediately, and eventually all other public and private fleets that receive any funding through State tax or fee revenue and/or utility ratepayer revenue. In addition, the Energy Policy Act (EPACT) now allows State and local agencies to achieve petroleum reduction goals relying on hybrids and other high-efficiency vehicles

instead of purchasing lower-efficiency vehicles that could in theory burn ethanol blends such as E85 (but instead use higher levels of gasoline.) For instance, the State of California has recently completed a purchasing arrangement that will assist State and many local agencies to purchase gas-electric hybrids that achieve a minimum of 42 miles per gallon, instead of the State minimum standards of 26 miles per gallons for other vehicle of similar type.

In addition to passenger vehicles, this type of standard could apply to CARB's transit bus fleet rule and could be considered for other fleet rules that would reduce GHG emissions from vehicles such as refuse trucks and port drayage trucks.

As a second step, Federal, State, regional and local government agencies -- as well as utility and other private fleets – should participate in advanced technology vehicle demonstrations. This effort should start immediately. Targets should be set with the ultimate goal of reaching a 100 percent ZEV target by 2035 or sooner. Vehicle fleets would then be fully transitioned to zero carbon technologies before AB 32's 2050 deadline for cutting total GHG emissions by 80 percent. The State of California and several organizations represented by ETAAC members (the Bay Area Air Quality Management District, PG&E, and the University of California – Davis) are among the organizations helping to demonstrate hydrogen fuel cell cars by including them in their fleets. Procuring ZEVs and PHEVs in fleets during the demonstration and early commercialization phase will achieve several important goals, among them the development of advanced vehicle technology and infrastructure and enhanced air quality. **13-123 cont.**

G. Vehicle Feebates, Registration Fees and Indexed Fuel Taxes

Fiscal incentives to promote more fuel efficient vehicles can complement carbon standards without restricting customer access to a full range of vehicle choices. Options include a revenue-neutral vehicle "feebate" program (see Chapter 2-E). Additional potential approaches include the idea of basing vehicle registration fees on GHG emissions. Yet another would be to base fuel tax levels on GHG emissions and indexed to match inflation and keep pace with VMT increases.

- *Timeframe*: By 2012.
- *GHG Reduction Potential*: Indexed fuel taxes will affect about one-third of California's emissions (from gasoline and diesel fuel) and could have a significant impact. It is not possible to estimate the available GHG emission reduction potential at this time. The other measures are also expected to offer a substantial benefit by improving the GHG emission rates of California's entire vehicle fleet.
- *Ease of Implementation:* Potentially difficult.
- *Co-Benefits Mitigation Requirements*: Increased gas taxes could be used in part to increase transit opportunities for low-income and other communities; changes to registration fees could be phased-in to give consumers time to adapt.
- *Responsible Parties:* State Legislature; State implementing agencies.

Problem: Adjusted for inflation, fuel taxes have steadily decreased as road usage, GHG emissions, and infrastructure needs have all increased dramatically. The Legislative Analyst's Office (LAO) has identified a critical need to increase fuel taxes to fund infrastructure upgrades. In addition, standards that are set based on different vehicle types may not completely reflect the climate change response benefits of purchasing vehicles in a class with lower GHG emissions.

Potential Solutions: Many countries create a market pull for more efficient and therefore cleaner vehicles through higher fuel taxes and registration fees levied on GHG emissions directly or on surrogate factors (vehicle weight, engine displacement). Upfront and rebates costs can be especially effective, such as vehicle purchase taxes that are reduced for low carbon vehicles and increased for high carbon vehicles. The U.K. indexes vehicle registration fees according to tailpipe GHG emissions, while Germany and Japan base fees on other factors that relate to GHG emissions, such as engine displacement and vehicle weight. Vehicle registration policies affect new vehicles as well as existing vehicles that would not be covered by new vehicle GHG standards. A phase-in period for existing vehicles could be considered by State policy makers to facilitate a smooth transition to this new pioneering system. This approach would send the right price signal to consumers.

California's LAO[51] has observed that just to maintain current infrastructure, gas taxes should be increased by ten cents per mile. Boosting the revenue collected from fuel taxes can also provide fiscal resources for new public transit systems. These systems could be designed to serve regions where consumers may be most affected by increased fuel costs, regions where Environmental Justice has been an issue. Taxes on gasoline in Japan are approximately triple that of California's combined $0.63 per gallon for Federal and State excise taxes. Some Europe countries impose taxes as six times that level. A modest tax increase in California's fuel tax would provide critical maintenance of road infrastructure and transit while still falling well below fuel taxes imposed in most other developed countries.[52] Indexing fuel taxes to inflation and VMT (as fuel consumption per mile is likely to fall without reducing the need for infrastructure) is crucial to avoid future funding shortfalls. The State should also encourage similar policies at the Federal level.

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H. Air Quality Incentives Programs and Standards

Air quality programs such as the Carl Moyer incentive program do not include a value for diminishing GHG emissions. Coordinating GHG emission reduction programs with existing air quality improvement programs (for both vehicles and other sources) would help meet AB 32's climate change response goals. It could also improve the efficiency of incentive programs to cut both GHG emissions and other air pollutants.

- *Timeframe:* By 2012.
- *GHG Reduction Potential*: To be determined, based on funding levels.
- *Ease of Implementation:* May be difficult to coordinate initially, but then easier to implement over time compared to managing separate, uncoordinated programs.

- *Co-benefits Mitigation Requirements*: Co-benefits include criteria pollutant reductions.
- *Responsible Parties:* State Legislature as needed; CARB; regional and local implementing agencies; any new organization created to administer GHG emission reduction funds.

Problem: Several types of State air quality incentive funds are available to decrease pollutants such as fine particulates and ozone that violate State and Federal standards. Many of these programs focus on vehicle retrofits. They have not traditionally reflected the need to treat GHG emissions as air pollutants. Incentives and air pollution control standards now need to recognize both GHG emissions and more traditional pollutants as high priorities.

Possible Solutions: The Carl Moyer Memorial Air Quality Standards Attainment Program provides incentive funds (currently $140 million per year) toward the incremental cost of new engines and equipment that go beyond State minimum air quality requirements for NOx, PM, and reactive organic gas (ROG).[53] Eligible projects include cleaner on-road, off-road, marine, locomotive and stationary agricultural pump engines. Forklifts, airport ground support equipment, and auxiliary power units are also eligible for State retrofit funds. The State, in partnership with local agencies, is also implementing a new Proposition 1B Goods Movement Program, to upgrade technology and reduce air pollution emissions and health risk from freight movement along California's trade corridors.[54] This State program is funded to provide $250 million annually over four years.

13-123 cont.

Any incentive funds that are available for GHG emission reductions in the transportation sector are likely to overlap with these existing programs. Coordination is clearly needed. A project could be funded if it meets cost-effectiveness criteria when both types of reductions – climate related and criteria pollutants -- are recognized, even if it could not qualify based on just one or the other. This would likely require the revision of program guidelines for existing programs. This approach has already been implemented for the Bay Area Air Quality Management District's Transportation Fund for Clean Air program.

It is important that technology-forcing standards recognize GHG emissions just as climate change response incentives and measures must consider effects on other air pollutants. Tailpipe standards should consider less prominent GHG emissions such as nitrous oxide (N_2O) and methane (CH_4). Standards such as federal Clean Air Act Best Available Control Technology should evaluate GHG emissions as an environmental impact along with other air pollutant emissions. Exceptions can be rendered. (For example, the Federal Clean Air Act Lowest Achievable Emission Rate does not allow for evaluation of cost or co-benefits/dis-benefits). ETAAC encourages continued efforts by State and local agencies to coordinate and integrate GHG emissions into existing air quality programs.

V. Low-Carbon Transportation Fuels

After VMT are reduced and the energy efficiency of motor vehicles is upgraded, there will still be a need for large quantities of alternative, cleaner transportation fuels. The lifecycle GHG emissions of transportation fuels are being addressed through the Low-Carbon Fuel Standard (LCFS) mandate being developed by CARB. The ETAAC transportation subgroup notes that other fuel tax incentives to encourage low carbon fuels are covered in Chapter 2 (the Financial sector). Likewise, biofuels production is covered in Chapter 6 (the Agricultural sector).

I. Create Markets for Green Fuels

The LCFS mandate being developed by CARB addresses the lifecycle GHG emissions of transportation fuels. However, independent incentives might expedite achieving or even exceeding that standard and creating a basis for deeper future reductions, while creating opportunities for additional in-state production.

- *Timeframe:* Could be implemented by 2010 and improved after that.
- *GHG Reduction Potential:* Unclear, but green products typically fill a few percentage points of markets for goods (e.g. renewable electricity).
- *Ease of Implementation:* Determining the lifecycle GHG emissions of biofuels is complex, but measurement systems are already being developed by CARB as part of the LCFS. However, providing the results of this analysis to consumers would require tracking of specific fuel blends down to the retail level, a level of detail not currently envisioned under the LCFS protocol. A new tracking system would therefore be required. A significant additional technical analysis would not be required to develop such a tracking system. **13-123 cont.**
- *Co-benefits Mitigation Requirements:* Low-GHG emission fuels may have better environmental performance on other dimensions, but in some cases may create other negative air quality impacts. Careful evaluation of these impacts is clearly needed. Policies should ensure that air and water pollution are not worsened by the LCFS.
- *Responsible Parties*: CARB; oil and gas industry; biofuels industry; electricity industry; possibly the auto industry.

Problem: Biofuels and other new alternative fuel products can have either a positive or negative effect on global climate change depending on production methods and other factors. Current corn-based ethanol production often releases GHG emissions similar to, and sometimes higher than, traditional fossil transportation fuels once all of the air emissions effects are accounted for. New technologies will be needed to significantly lower the GHG emissions of biofuels as well as improve co-benefits.[55] Any Green Biofuels program should be designed so that it encourages technologies that drive down GHG emissions. One approach might be to encourage California farmers to collect and use agricultural waste as a bio-fuel feedstock to complement the existing CARB regulatory requirements.[56] International, Federal and State standards for sustainable low

carbon bio-fuels are currently being developed. So far, however, they do not offer any environmental performance information to consumers. With additional tracking standards, these systems could be used to engage consumer demand through a "Green Fuels Labeling Standard" in California.

Possible Solutions: A voluntary or mandatory Green Fuels Labeling Standard could be created to guide consumer purchasing preferences. This is especially important for biofuels because of the potential negative environmental and social implications of different feed stocks and cropping methods. Once waste-derived biofuels are fully commercial, new incentives could be used to expand the blending of biomass-derived fuels with conventional fuels beyond LCFS requirements (e.g., cellulosic ethanol blended with gasoline, renewable diesel blended with petro-diesel). This information could be included on fuel content labels.

Measuring the lifecycle GHG emission content of biofuels and developing appropriate regulations is a challenging undertaking. Increased support for the collection and analysis of data (including development of better analytic methods) will be crucial to successful deployment of low carbon biofuels. A valuable near-term step would be for CARB to review available studies of this issue by the beginning of 2010, including the upcoming U.S. National Academies study called for in recent federal legislation.

Next Generation Transportation Fuels

Some next generation transportation fuels may require new refueling infrastructure and market rules. For example, the expected introduction of plug-in hybrid and full performance electric vehicles will probably require some new supply infrastructure (e.g. meters and appropriate tariffs). CARB's ZEV review panel projects that such needs will occur within the expected lifetime of the electric generation, transmission and distribution systems being planned today. Forward-looking planning will be necessary to capture the potential synergies between energy sources employed for traditional electricity use and new vehicle fuels. Similarly, the introduction of fuel cell vehicles would necessitate a refueling infrastructure.

Several different State agencies have roles to play to ensure that the private sector has the appropriate incentives and regulatory framework so that the next generation of transportation fuels can help California meet its climate change goals. Specific issues that require evaluation and action include appropriate energy procurement by the electricity sector -- enabling new vehicle technologies to be used as energy storage for the electricity grid -- and addressing how increased electricity demand for charging up vehicles does not add to California's overall peak demand for electricity.

13-123 cont.

VI. International GHG Emission Sources

International shipping and aviation are two sources of GHG emissions that are continuing to grow. Only international cooperation will fully address these large contributions to global climate change. The ETAAC transportation sector subgroup encourages State and local agencies to consider actions under their current regulatory authority to address these GHG emissions. Policy options include marine vessel speed reductions and carbon-based landing fees. Some policies designed to reduce NO_X emissions -- such as speed-reduction zones for marine shipping -- are expected to provide climate change response co-benefits. Some jurisdictions have used revenue-neutral incentives. Airport landing fees that vary according to the NO_X emissions of different planes is one prime example. It is also possible to lower GHG emissions from marine ports and airports through the use of cleaner energy sources to provide shore-based power for vessels, electric service vehicles, and so forth. These changes could provide important co-benefits in the form of improved air quality.

Aviation is both intrastate and international, and presents some unique opportunities. Because fuel is a major cost for the aviation industry, it has pursued significant energy efficiency improvements in recent decades. As is the case in other areas of the broad transportation sector, efficiency is only part of the solution. Better fuels and better infrastructure will also be needed. California should publicly support RD&D investigating biofuels and other alternative fuels for use in aviation applications. Increases in Federal support for RD&D for advanced air traffic management systems would help improve the air travel infrastructure and could provide modest reductions in aviation-related GHG emissions. Potential airport expansions should only be considered if the GHG emission effects are justifiable due to other co-benefits. The State of California could consider a detailed evaluation of how to reduce the carbon footprint of air travel in the state (or alternatives), including all three of these aspects: better aircraft, better fuels, and better infrastructure.

13-123 cont.

The International Marine Organization and International Civil Aviation Organization plays an important role in establishing many types of environmental requirements for these global market sectors. The Federal government will also need to play a leading role in encouraging international cooperation on broader efforts to reduce GHG emissions. Today, for example, California does not have the authority to set engine GHG emission standards for these sources. Any proposed changes to air traffic control patterns will require cooperation from the Federal Aviation Administration. These efforts will play an important role in combating the trend of increasing GHG emissions from these international sources of GHG emissions.

VII. Priority Actions

Item	Relates To	Who
1. Introduce standards to dramatically reduce GHG emissions from both light and heavy duty vehicles	Improved Vehicle GHG performance	CARB, auto industry, heavy duty vehicle manufacturers, Federal government
2. Implement requirements for low carbon fuels	Low GHG Fuels	CARB, Federal government, oil industry, electricity industry, auto industry, biofuel industry
3. Place a price on carbon through a cap or tax	Overall strategy	CARB, Federal government
4. Tie infrastructure funding to Smart Growth goals	Transportation Demand Management/ Transit/ Pedestrian & Cycling Friendly	State Government, Land Use Agencies, Regional Transportation Agencies, Developers
5. Incentives for Transit Villages	Transportation Demand Management / Pedestrian & Cycling Friendly	Same as above
6. Coordinate Air Quality Incentives & Standards with GHG Objectives	Improved Vehicle and Stationary Source GHG performance	CARB, local air Districts
7. Replace Automobile Level of Service as the benchmark for CEQA transportation evaluation	Transportation Demand Management / Transit/ Pedestrian & Cycling Friendly	State Resources Agency; state, regional, and local transportation planning agencies
8. GHG Based Vehicle Feebates	Improved Vehicle GHG performance	State Legislature, CARB
9. GHG Based License Fees	Improved Vehicle GHG performance	State Legislature & implementing agencies
10. Indexed Fuel Taxes	Transportation Demand Management and Low GHG Fuels	State Legislature, implementing Agencies
11. Congestion Charges	Transportation Demand/ Transit/ Pedestrian & Cycling Friendly	State Legislature, local transportation planning agencies, CalTrans/Regional Transportation Agencies
12. Pay-as-you Drive Insurance	Transportation Demand	Insurance Companies, State Insurance Commission, Transportation Agencies
13. Employer Based Commute Trip Reductions	Transportation Demand/ Transit/ Pedestrian & Cycling Friendly	CARB, employers, employees
14. Improve fuel LCA GHG measurement	Low GHGs	CARB, CEC, Universities, Federal Government
15. Create Green Fuels Markets	Low GHG Fuels	CARB, oil and gas industry, biofuels industry, electricity industry, possible the auto industry

13-123 cont.

[1] Bemis, G. *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004*, California Energy Commission, Sacramento, CA (2006) p. 117.

[2] Notes:
-Cars and light duty truck emissions are almost entirely from gasoline (less than 1 MMTCO2E came from distillate.)
-Ships in California waters include intrastate, interstate and international trip emissions out to 24 miles.
-Heavy-duty includes trucks with a loaded weight over 8500 lbs, as well as buses and motor homes.
-"Other" is assumed to be proportionate to light and medium duty for split between CO2, N2O and CH4.

[3] Mizutani, C., *Transportation Fuels, Technologies, and Infrastructure Assessment Report. Integrated Energy Policy Report*, California Energy Commission, Sacramento, CA (2003) p. 86.

[4] This regulation's implementation has been the subject of litigation brought by six automakers (DamilerChrysler, Ford, General Motors, Honda, Nissan, and Toyota). The U.S. Environmental Protection Agency has yet to issue a waiver needed under the federal Clean Air Act.

[5] Kavalec, C., Page, J.. et al, *Forecasts of California Transportation Energy Demand 2005-2025*, California Energy Commission, Washington, DC (2005).

[6] The ETAAC did not have the resources to evaluate current CARB regulations pertaining to AB 32. In addition, it would be premature for the ETAAC to make recommendations on those rulemakings at this time without the benefit of information that will be developed later during the rulemaking process and public comment period.

[7] Draft Expanded List of Early Action Measures to Reduce Greenhouse Gas Emissions in California Recommended for Board Consideration, September 2007.

13-123 cont.

[8] http://www.carbontrust.co.uk/default.ct

[9] Morgenstern, R. D. and Pizer, W. A., *Reality Check: The Nature and Performance of Voluntary Environmental Programs in the United States, Europe, and Japan*, Resources for the Future Press, Washington, DC, (2007).

[10] Turner, B. T., Plevin, R. J. et al., *Creating Markets for Green Bio-fuels*, Transportation Sustainability Research Center, University of California-Berkeley (2007) p. 62.

[11] http://www.arb.ca.gov/msprog/labeling/labeling.htm.

[12] Introduction drawn largely from *Climate Action Program at CalTrans*, December 2006.

[13] Roland-Holst, D., *Economic Assessments of California Climate Change Policy: Application of the BEAR Model* (2006); Hanneman, M. and Farrell, A. E., *Managing Greenhouse Gas Emissions in California*, University of California-Berkeley (2006).

[14] *2005 Urban Mobility Report*, (TTI).

[15] Preceding text from US DOT: http://www.fhwa.dot.gov/congestion/.

[16] Button, K. J., *Transportation Economics*, Edward Elgar, Brookfield, VT (1993).

[17] Noland Choo, S., Mokhtarian, P. L., et al., "Does Telecommuting Reduce Vehicle-Miles Traveled? An Aggregate Time Series Analysis for the US," *Transportation* 32(1) (2005) p. 37-64;

Handy, S., "Smart Growth and the Transportation-Land Use Connection: What Does the Research Tell Us?" *International Regional Science Review*, 28(2) (2005). p. 146-167;

Kitou, E. and Horvath, A. "Energy-related Emissions from Telework," *Environmental Science and Technology* 37(16): (2003) p. 3467-3475;

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Noland, R. B. and Quddus, M. A., "Flow Improvements and Vehicle Emissions: Effects of Trip Generation and Emission Control Technology," *Transportation Research Part D-Transport and Environment* 11(1) (2006) p. 1-14.

[18] CNT. *Combating Global Warming Through Sustainable Surface Transportation Policy*. Center for Neighborhood Technology (CNT), Chicago, Illinois. http://www.travelmatters.org/about/final-report.pdf. (2003).

Feigon, S., Hoyt, D., McNally, L., Campbell, S., and Leach, D., *Travel Matters: Mitigating Climate Change with Sustainable Surface Transportation*, Transit Cooperative Research Program Report 93, National Research Council, Transportation Research Board, Washington, D.C. (2003): http://ttap.colostate.edu/Library/TRB/tcrp_rpt_93.pdf,

[19] Parker, T., McKeever, M, Arrington, G.B., and Smith-Heimer, J., *Statewide Transit-Oriented Development Study: Factors for Success in California*, Business Transportation and Housing Agency and California Department of Transportation, Sacramento, CA (2002) p. 43. http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Statewide_TOD_Study_Final_Report_Septpercent2002.pdf.

[20] JHK and Associates, *Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emission*, California Air Resources Board, Sacramento, CA (1995): http://safety.fhwa.dot.gov/ped_bike/docs/landuse.pdf.

[21] Levine, Jonathan, *Zoned Out: Regulation, Markets, and Choices in Transportation and Metropolitan Land-Use*, Resources for the Future.

[22] http://www.energy.ca.gov/2007publications/CEC-600-2007-008/CEC-600-2007-008-SD.PDF.

[23] http://www.smartcommunities.ncat.org/landuse/tools.shtml.

[24] Brueckner, Jan K., "Urban Sprawl: Diagnosis and Remedies," *International Regional Science Review* (2000).

[25] Ewing, Reid et.al., "Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity," *American Journal of Health Promotion*, September, 2003.

[26] http://opr.ca.gov/index.php?a=ceqa/index.html.

[27] San Francisco Country Transportation Authority December 12, 2007 letter to Steve Church.

[28] Greenberg, Allen. *Applying Mental Accounting Concepts in Designing Pay-Per-Mile Auto Insurance Products*, US Department of Transportation, Washington, DC (2005).

[29] Litman, Todd., *Distance-Based Vehicle Insurance Feasibility Costs and Benefits: Comprehensive Technical Report*, Victoria Transport Policy Institute, Victoria, B.C., February 19, 2007 (available at www.vtpi.org).

[30] Greenberg, Allen, *Applying Mental Accounting Concepts in Designing Pay-Per-Mile Auto Insurance Products*, US Department of Transportation, Washington, DC (2005) p. 3.

[31] Greenberg, Allen, *Comparing the Benefits of Mileage and Usage Pricing Incentives with Other Government Transportation Incentives*, Transportation Research Board, available on TRB 82nd Annual Meeting Compendium of Papers CD-ROM, November 15, 2002.

[32] Litman, p. 75.

[33] Ibid, p. 76.

[34] Greenberg, p. 3.

[35] http://www.vtpi.org/tdm/tdm79.htm.

13-123 cont.

[36] The California Air Resources Board emissions inventory for gasoline powered vehicles alone exceeds 137 tpy CO2(eq) for 2004. Based on data from London and Stockholm showing reductions of ten percent or more from the covered areas, applying this policy to ten percent of the state's inventory could potentially achieve one million tons of reductions, or greater, if similar results are achieved.

[37] San Francisco Climate Action Plan (2004.)

[38] SFCTA website: http://www.sfcta.org/images/stories/Planning/CongestionPricingFeasibilityStudy/PDFs/sfcta_maps_2007-07.pdf.

[39] Central London Congestion Charging, Forth Annual Report, June 2006: http://www.sfcta.org/content/view/415/241/.

[40] SFTA website.

[41] City of Stockholm (2006.)

[42] The King Review of low-carbon cars (2007) p.50.

[43] McManus, *Economic Analysis of Feebates to Reduce Greenhouse Gas Emissions from Light Vehicles for California*, University of Michigan Transportation Research Institute, UMTRI-2007-19-1, May 2007.

[44] Report of the CARB Independent Expert Panel 2007 Executive Summary Only, prepared for State of California Air Resources Board: http://www.arb.ca.gov/msprog/zevprog/zevreview/zev_panel_report.pdf.

[45] Vyas, Saricks and Stodolsky, *The Potential Effect of Future Energy-Efficiency and Emissions-Improving Technologies on Fuel Consumption of Heavy Trucks*, Argonne National Laboratory, August 2002; Langer, *Energy Savings Through Increased Fuel Economy for Heavy-Duty Trucks*, National Commission on Energy Policy, February 2004.

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[46] The King Review of low-carbon vehicles (2007) p.47.

[47] Electricity, based on marginal supply from a combined cycle power plant, and hydrogen from steam methane reforming, both have significantly lower GHG profiles compare to current vehicle fuels (King Review, section 3.32.) As noted later in this report, creating zero and low-carbon energy supplies for zero-tailpipe emission cars will continue to be an important policy objective.

[48] CARB Presentation, *Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*, September 23, 2004.

[49] California Climate Action Team report (2006).

[50] Vyas, Saricks and Stodolsky, *The Potential Effect of Future Energy-Efficiency and Emissions-Improving Technologies on Fuel Consumption of Heavy Trucks*, Argonne National Laboratory, August 2002; Langer, *Energy Savings Through Increased Fuel Economy for Heavy-Duty Trucks*, National Commission on Energy Policy, February 2004.

[51] Legislative Analyst's Office, Addressing the State's Highway Maintenance and Rehabilitation Needs, August 21, 2007.

[52] Japan has arguably the most developed system of fiscal incentives for fuel efficient vehicles worldwide, levying an annual automobile tax based upon vehicle weight, auto registration fees and a sales tax surcharge both proportional to engine size, and tax breaks for fuel efficient vehicles. Combined with the higher fuel taxes common to other countries, these incentives establish a significant premium for operating large, inefficient vehicles -- on the order of an additional $1800 per year for a mid-sized SUV (ICCT analysis).

[53] http://www.arb.ca.gov/msprog/moyer/facts/about.htm.

[54] http://www.arb.ca.gov/bonds/gmbond/gmbond.htm.

[55] Farrell, A.E. and Gopal. A.R, "Bioenergy Research Needs For Heat, Electricity, And Liquid Fuels," *Material Research Society Bulletin* 33(4): Special Issue on Energy (2008).

[56] Turner, B.T., Plevin, R.J., O'Hare, M. and Farrell, A.E.. Creating Markets for Green Bio-fuels, University of California- Berkeley: http://repositories.cdlib.org/its/tsrc/UCB-ITS-TSRC-RR-2007-1/.

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Exhibit H

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Exhibit H

Driving Urban Environments:
Smart Growth Parking Best Practices

A publication of the Governor's Office of Smart Growth

Robert L. Ehrlich, Jr., Governor ♦ Michael S. Steele, Lieutenant Governor
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INTRODUCTION

Over the last 50 years, new patterns of development have reflected both the mobility and convenience provided by the car and the segregation of land uses decreed by zoning codes that put residences in one area, offices in another, and retail in yet another spot. Increasingly far-flung destinations and more complex daily activities rely on the ability to get from one place to another as fast and predictably as possible. We have to drive to get from work to home to shopping, and at each place, we need to park. We expect safe, plentiful, easily accessed parking at work, at home, and at the store. Parking has become part of our culture: an office perk, a selling point for retailers, a display case for a household's cars and a requirement for financing development projects.

Our communities have become increasingly worried, however, about the downside of an auto-based landscape that is no longer holding the promise of progress and growth, but rather fosters congestion that steals precious time from our lives. In contrast to auto-oriented sprawl, smart growth recognizes that the future and vitality of our communities is dependent upon our ability to foster a better planned, more environmentally protective, more sustainable pattern of development.

This work, however, does not come without its challenges, and no aspect of development illustrates this better than parking. Indeed, one of the biggest challenges facing smart growth is identifying new ways to address the need for parking while minimizing its negative impacts and encouraging better and different design. Parking is consuming a huge amount of land that could otherwise be developed. Surface and structured parking lots present sterile, unattractive environments that deaden city and suburban streets alike, further isolate uses and preclude lively pedestrian-friendly streets. Moreover, the adverse environmental impacts of parking lots, particularly on water quality, are increasingly recognized.

As developers attempt to meet the parking requirements of their projects, they find themselves beset with obstacles related to zoning, financing, and design, just to name a few. Parking requirements now drive many site designs, and are often the make or break issue for financing new developments. Too many quality smart growth projects remain on the drawing board because they simply cannot solve the parking dilemma. We need parking, but we need to re-think parking design, parking financing, and parking supply and demand to better meet the needs of communities, developers, and users.

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This study presents an overview of parking strategies that meet the challenges faced by projects in the context of smart growth. Recognizing the importance of parking in development, it looks for new ways to manage parking supply and demand, to design parking facilities, and to provide financing, offering more, not fewer, options to communities, households and developers. These creative approaches are intended to promote better project design, reduce construction and operational costs, and add value to development projects.

The main sections of this study specifically address these three areas—parking management, parking design, and parking financing. The first section identifies parking management strategies that control the supply and demand for parking. The following section proposes innovative design strategies that reduce the aesthetic and environmental impacts of parking facilities, including on-street parking, surface parking lots, and parking structures. The final section outlines various financing mechanisms and incentives for the construction of both public and private parking structures.

It is hoped that this study will inform and engage local governments, developers, financial institutions, and citizens in a dialogue that will lead to broader implementation of "win-win" parking solutions, enhancing the attractiveness, convenience, and quality of life in communities across Maryland and beyond.

PARKING MANAGEMENT

As dependency on the automobile has grown, local policies have reinforced the car culture, accommodating increased parking demand through local zoning ordinances. The primary tool local governments have used to accommodate parking is parking ratio ordinances, which establish the minimum number of spaces a development project must provide for a given land use and project size. Table 1 outlines some of these general standards for minimum parking requirements based on land use. These ratios are typically drawn from generic parking generation rates, irrespective of site-specific and project-specific characteristics and other variables that would help to more accurately reflect market reality. The overstatement of parking ratios has in many cases led to an oversupply of parking.

There are many problems associated with current parking ratios and the subsequent oversupply of parking. These traditional approaches to regulating parking lead to vast expanses of parking which in turn separate land uses, reduce densities, impair walkability, and create obstacles to providing transit and pedestrian friendly communities. From a developer's perspective, inflated parking ratios reduce the development potential of a site, requiring more land to be used for parking as opposed to a higher and better use, and adding significant costs to development projects. In fact, some development projects may not be financially feasible under current local parking policies.

TABLE 1. General Standards for Minimum Parking Requirements

LAND USE	PEAK SPACE FACTOR	UNIT
Shopping Center > 600,000 square feet	4.5 spaces	per 1,000 square feet gross leasable area
Shopping Center < 600,000 square feet	4.0 – 4.5 spaces	per 1,000 square feet gross leasable area
Office	0.50 – 3.00 spaces	per 1,000 square feet gross leasable area, or
	0.10 – 0.75 space	per employee
Industrial	0.67 – 3.50 spaces	per 1,000 square feet gross leasable area, or
	0.36 – 1.60 spaces	per employee
Residential	0.20 – 2.00 spaces	per unit

Source: Urban Land Institute and National Parking Association, *The Dimensions of Parking*, Fourth Edition [Washington, D.C.: ULI, 2000]

Addressing these concerns requires local jurisdictions and developers to work together to revise parking policies to more appropriately manage parking. Revised parking policies should accommodate necessary parking, while at the same time encouraging attractive, pedestrian and transit friendly urban design, promoting alternative modes of transportation, preserving open space, and improving air and water quality.

This section of the paper details parking management best practices that aim to achieve the above mentioned objectives. Such "practices" or strategies include reduced minimum parking requirements, parking maximums, area-wide parking caps, shared parking, and parking districts. These strategies could be required through local zoning ordinances or be voluntary, on a project-by-project basis, implemented through developers' agreements. Given that efforts to control the supply of parking will only be feasible and effective when there are concurrent efforts to reduce the demand for parking, this section also proposes various best practices to reduce the demand for parking including transit investments, transit-oriented development and traditional neighborhood design policies, transportation demand management programs, unbundled parking, and parking pricing strategies.

Limiting Parking Supply

Local planners have traditionally regulated the supply of parking through zoning codes that prescribe minimum parking requirements for development projects based on land use and size. These minimum

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requirements are typically drawn from parking generation rates and standards that are published by the Institute of Transportation Engineers. In one such commonly used publication, *Parking Generation*, the parking generation rates are derived from a small number of studies that measure peak parking demand at suburban locations, where parking is free and there is no public transit (Shoup, *Roughly Right or Precisely Wrong*). The maximum parking demand from these studies oftentimes becomes the minimum parking requirement established in zoning codes. Recognizing the limitations of these parking generation rates, planners will sometimes look to zoning codes in comparable cities to further inform their own minimum parking requirements. However, this comparison is also quite limited in that it cannot account for all of the geographic and demographic factors specific to a particular jurisdiction or development site. As a result of applying published generic parking standards or borrowing parking standards from seemingly comparable cities, minimum parking requirements tend to be excessive and inflexible, leading to more parking than is necessary.

Vast expanse of underutilized parking at shopping center in Towson, Maryland.

One of the primary ways local planners can more appropriately control the supply of parking is by revising local zoning ordinances to more accurately reflect local parking demand and circumstances. This portion of this section proposes potential revisions to local zoning ordinances including reduced parking requirements given a project's proximity to transit, surrounding land uses, demographics of prospective users, implementation of transportation demand management programs, or payment of fees in lieu of parking. Other strategies that might be considered for incorporation in local ordinances include parking maximums, area-wide parking caps, and shared parking. The roles parking management districts can play in controlling the supply of parking are also discussed in this section.

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Reduced Minimum Parking Requirements

Local zoning ordinances have historically controlled the amount of parking at a site by imposing minimum parking requirements, calculated as a ratio of the number of parking spaces required per square foot, per dwelling unit, or other measure of intensity. This ratio varies by the type of land use. Rather than imposing inflexible requirements, local zoning ordinances could incorporate mechanisms to tailor parking requirements to specific development projects. The following list of factors are among those that should be considered.

- *Locational Factors*. The location of the proposed project will impact parking demand. For example, if a project is well served by mass transit, the project might generate a lower parking demand than what would otherwise be anticipated, relying on generic parking generation formulas. Moreover, if the proposed project is located amidst high-density development with a mix of land uses, there might be existing parking facilities nearby, thus reducing the demand for parking on-site. Users may also access the project and other nearby uses on foot, further reducing parking demand.

- *Demographic Factors*. The demographics of the anticipated users of a project, including employees, customers, and residents, will impact parking demand. For example, due to

Reduced Minimum Requirements for Locational and Demographic Factors - San Diego, California

The San Diego Municipal Code permits reduced minimum parking requirements for residential, office, retail, institutional, and industrial uses in designated transit areas and for residential uses in designated very low income areas. With respect to residential uses, the minimum parking requirements can be reduced in multiple dwelling unit developments, depending on the multiple dwelling unit type (number of bedrooms). For example, in a multiple dwelling unit development with 2 bedroom units, the basic minimum parking requirement is 2 spaces per dwelling unit; however, in both transit areas and very low income areas this requirement is reduced to 1.75 spaces per dwelling unit. With respect to nonresidential uses, the reduction in minimum parking requirements for developments in transit varies based on use. However, in general the minimum parking requirement for nonresidential uses in transit areas is about 85% percent of the minimum requirement for development outside transit areas.

the high cost of car ownership, low-income residents generally have lower levels of car ownership than that of the general public. If the anticipated users of a proposed project have low levels of car ownership, the project might generate a lower parking demand than what would otherwise be anticipated. The age distribution of anticipated users will also be indicative of parking demand. For example, if the anticipated users of a proposed project are seniors, the project will necessitate less parking than what would otherwise be anticipated.

In addition to tailoring parking requirements to project-specific conditions such as locational and demographic factors, local zoning ordinances might also prescribe reductions to minimum parking requirements on a project-by-project basis in exchange for a developer's commitment to a transportation demand management program or payment of fees in lieu of providing the required parking.

- *Transportation Demand Management Programs*. Transportation Demand Management (TDM) programs are typically employer-led programs intended to reduce the parking demand of employees by supporting carpooling, offering subsidies for transit, furnishing bicycle facilities, and providing shuttle service from off-site parking facilities. These features of TDM programs are discussed in greater detail in the following section on controlling parking demand. An example of a jurisdiction that reduces minimum parking requirements in exchange for an employer's creation and implementation of a TDM program is Hartford, Connecticut, where parking requirements can be reduced up to 30 percent in exchange for discounted carpool parking, rideshare promotions, subsidized transit passes and shuttle service from off-site parking.

- *Fees-in-lieu*. Fees-in-lieu are established by jurisdictions as an alternative to requiring on-site parking facilities. More specifically, some local jurisdictions allow reductions to minimum parking requirements in exchange for developer payment into a municipal parking or traffic mitigation fund. The accrued money from the municipal parking fund helps finance city-owned, centrally located, off-site parking facilities. The in-lieu fees may be mandatory or voluntary and are set either by calculating a flat rate for each parking space not provided or by carefully determining appropriate development-specific fees on a case-by-case basis. By paying fees-in-lieu, developers have the ability to circumvent constructing on-site parking facilities, and are subsequently able to improve site design and preserve unique and historic resources that might otherwise be demolished to accommodate on-site parking. Fees-in-lieu tend to be very effective when rapid development is occurring in a defined area. However, absent a critical mass of concurrent development projects in a defined area, the municipal parking fund may only increase in increments insufficient to develop municipal parking structures in a timely manner (Urban Land Institute 2000). As a result, developers might only opt to pay in-lieu fees when a parking facility will be available on a definite schedule and within an acceptable proximity to the development project. An example of a jurisdiction that allows developers to pay fees-in-lieu of the required parking is the Town of Westport, Connecticut. The Town's Zoning Regulations allow for developers to pay fees-in-lieu of providing all or a portion of the off-street parking spaces required for projects located in a designated Historic Design District. In this example, the fee-in-lieu of parking is set at $2,000 per

Reduced Minimum Requirements for Transportation Demand Management Programs – Seattle, Washington

The Seattle Municipal Code stipulates that for office or manufacturing uses that require 40 or more parking spaces, the minimum parking requirements may be reduced up to 40% by substituting transportation demand management programs. These provisions include:

- for every certified carpool space, the total parking requirement may be reduced by 1-9/10 spaces up to a maximum of 40% of the total parking requirement;
- for every certified vanpool purchased or leased by the applicant for employee use, the total parking requirement may be reduced by 6 spaces up to a maximum of 20% of the total parking requirement;
- if transit passes are provided to all employees and transit service is within 800 feet of the development, the total parking requirement may be reduced up to 10%; and
- for every 4 covered bicycle parking spaces provided, the total parking requirement may be reduced by 1 space up to a maximum of 5% of the total parking requirement.

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deficit parking space and must be paid in full by the applicant prior to the issuance of a zoning permit.

Local zoning ordinances should be clear about the terms and conditions for reductions to minimum parking requirements "by-right", specifying the percent of required spaces that can be reduced for such conditions as proximity to transit, surrounding land use mix and density, demographics and behaviors of prospective users, implementation of TDM programs, and payment of fees-in-lieu. By setting clearly defined terms and conditions for reductions in minimum parking requirements, local jurisdictions can limit the number of projects that have to go through the lengthy and uncertain process of receiving a zoning variance.

Although reduced minimum parking requirements might benefit developers by reducing the costs associated with the construction, operation, and maintenance of parking facilities, developers may not opt for the reduced parking requirement because of impacts insufficient parking might have on the marketability of the project to lending institutions and prospective users. As a result, developers might still oversupply parking in order to meet inflated financing standards set by lending institutions. However, in many cases, lending institutions do refer to local zoning, and local jurisdictions have been revising local zoning ordinances to incorporate parking maximums or area-wide parking caps to ensure there is not an oversupply of parking; these strategies are discussed in the next part of this section.

Parking Maximums and Areawide Parking Caps

As discussed in the previous section on reduced minimum parking requirements, local zoning ordinances usually establish the amount of parking developers must provide. However, in contrast to minimum parking requirements, it is becoming more and more common for local jurisdictions to revise zoning ordinances to incorporate parking maximums or areawide parking caps, both intended to ensure that there is not an excess supply of parking.

- *Parking Maximums.* Parking maximums restrict the total number of parking spaces that can be constructed at a particular development site. For example, the City of Seattle allows a maximum of one parking space per 1,000 square feet of downtown office space, and is considering extending this maximum to areas outside of the downtown. The City of San Francisco limits parking to 7% of a downtown building's floor area (Millard-Ball 2002). Maximums can complement minimum parking requirements, thus ensuring a threshold level of parking supply, or can stand alone, leaving individual developers to determine the appropriate amount of parking necessary. While reduced minimum parking requirements allow developers the choice of providing more parking than the required amount, parking maximums are absolute limits on the amount of parking that can be provided. As such, parking maximums leave little room for making mistakes in projecting parking demand. If a jurisdiction underestimates parking demand and sets maximums too low, developers cannot "second guess" that decision and provide more parking, as they can with reduced minimum parking requirements.

- *Areawide Parking Caps.* Areawide parking caps limit the total number of parking spaces that can be constructed in a defined area. Similar to parking maximums, areawide parking caps set

Parking Maximums – Portland, Oregon

The Portland City Code has implemented parking maximums to complement parking minimums in areas outside the Central City district. The zoning ordinance specifies that the purpose of such provisions is to promote the efficient use of land, enhance urban form, encourage use of alternative modes of transportation, provide for better pedestrian movement, and protect air and water quality. The maximums vary with the use the parking is serving and the location of the use. That is, areas that are zoned for more intense development and are easily reached by alternative modes of transportation have lower maximums than areas of less intense development or less frequent or no transit service. For example, the minimum parking requirement for general office use is 1 space per 500 square feet of floor area, and the maximum parking requirement is 1 space per 294 square feet of floor area. However, if the development is located more than ¼ mile from a transit stop with 20-minute peak-hour bus service and more than ½ mile from a transit stop or station with 20-minute peak-hour light rail or streetcar service, the maximum number of parking spaces is actually increased to 125% of what otherwise would be the maximum requirement.

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an absolute limit on the amount of parking that can be provided, in so doing, leaving little room for mistakes in projecting parking demand. Areawide parking caps require considerable administrative and planning effort to determine the appropriate number of parking spaces for a defined area, and to accurately apportion the allotted spaces to specific development projects.

Both parking maximums and areawide parking caps encourage better utilization of existing parking facilities and force businesses to encourage their employees and customers to use alternative modes of transportation. In fact, many jurisdictions that have instituted parking maximums or areawide parking caps have done so in response to non-attainment of environmental standards, particularly, air quality standards. For either parking maximums or areawide parking caps to be successful, it is imperative to have accessible and frequent public transportation, and the jurisdiction must have a strong real estate market, where the locational advantages considerably outweigh the perceived drawback of a lack of parking.

Shared Parking

Shared parking can be defined as parking utilized jointly among different buildings and facilities in an area to take advantage of different peak parking characteristics that vary by time of day, day of week, and/or season of year. For example, many businesses or government offices experience their peak business during normal daytime business hours on weekdays, while restaurants and bars peak in the evening hours and on weekends. This presents an opportunity for shared parking arrangements. Historically, local zoning ordinances have not permitted shared parking—stating that if two or more uses are located on the same lot or in the same structure, the total number of parking spaces required equals the sum of spaces required for each individual use. Since most parking spaces are only used part time, this policy leads to the underutilization of many parking facilities, with a significant portion of spaces unused. On the other hand, by allowing for and encouraging shared parking, local jurisdictions can decrease the total number of spaces required relative to the total number of spaces needed for each land use separately. As a result, allowing for shared parking arrangements significantly reduces the amount of land devoted to parking and, in so doing, creates more opportunities for creative site planning and landscaping.

Some local jurisdictions do incorporate language in local ordinances to permit and even encourage shared parking. These jurisdictions allow shared parking to meet minimum parking requirements for uses located within the same lot or building and also permit off-site shared parking arrangements to meet on-site parking requirements for complementary uses within a defined area. One way in which local ordinances help enable shared parking is to allow for off-street parking facilities to be located off-site of the lot on which the structure or use being served is located. Such ordinances usually specify a maximum distance from the structure or use within which the off-site parking facility must be located. These location requirements are typically based on acceptable walking distances. For example, the San Diego (CA) Municipal Code states that shared parking facilities must be located within 600 feet of the uses served. The Eugene (OR) Municipal Code allows for a longer distance stating that required off-street parking facilities must be within 1320 feet of the development site that the parking is required to serve. In addition to revisions to local zoning codes to enable shared parking, shared parking arrangements can be implemented through shared parking agreements between individual developers or the construction of public parking facilities.

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There are several barriers to implementing shared parking arrangements. In particular, there is a considerable amount of planning needed to determine the appropriate number of parking spaces under shared parking arrangements. Some local jurisdictions calculate this number through the following method: 1) determine the minimum amount of parking required for each land use as though it were a separate use, by time period; 2) calculate the total parking required across uses for each time period; and 3) set the requirement at the maximum total across time periods. Other jurisdictions allow for the parties involved to determine the appropriate number of spaces. In these cases, the applicants must submit an analysis that shows that peak parking times occur at different times and that the parking area will be large enough to accommodate the anticipated demand. Since changes in ownership, operations, or use, might alter parking demand in the future, many ordinances that allow for shared parking require contingency plans to accommodate additional parking that may be necessary in the future.

Shared Parking – Montgomery County, Maryland

The Montgomery County Zoning Ordinance allows for shared parking when any land or building is under the same ownership or under a joint use agreement and is used for 2 or more purposes. The uses being served by the shared parking arrangement must be within a 500 feet walking distance of the shared parking facility. The number of parking spaces required under a shared parking arrangement in Montgomery County is calculated by the previous mentioned method.

The following is a generalized example of calculating the shared parking requirement for a mixed use development, given the regulations in the Montgomery County Zoning Ordinance. The calculations are based on a development project with general retail and office uses. The retail use has a gross floor area of 100,000 square feet and the office use has a gross floor area of 100,000 square feet. The development is located in the designated Southern Area of Montgomery County and is located 1,000 feet from a Metro station. Given this location, the minimum amount of parking normally required for a retail use is 5 spaces per 1,000 square feet gross floor area and the minimum requirement for an office use is 2.1 spaces per 1,000 square feet gross floor area. The following table summarizes the calculations. The "percentage of parking requirement column" is based on the parking credit schedule in the Montgomery County Zoning Ordinance.

	OFFICE USE			RETAIL USE			
	Minimum Parking Requirement	Percentage of Parking Requirement	**Adjusted Parking Requirement**	Minimum Parking Requirement	Percentage of Parking Requirement	**Adjusted Parking Requirement**	**Parking Requirement by Time Period**
Weekday Daytime	210	100%	**210**	500	60%	**300**	**510**
Weekday Evening	210	10%	**21**	500	90%	**450**	**471**
Weekend Daytime	210	10%	**21**	500	100%	**500**	**521**
Weekend Evening	210	5%	**10.5**	500	70%	**350**	**360.5**
Nighttime	210	5%	**10.5**	500	5%	**25**	**35.5**

For this example, the minimum parking requirement for the shared parking arrangement is **521 spaces** since that is the maximum number of spaces across the five time periods. This is significantly less than what would otherwise be required, 710 spaces, if shared parking were not permitted—a 26% reduction in the minimum parking requirement.

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Parking Management Districts

Parking management districts are areas designated by local jurisdictions in which parking supply and rates are regulated to meet the parking needs of the area, at the same time as promoting transit use, ridesharing, and other alternative modes of transportation to the single occupancy vehicle. The two key components of parking management districts—supply management strategies and pricing policies—are designed to work together to enhance economic development and encourage a balanced transportation system in the parking management district. District-based supply management strategies are established to encourage mixed use development projects and areas and to ensure the maximum utilization of land, requiring less land area for parking and, in so doing, making more land available for tax-generating purposes. To complement these supply management strategies, district-based pricing policies are established to influence individual travel behavior and encourage alternative modes of transportation. These pricing policies are discussed in greater detail in the section of this paper on controlling parking demand.

With respect to district-based supply management strategies, the parking supply in parking management districts can be managed on a project-by-project basis or through the development of centralized, shared parking facilities. That is, some local jurisdictions manage parking supply in parking management districts by requiring parking ordinances for development projects located in the district. In applying for a parking

ordinance, developers must justify the parking levels that will be built as a part of the development project. For example, in Baltimore, Maryland, no land may be used as a parking lot nor may any building be razed so as to permit the use of the land as a parking lot unless authorized by an ordinance of the Mayor and City Council. This requirement is to permit the Mayor and City Council to consider and evaluate the need for the parking lot, the proposed appearance of the parking lot, and possible aesthetic damage to the area surrounding the parking lot, with particular respect to the proposed removal of historic or aesthetically valuable properties. By requiring a parking ordinance for development projects located in a parking district, jurisdictions can control the overall parking supply regulating on-site parking on a project-by-project basis.

Local jurisdictions can also manage parking supply in parking management districts by developing, operating, and maintaining publicly-owned, centralized parking facilities financed through fees in lieu and other methods described later in this paper in the section on parking financing. These facilities alleviate the need for individual development projects to provide parking on-site. For example, Montgomery County, Maryland, has established four parking management districts in Bethesda, Montgomery Hills, Silver Spring, and Wheaton. The purpose of each district is to support the comprehensive development of the central business district by providing, operating and maintaining economically self-sufficient parking facilities which keep pace with the needs generated by growth in each district. Moreover, the number of parking spaces provided in each district is carefully calculated given the desired modal split between private cars and transit. There are four major funding sources of the parking management districts including fees in lieu, parking receipts, enforcement revenues, and income from investments. By developing, operating, and maintaining centralized parking facilities, jurisdictions can control the overall parking supply, encouraging the shared use of off-site parking facilities by a variety of development projects.

Challenges to Limiting Parking Supply

There are several challenges to limiting parking supply through the above-mentioned strategies. Supply management strategies presuppose that the projected variations in parking demand are accurate, which is not always the case. Furthermore, changes in ownership or operations of existing uses, or future changes in land use, might alter parking demand. In case the projected parking demand proves inaccurate or changes over time and, as a result, projects generate a greater parking demand than originally anticipated, some local jurisdictions will only approve reduced minimum parking requirements or shared parking arrangements if the developer has an agreed upon plan to accommodate the additional spaces (Urban Land Institute 2000). Such plans might include land banks or landscaped reserves. For example, the Iowa City Zoning Ordinance allows for land banked areas to be used in place of up to 30% of the required parking. If at some point in the future, the additional parking spaces are needed, the property owner will be required to construct parking on the land banked area. Similar to Iowa City, Palo Alto, California, allows for land banked areas to be used in place of 50% of the required parking. However, in the case of Palo Alto, the land banked area is actually more appropriately called a landscaped reserve since the land must be landscaped or serve a recreational function such as a play area. Jurisdictions might also require developers' agreements and/or land covenants to ensure the continued implementation of agreed upon programs, irrespective of future ownership, operations, or change in use.

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As discussed previously, parking maximums and areawide parking caps leave little room for mistakes in projecting parking demand. As a result, these policies must be somewhat flexible and regularly revised to ensure that an adequate level of parking is supplied. While some jurisdictions are revising local codes to incorporate maximums or areawide caps to complement minimum parking requirements, it is becoming more popular to replace minimums and maximums with more flexible parking medians. Under median parking requirements, a certain percentage of the median requirement is allowed above or below the median by right. Above or below this by right increase or decrease the developer must provide documentation to justify the levels of parking.

Overall, limiting parking supply might have unintended impacts should the actual parking demand exceed the anticipated level. If the parking supply is unable to accommodate demand, there might be spillover parking into adjacent uses and residential communities. In fact, many neighborhood residents will vehemently oppose any parking supply management strategy in fear that their neighborhood will become flooded by spillover parking with more cars bringing traffic and congestion. A potential solution to spillover parking is the creation and implementation of residential parking permit districts. Residential parking permit districts are designated areas in which the residents work with local jurisdictions to establish a program allowing them to park on the neighborhood streets, but restricts others from parking in these areas during certain hours. These districts are designed to reduce the impacts caused by students, customers, and

employees who do not park in the spaces provided in the nearby schools or businesses. In residential parking permit districts, permits could be made available to residents for a nominal fee—the revenues from these fees could in turn be used to fund neighborhood enhancements.

Finally, limiting parking supply will only be effective if there are concurrent efforts to control parking demand. Strategies to control parking demand, including transit investments, transit-oriented development and traditional neighborhood design policies, transportation demand management programs, unbundled parking, and pricing strategies, are discussed in this next portion of this section.

Controlling Parking Demand

One of the most effective ways of limiting parking supply is to reduce the needed supply through measures to control parking demand. In addition to the above mentioned supply management strategies, it is possible to reduce supply by influencing demand through investments in alternative modes of transportation, direct financial incentives for non-single occupancy vehicle use, pricing strategies, and policies supportive of transit-oriented development and traditional neighborhood design. This portion of this section outlines ways in which both the public and private sectors can influence parking demand, thus reducing the need for and subsequent provision of parking.

Transit Investments

One of the most effective ways of reducing the demand for parking is by providing people with a viable alternative to the personal automobile. Therefore, in seeking to control the demand for transportation facilities tailored to the automobile, the public sector must make a commitment to expand and otherwise improve transit systems and services. There are various ways in which transit systems could be improved to better meet the needs of existing users and potentially attract new users, including expanding already existing routes for existing modes, adding new routes for existing modes, and creating new modes such as express bus service. Capital investments could also be made to improve maintenance of facilities, such as buses and trains, and to revitalize transit stations, bus stops, and their surrounding neighborhoods. In addition to these capital investments in routes, modes, and facilities, operational improvements such as scheduling changes can be instituted to offer more frequent and convenient service. There are several challenges to these investments in transit. Capital projects may be extremely costly and demand a substantial upfront investment of government resources. Moreover, extensive planning and coordination is important to ensure appropriate location of routes and stations—this planning process adds additional time to what is already a time consuming process. As a result, it may take a long period of time before capital projects are fully operational. Finally, capital investments should be complemented by inducements such as marketing campaigns to help people realize the value of substituting mass transit for single occupancy vehicle use, improvements to fare structures, and enhanced passenger amenities.

MetroLink – St. Louis, Missouri

In July of 1993, MetroLink, a regional light rail system, began operating in St. Louis, Missouri. MetroLink's alignment stretches 34.3 miles from Lambert International Airport in St. Louis to Southwestern Illinois College in Belleville, Illinois. The system was built and is operated by Bi-State Development Agency as part of a fully integrated regional transportation system that also includes MetroBuses. The capital costs of the existing alignments was close to $800 million, of which the Federal Transit Administration paid about $600 million and the County governments paid the remaining portion. The federal contribution comes from its one-cent gasoline tax revenue base and covered all costs for design and engineering, construction, procurement, testing, start-up and project administration. The local match came from the asset value of the donated rights-of-way, structures, and facilities, and from a ½ cent sales tax. MetroLink operations are subsidized by sales taxes and passenger fares. The base fare is $1.25—service is free during lunch hours in the downtown district. In its first year of operation MetroLink carried nearly 9 million customers, almost double the projected ridership. In Fiscal Year 2001, 14.2 million customers rode MetroLink. It is estimated that 21% of MetroLink customers are former bus riders and the other 79% are new to transit. MetroLink has reduced vehicle miles traveled in the St. Louis region by as much as 139,100 miles per day, has saved 7,130 gallons of fuel each day, and in its first year of operation, reduced carbon emissions by between 4,500 and 9,600 metric tons (EPA TRAQ).

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Transit-Oriented Development and Traditional Neighborhood Design Policies

To help foster pedestrian and transit friendly communities in which people do not need to rely exclusively on the personal automobile, local jurisdictions can develop policies that encourage transit-oriented development and traditional neighborhood design. Transit-oriented developments (TOD) are location-efficient, compact, walkable development projects with a balanced mix of residential, business, and institutional uses clustered around transit stations. Traditional neighborhood design (TND) developments are compact, mixed use, pedestrian-oriented communities that connect people to places and people to people. Both TODs and TND developments encourage the development of denser, mixed-use, pedestrian oriented areas where frequently visited services, jobs, housing, and, in the case of TOD, transit, are all easily accessible, reducing the reliance on the personal automobile and the subsequent need for parking facilities.

Although the benefits of TOD and TND have been well documented, there are still many challenges to both types of projects including community fears that increased densities will increase traffic congestion and lower property values, and developer and lender fears that TOD and TND projects have higher costs and risks than conventional development projects. Moreover, in many jurisdictions, existing codes and ordinances do not allow for the construction of mixed-use, pedestrian-oriented developments as alternatives to conventional use-segregated developments or require a prohibitive number of zoning variances.

Local jurisdictions can help enable TOD and TND by revising local zoning ordinances to include TOD and TND zones that allow for a mixing of uses and increased densities, can include affordable housing and reduced parking requirements, and prescribe design guidelines such as site development design criteria, street and streetscape design criteria, landscape design criteria, environmental standards, and scale requirements. Local jurisdictions can also help encourage TOD and TND projects by creating small area TOD and TND plans, making the necessary capital investments to support TOD and TND projects, and providing land assembly assistance and/or expedited permitting to developers wishing to undertake such projects.

Transit-Oriented Development Zoning – Concord, North Carolina

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The Unified Development Ordinance of the City of Concord, North Carolina, designates transit-oriented development (TOD) districts to encourage a mixture of residential, commercial, and employment opportunities within a specified radius of identified light rail station or other public transit stations. The TOD zone allows for more intense and efficient use of land for the mutual reinforcement of public investments and private development in transit areas. The TOD zones are divided into two distinct subdistricts—TOD core and TOD periphery. All areas within ¼ mile of a transit station are classified as TOD core areas and all areas between ¼ and ½ mile of a transit station are classified as TOD periphery areas. The Unified Development Ordinance outlines different requirements for each of the subdistricts. The Ordinance allows for a mixing of residential and non-residential in both the TOD core and periphery areas, but does not prescribe the amount of land that needs to be allocated to each use. The Ordinance does regulate the density and floor area ratios in the TOD subdistricts. The following table illustrates this:

	Density (residential units per acre)		Floor Area Ratio (non-residential units)	
	Minimum	Maximum	Minimum	Maximum
TOD core				
Parcels, 2 acres or more	16	20	0.70	1.20
Parcels, less than 2 acres	12	16	0.50	1.00
TOD periphery				
Parcels, 2 acres or more	12	16	0.50	1.00
Parcels, less than 2 acres	8	12	0.30	0.60

The Concord Ordinance also details parking regulations specific to the TOD zones. More specifically, the Ordinance reduces minimum parking requirements in portions of TOD zones, stating that if a site is within 500 feet of a light rail alignment, the minimum required parking spaces is 50% of what otherwise would be required by the Ordinance. In addition, the Ordinance prohibits all surface parking facilities in the TOD core areas and allows for surface parking for only commercial uses in TOD periphery areas.

Traditional Neighborhood Design Zoning – Austin, Texas

The City of Austin's City Code allows for traditional neighborhood design by-right by designating traditional neighborhood zoning districts to encourage mixed use, compact, pedestrian-friendly development that diversifies and integrates land uses within close proximity to each other, and provides for the daily recreational and shopping needs of residents. As stipulated in the Austin Code, a traditional neighborhood district (TND) may consist of an area no less than 40 contiguous acres and not more than 250 contiguous acres. The City Code outlines five different types of areas in a TND—Neighborhood Center Area, Mixed Residential Area, Neighborhood Edge Area, Workshop Area, and Employment Center Area. The Code outlines different land use, site development, and design regulations for each type of area. A TND must have one Neighborhood Center Area and at least one Mixed Residential Area.

- A Neighborhood Center Area serves as the focal point of a TND, containing retail shops, offices, banks, a post office, places of worship, a community center, attached residential dwellings, and other uses that meet the daily needs of the residents. Townhouse, condominium, and multifamily uses shall be allocated not less than 20% of the land area, commercial uses shall be allocated not less than 20% of the land area, and civic uses shall be allocated not less than 5% of the land area in a Neighborhood Center Area. In addition, a Neighborhood Center Area is pedestrian-oriented, encouraging movement between the neighborhood center and Mixed Residential Area, and must include a public square.

- A Mixed Residential Area includes a variety of residential land uses including single-family homes, duplexes, townhouses, and apartments. Residential retail, commercial, and civic uses may also be located in a Mixed Residential Area. A Mixed Residential Area must include formal and informal open spaces and promote pedestrian activity. Single family residential use shall be allocated not less than 50% and not more than 80% of the land area, duplex use shall be allocated not more than 10% of the land area, townhouse, condominium, and multi-family uses shall be allocated not less than 10% of the land area, commercial uses shall be allocated not less than one percent and not more than two percent of the land area, and civic uses shall be allocated not less than two percent of the land area in a Mixed Residential Area.

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In addition to a Neighborhood Center Area and at least one Mixed Residential Area, a TND may also have a Neighborhood Edge Area, a Workshop Area, or an Employment Center Area. A Neighborhood Edge Area is the least dense portion of a TND, with larger lots and greater setbacks than the rest of the area. A Workshop Area provides space for commercial and light industrial uses that are not appropriate for the Neighborhood Center Area, while an Employment Center Area provides space for large office and low-impact manufacturing uses.

Under the Austin City Code, formal and informal open spaces and an interconnected network of streets and alleys are all required components of a TND. More specifically, the Austin City Code requires that not less than 20% of the gross land area of the TND be open space and that overall impervious cover for a TND be limited to 65% of the net site area or the amount permitted in the watershed, whichever is less. The Code details impervious cover limits for each of the five types of areas as well.

Finally, the Austin City Code sets forth parking regulations specific to TND zones. Some of the more innovative TND parking regulations in the Code include the following: 1) A parking lot shall be located at the rear or side of a building (if at the side, appropriate screening must be provided; 2) A commercial use parking lot or garage must provide one bicycle parking space for every 10 motor vehicle parking spaces; 3) For parking in a Neighborhood Center Area, the required parking for a use may be located anywhere in the Neighborhood Center Area (community parking facilities are encouraged); 4) For parking in a Neighborhood Center Area, not more than 125% of the required parking for a use may be provided on-site; and 5) For parking in a Neighborhood Center Area, a commercial or a multi-family use may apply adjacent on-street parking toward the minimum parking requirements.

Transportation Demand Management Programs and Transportation Management Associations

According to Census 2000, it is estimated that 76% of workers sixteen years and over commute to work alone, 11% carpool, 5% take public transportation, and the remaining portion take another means or work from home. There are various reasons for this journey-to-work behavior—people may not live (or work) in an area that is within close proximity to transit service, people may want to have their personal automobile at work to perform errands or in case of emergency, or they may have off-site meeting during the day and need their personal automobile to get between the work place and the meeting site. In addition to these various and valid reasons, the provision of free parking at the workplace has clearly played a large role in influencing journey-to-work behavior. Most people want parking at work to be easily accessible and convenient so getting to and from the car does not add additional time to the workday. In response to these needs, free on-site parking has become a fringe benefit and a factor in the ability to recruit and retain employees.

Absent financial incentives for alternative travel modes to the single-occupancy vehicle and programs that alleviate the need for a personal automobile at work, solo driving will remain the overwhelmingly preferred mode of travel to work. Many employers and local jurisdictions have begun to implement transportation demand management (TDM) programs to influence travel behavior and induce people to take alternative modes to the personal automobile. TDM is a general term for programs that encourage a decrease in the demand for parking and other transportation tailored to the single-occupancy vehicle. TDM programs can either be employer-led programs designed to reduce the parking demand generated by employees, or publicly initiated programs to reduce the overall parking demand for all trips, not just journey to work trips. These programs might be direct financial incentives to use alternative travel modes or inducements such as preferential parking for carpools and vanpools, bicycle amenities, shuttles from peripheral parking locations and transit stations, and car sharing programs. Many of these programs are described in greater detail below.

- *Cash-Out Programs*. Many employers provide their employees with free on-site parking. Although employees do not see the costs of parking directly, these costs usually are passed on to all employees in the form of lower wages. Therefore, regardless of car ownership or journey to work mode, most employees end up paying for the costs of on-site parking facilities. In other words, employees who use alternative modes to the single occupancy vehicle in the end cross-subsidize those who drive to work alone. Many employers are now establishing and implementing cash-out programs to provide subsidized employees with a choice of receiving free parking or foregoing free parking for a cash payment equaling the cash equivalent of free parking, to use transit or other alternatives to the single-occupancy vehicle. As more and more employees opt for cash out, employers will likely require less and less parking. In fact, a Canadian study conducted by the Victoria Transport Policy Institute showed that cash out reduces parking demand by 15-25%. However, the effectiveness of cash out typically depends on the availability of transit and other alternative modes to solo driving and the availability, or lack thereof, of free and unregulated parking supplies, especially where employees could still park after taking the cash out rather than taking an alternative to the single occupancy vehicle. Moreover, cash out is not as effective in reducing solo driving as

Commuter Choice Maryland

Commuter Choice Maryland is a State-sponsored initiative to encourage employers to implement transportation demand management programs that reduce the use of single-occupancy vehicles. Commuter Choice Maryland programs can help employers save on taxes, reduce parking demand and costs, and recruit and retain valuable employees. Employers participating in Commuter Choice Maryland can develop a transportation demand management program tailored to their own individual needs—components of a Commuter Choice Maryland program might include employer-provided transit passes or vouchers, a vanpool program, a parking cash-out program, or a guaranteed ride home program. Employers implementing one of these programs through Commuter Choice Maryland can receive a Maryland state tax credit up to 50% for every dollar spent on commuter benefits programs. A maximum of $30 per participating employee per month applies to the state tax credit. In addition to the state tax credit, federal legislation passed as a part of the Transportation Equity Act of the 21st Century allows participating employers to offer federal tax-free commuter benefits to employees. As of January 1, 2002, tax-free benefits for transit and vanpool expenses can be offered in any amount up to $100 per month.

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charging employees for parking with no other compensation. More specifically, according to a model developed by Donald Shoup at the University of California-Los Angeles, cash out is about two thirds as effective as charging for parking. Some local jurisdictions may enact ordinances to require employers who offer subsidized parking to offer eligible employees the option of taking the cash equivalent of free parking, while other jurisdictions leave it up to the employer as to whether or not they will implement a cash-out program. Finally, it is important to note that cash-out is different from transit subsidies, which are direct payments to employees for use of public transportation and usually equal the cost of a monthly pass or a portion thereof.

- *Peripheral Parking with Shuttles.* Local jurisdictions and employers may wish to provide peripheral parking locations outside the main activity center and offer shuttle service from those locations to the main core and employment sites. Local jurisdictions and employers might also wish to provide shuttle service from transit stations to employment sites that are located in areas that are not well-served by mass transit. Providing shuttle service from peripheral parking locations may not be effective in reducing single-occupancy vehicle use or overall parking demand, it might just shift where the necessary parking spaces are actually located from the main activity center to a more peripheral location. However, providing shuttle service from transit stations to employment sites can help reduce single-occupancy use and parking demand since people living in close proximity to a transit station will now have a viable alternative to driving to work. Shuttle service could also provide guaranteed ride home on an as needed basis.

- *Preferential Parking for Carpools and Vanpools.* In privately owned parking facilities developers or employers might provide incentives for alternative modes of travel to the single occupancy vehicle by reserving close-in, secure, covered, or otherwise preferable parking spaces for high-occupancy vehicles. Local jurisdictions can do the same in publicly owned facilities and might consider enacting legislation to require operators of privately owned facilities to do so. For example, the Portland Municipal Code requires for office, industrial, and institutional uses where more than 20 parking spaces are required that 5 spaces or 5% of the spaces, whichever is less, must be reserved for carpools. Moreover, the carpool spaces must be the closest spaces to the building entrance

Downtown Area Shuttle – Baltimore, Maryland

In March of 2002, Downtown Partnership of Baltimore began operating an employee shuttle program—the Downtown Area Shuttle (DASH). DASH service provides Downtown employees with access to over 1,200 parking spaces near Ravens Stadium and a convenient, reliable commuter bus connection to various employment sites and the core of Downtown Baltimore. The monthly fee for the use of the parking facilities at Ravens Stadium and the shuttle service is $50. Employees that carpool are charged a monthly rate of $20. Currently, this monthly program is only available to employees whose employers have contracted with Downtown Partnership. Other Downtown employees, residents, and visitors can ride the shuttle throughout Downtown for a 50-cent fare, but will not be able to park in the Ravens Stadium parking lots.

Triangle Transit Authority Rideshare Program – Greater Triangle Region, North Carolina

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The Triangle Transit Authority (TTA), a regional public transportation authority serving Durham, Orange and Wake Counties in North Carolina, offers a rideshare program to provide vanpool and carpool services. In particular, as a part of the vanpool program, TTA provides a 15-passenger van to no fewer than seven commuters who live and work near each other and who share approximately the same work schedule. In addition to the vehicle, TTA pays for gas, and arranges and pays for maintenance. Vanpool riders pay a monthly fare based on monthly mileage. For example, a vanpool with a total monthly mileage of 520 miles pays in total $500.45 (or $35.75 per person based on a vanpool of 14). A vanpool with a total monthly mileage of 3145 miles pays in total $1,299.68. TTA offers a seat subsidy program to encourage the formation of vanpools. The rideshare program, among other TTA services and programs, is funded by a vehicle registration tax of up to $5 per registration, authorized by the North Carolina General Assembly in 1991, in addition to program revenues.

or elevator, but not closer than parking for the disabled. Local jurisdictions and employers could also promote carpooling or vanpooling by subsidizing vehicles or fuel costs.

- *Bicycle Facilities and Amenities*. Employers can encourage bicycling by providing bicycle parking or storage, showers, and lockers on-site. Local jurisdictions should consider requiring bicycle parking in zoning ordinances and reducing minimum parking requirements given the provision of bicycle parking over the required amount. For example, the Portland Municipal Code requires a minimum number of short term and long term bicycle spaces for residential and non residential uses. These requirements are intended to help meet the City's goal that 10% of all trips be made by bicycle. Moreover, bicycle parking may substitute for up to 25% of the required automobile parking—for every 5 non-required bicycle parking spaces, the automobile requirement is reduced by one space.

- *Car Sharing*. Both the public and private sector in the United States are beginning to follow Europe's lead in instituting car sharing programs to grant residents or employees access to a car when they need it without incurring the fixed costs associated with owning and operating a personal automobile. According to Zipcar, a privately owned car sharing company, each car sharing vehicle replaces four to eight privately owned cars, thus reducing parking demand. Moreover, car sharing reduces vehicle miles traveled, thereby, helping to alleviate traffic congestion and improve air quality. According to the Victoria Transport Policy Institute, car sharing is most effective in high-density, mixed-use areas where there are a variety of travel choices, flexible parking requirements, and transportation management associations that encourage employers and employees to use alternative travel modes to the single-occupancy vehicle. In car sharing arrangements, vehicle fleets are located in various areas throughout the jurisdiction, usually at transit nodes or in commercial districts. Residents can pay an annual membership fee and reserve a car by phone or on-line typically up to a year in advance. Members are then charged based on usage. This rate typically covers gas, maintenance, insurance, and parking. Some local jurisdictions are beginning to promote car sharing by reducing minimum parking requirements when developers or employers institute or participate in car sharing programs. For example, the Seattle Municipal Code allows for up to 5% of the total number of parking spaces provided in a project to be used to provide parking for vehicles operated by a City-recognized car sharing program. The number of required spaces may be reduced by one space for every parking space leased by a City-recognized car sharing program.

Car Sharing Programs in Washington D.C.

In December of 2001, the Washington Metropolitan Area Transit Authority (WMATA) launched a new car sharing program in the Washington D.C. area. WMATA is partnering with Flexcar, a privately owned, national car sharing company, to make cars available for hourly rental at or near selected Metro stations 24-hours-a-day, seven-days-a week. Flexcar charges a one-time $25 member initiation fee and offers different payments plans, including hourly and mileage rates, based on user needs and usage. One option charges members a monthly fee of $35 for 5 hours, while another option charges a $525 monthly fee for 100 hours of use. Flexcar currently has 36 cars at 21 locations in the Washington region and has over 500 approved members. The program has plans to expand to 200 cars by 2003 to keep pace with the increasing demand. Local jurisdictions in the Washington region are helping to ensure the success of car sharing programs. In Arlington County, Virginia, the County's Commuter Assistance Program is offering a $500 subsidy for businesses to join Flexcar or Zipcar, another for-profit car sharing company operating in the Washington region. The City of Alexandria, Virginia, will reimburse up to $105 of membership and application fees for residents and up to $50 for business membership fees and half of each employee's application fee up to $20 for membership to Flexcar or Zipcar.

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As stated previously, TDM programs can be employer-led or publicly-initiated programs. However, it is becoming more common for TDM programs to be administered by transportation management associations. In fact, transportation management associations play an integral role in garnering support for and implementing demand management programs and district-based parking management strategies.

Transportation management associations are independent, non-profit, member-controlled organizations that bring together employees, retailers, business owners, public sector representatives and others to address transportation issues and provide transportation services in a particular area. The main objectives of transportation management associations are to improve air quality, circulation, and the attractiveness of the urban environment through the promotion of alternative modes to the single-occupancy vehicle. To achieve these objectives, transportation management associations might provide discounted transit passes, shuttle bus services from off-site parking facilities, guaranteed ride home programs, bicycle facilities, car sharing programs, and information kiosks.

Unbundled Parking

The costs of parking are often bundled into the rent or purchase price for residential and commercial units and buildings. This practice assumes that all tenants and owners have the same parking demand; therefore, regardless of car ownership all tenants and owners bear the costs of parking through increased rents or inflated purchase prices. Including costs of parking in rents and purchase prices encourages automobile ownership and is a disincentive for using alternative transportation modes. On the other hand, separating the payment of parking from the rent payment or purchase price, also known as "unbundling", can provide a more equitable allocation of costs by allowing tenants and owners to pay only for the parking they use and can reduce parking demand by making households pay the full cost of parking. Given that unbundling can reduce parking demand, development projects that unbundle parking or provide rebates to households who own fewer or no vehicles and will not use their allotted parking space or spaces could provide less parking than what otherwise might be required.

Pricing Strategies

One of the simplest ways to reduce parking demand is to charge users directly for the cost of parking. That is, parking prices for on-street meters and off-street parking facilities can be set to alter the cost of driving solo relative to travel alternatives, thereby influencing travel choice and reducing parking demand. In fact, according to the Victoria Transport Policy Institute, parking pricing typically reduces parking demand by 10-30% compared to unpriced parking. There are various ways in which operators of publicly owned and privately owned parking facilities can price parking to differentiate prices among different users to achieve economic, strategic, and policy objectives. Such pricing strategies include time-based pricing, vehicle occupancy pricing, and vehicle size pricing.

A sign on a parking garage in Gaithersburg, Maryland, advertises free parking, encouraging automobile use.

- *Time-Based Pricing*. Time-based pricing can be implemented in on-street parking and off-street parking facilities to discourage long-term commuter parking and encourage turnover, which is usually necessary for parking facilities to cover costs and earn a reasonable return. More specifically, meter rates and parking prices in lots and structures can be set to increase over time to variable rates that become more expensive for each additional hour.

- *Vehicle Occupancy Pricing*. Vehicle occupancy pricing can be established in off-street parking facilities to encourage the use of high occupancy vehicles. More specifically, rates can be set at or above market rates for solo drivers, while carpool or vanpool rates are discounted or free.

- *Vehicle Size Parking*. Vehicle size parking can be established in off-street parking facilities to encourage the use of compact cars, which demand a smaller land area for parking. More specifically, rates can be set at or above market rates for sport utility vehicles and other vehicles that might take up more than one space and can be set below market rate for compact vehicles.

To complement these parking pricing strategies, local jurisdictions could levy parking taxes on operators of off-street parking facilities. These taxes are typically passed on to users in the form of higher parking rates. For example, in Baltimore, Maryland, the Baltimore City Parking Authority collects a parking tax equal to

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11% of a parking facility's gross transactions and $14 per month per monthly user. Moreover, local jurisdictions could implement and enforce time limits on meter parking to encourage turnover in commercial districts and discourage long-term commuter parking.

There are several challenges to implementing parking pricing, parking taxes, and time limits. First of all, it is generally difficult to impose parking pricing where parking is currently free. Moreover, if there are uncontrolled parking supplies nearby, users can circumvent paying for parking and park in those available spaces. Finally, as discussed previously in this paper, pricing strategies should only be implemented in areas where there is a viable alternative to the personal automobile and where the market is sufficiently strong so that pricing will not lead to economic dislocation.

Challenges to Controlling Parking Demand

The biggest challenge to controlling parking demand is that despite investments in transit infrastructure, parking pricing policies, and other demand management strategies, many people will still choose the single occupancy vehicle as their primary travel mode. Since the middle of the last century the American public indeed has had a love affair with the personal automobile—it is entrenched in the American way of life. Getting people to change their behavior has proven rather difficult. Demand management strategies must be complemented with aggressive marketing campaigns and education and outreach efforts to make people realize the value of substituting alternative modes to the personal automobile. Moreover, in developing and revising parking policies and programs, both the public and private sectors need to engage all of the stakeholders in the process so that the general public has a sense of collective responsibility over the success of such policies and programs. The following section is a summary of some of the supply and demand managements strategies proposed in this section that the public and private sectors might wish to include in parking policies and programs.

Possible Strategies

Local Jurisdictions

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- Conduct a comprehensive review of parking requirements.
- Reduce parking requirements for specific locational and demographic factors.
- Reduce parking requirements when TDM programs are implemented.
- Reduce parking requirements in exchange for fees in lieu.
- Adopt maximums to complement minimum parking requirements or establish parking medians.
- Allow for shared parking at mixed-use development projects and in mixed-use areas.
- Designate parking management districts and develop area parking management plans for those districts. Parking management plans might include areawide parking caps, regulation of on-site parking facilities through parking ordinances, shared parking arrangements, construction of centralized publicly owned parking facilities, and pricing strategies.
- Allow landscaped reserves to meet parking requirements.
- Establish residential parking permit programs.
- Revise local zoning ordinances to create transit oriented development and traditional neighborhood design zones that allow a mixing of uses, increased densities, affordable housing, reduced parking requirements, and pedestrian oriented and environmentally friendly design.
- Enact ordinances to require employers who offer subsidized parking to offer eligible employees the option of taking the cash equivalent of free parking.

- Form public-private partnerships to provide shuttle service from peripheral parking locations and transit stations to employment site and the central business district.
- Require a certain percentage of spaces to be designated for carpools or vanpools.
- Form public-private partnerships to provide vanpool services or car sharing programs.
- Require development projects to include bicycle parking and reduce minimum parking requirements given the provision of bicycle parking over the required amount.
- Encourage unbundling of housing and parking costs.
- Set parking prices in municipal structures to benefit priority users such as high occupancy vehicles and compact cars.
- Implement time-based pricing to set prices higher during peak periods and increase over time.
- Provide signs, maps, and brochures to provide accurate information to users on parking facilities and availability.
- Elicit public involvement and include all stakeholders from the start in planning parking policies and programs.

Developers

- Provide an appropriate amount of parking given carefully estimated parking demand, as opposed to oversupplying parking.
- Seek opportunities to share parking between uses within a development project or with complementary uses in close proximity.
- Pursue transit-oriented development and traditional neighborhood design projects to create compact, mixed-use, pedestrian-friendly, walkable communities with viable alternatives to the personal automobile.
- Reserve close in, secure, covered, or otherwise preferable parking spaces for carpools and vanpools.
- Provide bicycle parking facilities including racks and lockers.
- Unbundle the cost of parking from the rent or purchase price of residential and commercial units or buildings.
- Charge users for the cost of parking and set parking rates to benefit priority users such as high occupancy vehicles and compact cars.

Employers

- Offer employees eligible for subsidized parking the option of taking the cash equivalent of free parking.
- Provide transit subsidies or discounted transit passes.
- Work with the public sector and/or other area employers to provide shuttle service from peripheral parking locations and/or transit stations.
- Work with the public sector and/or other area employers to develop and implement vanpool or car sharing programs.
- Reserve close in, secure, covered, or otherwise preferable parking spaces for carpools and vanpools.

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- Provide bicycle parking facilities including racks and lockers and provide bicycle amenities such as showers and clothes lockers on-site.
- Implement a guaranteed ride home program.
- Provide information kiosks or bulletin boards to inform employees of ridesharing opportunities and programs.
- Charge users for the cost of parking and set parking rates to benefit priority users such as high occupancy vehicles and compact cars.

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PARKING DESIGN

Since the advent of the personal automobile, the American landscape has become predominantly a habitat for cars, with streets, parking facilities, and other auto-oriented uses dominating the built environment. Parking facilities in particular have become an omnipresent feature of the American landscape, consuming land and resources, inhibiting the functioning of natural systems, creating dead gaps in what otherwise might be vibrant commercial areas, and creating conflicts between vehicles and pedestrians and bicyclists. This adverse impact on the walkability of communities is a particular challenge to creating lively, mixed use places with a unique sense of identity—attractive places where people want to linger, to gather, and to return over and over. It is precisely these kinds of walkable places that are essential to the success of smart growth development strategies.

This section of this paper proposes best practices to reverse the negative impacts parking facilities have traditionally had on the environment and the character of urban places. The best practices outlined in this section are organized by the objective each strategy or "practice" aims to achieve. The five main overarching objectives are:

- Design sites such that vehicles are not the dominant feature;
- Provide necessary parking without large expanses of pavement;
- Minimize runoff from parking lots utilizing techniques to return surface water to the ground;
- Encourage vibrant street level activity; and
- Create a safe and comfortable environment for pedestrians and bicyclists as well as vehicles.

The three types of parking facilities—on-street parking, surface parking lots, and parking structures—are each appropriate in different settings and under different circumstances, and all play integral roles in shaping the character of the built environment. For each proposed best practice, the type of parking the strategy applies to is listed. The final portion of this section briefly discusses some of the challenges to implementing smart parking design best practices.

OBJECTIVE: Design sites such that vehicles are not the dominant feature.

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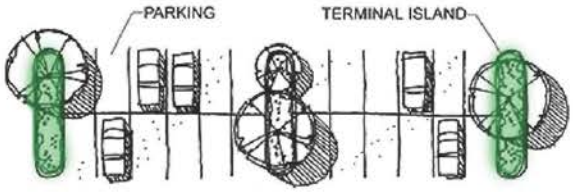
No one wants acres of pavement or blank walls dominating the streetscape, yet parking needs to be convenient, safe, and accessible. Given the adverse impacts of the visual prominence of parking facilities, local jurisdictions and developers alike should seek innovative design strategies to ensure that parking facilities do not become the dominant feature of the streetscape. The following are some best practices that might be considered.

- *Location*. The location of parking facilities behind buildings is vital in creating more welcoming and pedestrian-friendly streetscapes that will attract users over and over again. The desire for safe, convenient, and accessible parking has typically led to the placement of parking areas in front of buildings. For example, in retail projects, shoppers typically want to enter and exit the parking facility with ease and want to avoid the frustration and stress associated with having to drive around and look for parking. In response to these needs, developers have typically provided parking areas in front of retail uses where it is highly visible and readily available. However, the placement of parking facilities in front of buildings has an effect on people as they walk or even drive by. Parking facilities in front of buildings create physical and psychological barriers to the building, as opposed to buildings placed close to the street, framing the public space and inviting people in. Indeed, from an urban design perspective, parking considerations should be secondary to the design and placement of buildings on the site. Parking facilities can be located in the interior of blocks and concealed by "liner" buildings with retail, offices, and housing. Parking is then

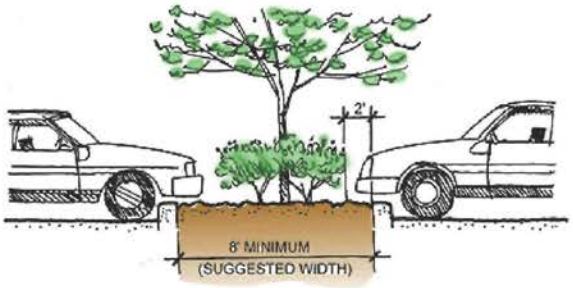
This parking structure in Bethesda, Maryland, is embedded in the block, obscured from street activity by more active uses.

found behind the building, accessible yet out of view. Signage could be used to direct users to the parking facility. And since for safety reasons developers typically want a single entrance, wayfinding will have to incorporated to get people from the parking area to the entrance, which may be in the front of the building. Moreover, on-street parking could be provided in the front of the building to provide visible and convenient auto access.
Applicability: Parking lots and structures

- *Screening and Landscaping*. As discussed previously, if at all possible, parking facilities should be placed behind buildings in the interior of blocks. For facilities placed to the front or side of buildings, there are various ways to screen parked cars from street level activity, thereby providing the necessary parking without overly compromising urban design. Parking facilities, including lots and structures, could be located where the site topography can help conceal them. Integrating parking facilities into site topography might also limit the impact a project may have on the functioning of natural systems. With respect to parking lots, when a parking lot abuts a public street the parked cars should be screened from public street frontage to obscure a majority of the parked cars. Screening can be continuous landscaping, attractive fencing or stone walls, among other materials. Overall, the buffer between the parking lot and the street should be no less than 15 feet wide—this liberal width should help to encourage the placement of parking lots behind buildings versus along the street. Finally, landscaping on the periphery of a parking facility and within parking areas can be used to soften the appearance of a parking facility from the street. More specifically, expanses of parking should be broken up with landscaped islands and planted strips, which include shade trees and shrubs. Such landscaping provides a canopy cover and reduces the urban heat island effect in the summer. Landscaping not only provides shade on hot days, absorbs carbon dioxide, and reduces pollutants emitted by vehicles as they sit in the sun, but also breaks up the visual impact, making the parking lot feel smaller and less overwhelming.
Applicability: Parking lots and structures



Terminal Islands



Divider Medians

These two figures from the Henderson (Nevada) Development Code illustrate two parking lot landscaping techniques—terminal islands and divider medians. According to the interior parking lot landscaping standards in the Code, terminal islands must be provided at the end of each parking row, and divider medians between abutting rows of parking spaces are encouraged. Moreover, the Code stipulates the following: 1) for parking lots with 5-100 spaces, 1 tree must be planted for every 10 spaces; 2) each parking space must be located within 40 feet of a tree; and 3) at least 10 percent of the interior area of a parking lot must be devoted to landscape planting areas.

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- *Architectural Treatments.* With respect to parking structures, there are various ways to help integrate parking structures with their surroundings, particularly through scale, materials, colors, and style. Architectural treatments can be used to screen cars and relate to the design of adjacent buildings. The architectural treatments should be divided into 30′ increments to better integrate the parking structure with the scale and character of adjacent buildings and to provide the visual breaks to hold the interest of walkers passing by. Façade elements around the entry to the structure should be emphasized to reduce the visual prominence of the structure entry.
Applicability: Parking structures

OBJECTIVE: Provide necessary parking without large expanses of pavement.

According to the Center for Watershed Protection, as much as 65% of the total impervious surface cover in the American landscape are surfaces designed for cars including, but not limited to, streets, parking lots, and

driveways. The paving over of the American landscape is clearly unsustainable, consuming land and resources and creating huge volumes of stormwater runoff that tax the capacity of sewer systems and degrade water quality in streams and other waterways. Local jurisdictions and developers alike should determine ways in which they can provide the necessary parking, while minimizing the amount of acreage that is converted to parking. The following are some best practices that might minimize the amount of pavement required for a parking facility while allowing the most cars to park on the site.

- *Provision of On-Street Parking*. On-street parking provides convenient access to adjacent uses and provides the best possible option to visitors since it offers the shortest possible time between stopping and shopping. Moreover, the provision of on-street parking can lessen the need for parking lots and structures, which convert a significant amount of acreage to parking. There are three different types of on-street parking—head-in, angle, and parallel. Each type of on-street parking has its pros and cons. Both head-in and angle parking can provide for more cars than a parallel parking configuration, but both require a considerable amount of right-of-way and, therefore, necessitate wider streets. Moreover, both head-in parking and angled parking create the potential for a greater number of traffic accidents, as drivers must back out of spots into the flow of traffic. Therefore, both of these types of parking are best designed on streets with slow moving traffic. On the other hand, parallel parking decreases the potential for accidents and requires a narrower right-of-way; however, parallel parking accommodates fewer cars than the other types of on-street parking. While on-street parking—head-in, angled, or parallel—may not fully accommodate the amount of parking necessary, it does provide visible and convenient auto access and can satisfy short-term parking needs. To complement on-street parking, development projects can incorporate other parking facilities, namely surface lots and structures, to accommodate longer-term parking needs.
  Applicability: On-street parking

King Farm, a New Town in Rockville, Maryland, utilizes on-street parking to accommodate required parking spaces and alleviate the need for parking lots and structures. This street uses both parallel parking and angled parking.

- *Construction of Structures Rather Than Lots*. Building vertically reduces the acreage of land converted to parking, thereby, reducing impervious surfaces. However, the type of parking facility—lot or structure—in a development site is usually determined by balancing the cost of land against the cost of constructing parking. In urban areas where land costs are at a premium, it is more cost-effective to build a parking structure than to build a surface parking lot. In suburban areas, the availability and low cost of land make surface parking lots more cost effective than parking structures. In these suburban areas, absent significant incentives to defray the costs of structured parking, it is unlikely that structured parking will become the norm. The following section of this paper on parking financing outlines some incentives and financing programs for structured parking.
  Applicability: Parking structures

Washingtonian Center, a retail and entertainment center in Gaithersburg, Maryland, includes a large structured parking facility to accommodate the necessary parking. This view is of the back of the structure; the front of the structure incorporates retail uses on the first floors.

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- *Automated Parking Structures*. Automated parking structures have the potential to change the dynamics of land use, significantly reducing the demand for land devoted to parking and making more land available for revenue generating purposes. Automated parking can squeeze up to two times the number of cars in the same space as a conventional garage or, in other words, accommodate the same number of cars in half the space, and can be built on a site as small as 60 feet by 60 feet, in structures up to 20 stories high, above or below ground. These facilities are able to be so space-efficient because they operate using a computerized network of rails and pallets that lift and carry cars from the entrance bay to available slots with no human intervention. In addition to reducing the amount of land devoted to parking, there are many other benefits to automated parking. Automated parking makes parking safer and more convenient, eliminating the risk of car damage, theft, or personal injury, and reducing the water and air pollution attributed to exhaust fumes and impervious surfaces. Moreover, automated parking structures have complete flexibility in the design of the façade; therefore, they can be easily incorporated into existing urban design. In terms of costs, automated parking is now becoming a price-competitive and viable alternative to traditional ramp garages, as land costs in urban areas are at a premium. Automated structures have lower land acquisition costs since they require less land, construction costs are typically about the same as conventional above ground structures, and operating costs are somewhat lower since many automated structure are completely computerized and only require one person on-site. One potential drawback to automated parking is that it might make parking too efficient, leading to an increased driving demand.
  Applicability: Parking structures

- *Reduced Stall Dimensions and Compact Car Spaces*. Reducing the size of parking stall dimensions overall and dedicating a certain percentage of stalls to compact cars can reduce impervious surface cover. While the trend toward larger sport utility vehicles is often cited as a barrier to implementing stall minimization, stall width requirements in most local ordinances are much larger than the widest sport utility vehicles (Center for Watershed Protection). Reducing stall dimensions and dedicating compact car spaces will only be effective in reducing the footprint of parking structures if the number of parking spaces per floor is limited and additional spaces are accommodated by building additional floors.
  Applicability: On-street parking and parking lots and structures

- *Tandem/Stacked or Valet Parking*. Providing the required parking spaces in tandem or stacked parking arrangements or offering valet parking service reduces the amount of land devoted to parking. The City of Portland, Oregon, allows stacked parking or valet parking if an attendant is present to move vehicles. If stacked parking is used for required parking spaces, some form of guarantee must be filed with the City of Portland to ensure that an attendant will be present when the parking facility is in operation.
  Applicability: Parking lots and structures

- *Alternative Pavers*. Utilizing alternative pavers that permit water to penetrate reduces the overall impervious surface coverage and creates less stormwater runoff. Alternatives to concrete and asphaltic concrete include gravel, cobble, wood mulch, brick, grass pavers, turf blocks, natural stone, pervious concrete, and porous asphalt. Alternative pavers may not be ideal depending on site-specific characteristics such as climate, soil type, and traffic volume. However, they are recommended for overflow areas and can be used in cross walks and stalls to create a break in the paved area, thereby, facilitating groundwater recharge.
  Applicability: Parking lots

The use of alternative pavers in overflow areas reduces impervious surface coverage and helps facilitate groundwater recharge.
***Credit*: Center for Watershed Protection**

- *Multiple Lots*. Breaking up large parking lots into two or more areas can reduce the total amount of impervious surface and disconnect paved surfaces, thereby reducing stormwater runoff and facilitating

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groundwater recharge. This practice also breaks up the perceived visual mass of parking facilities and can help to integrate "big box" uses, such as grocery stores, into neighborhood shopping districts.
Applicability: Parking Lots

OBJECTIVE: Minimize runoff from parking facilities utilizing techniques to return surface water to the ground.

Parking facilities have serious impacts on the functioning of natural systems, depleting the water supply and degrading water quality. Traditional stormwater management systems carry and discharge runoff from parking facilities directly into streams and rivers, thereby preventing ground water recharge and dumping pollutant loads into our waterways. Local jurisdictions and developers should seek innovative ways to manage stormwater runoff that support the functioning of natural systems. The following are some best practices that might be considered. Some of these practices may be more expensive upfront than traditional approaches; however, the costs may be offset by the reduced need for stormwater facilities and reduced maintenance costs.

- *Low Impact Development Techniques*. Local jurisdictions and developers are increasingly turning to Low Impact Development (LID) techniques to manage stormwater on-site. In particular, LID techniques can be critical in controlling the quality and quantity of stormwater runoff generated from the impervious surface of parking facilities. LID uses a wide array of methods to retain, detain, filter, recharge, and pass runoff through decentralized, distributed, small-scale controls to reestablish the predevelopment volume of runoff, recharge, storage, and evaporation on a development site. Ultimately, LID seeks to protect and restore important ecological and hydrological functions. Major components of LID include: 1) conservation of forests, natural vegetation, streams, wetlands, and open space, to the greatest extend practicable; 2) minimization measures including reduced clearing and grading, saving infiltratable soils, reducing or disconnecting impervious surfaces, reforesting, and reducing the use of pipes, curbs, and gutters; 3) concentration of runoff in open drainage systems and vegetative swales to slow down runoff, reduce discharges, and encourage more infiltration and evaporation; 4) integration of retention, detention, filtration, storage, and capture of runoff systems into the site; and 5) promotion of pollution prevention measures. With respect to parking facilities, common LID techniques used to control stormwater runoff include open sections, swales, and bioretention areas. Open sections encourage sheet flow to open channels where pollutants are removed through infiltration and vegetation/soil filtering prior to discharge, as opposed to the traditional curb and gutter methods that convey stormwater runoff and associated pollutant loads into streams. Vegetative swales direct stormwater into shallow bioretention areas that temporarily detain the water, facilitating infiltration into the subsurface and slowing and cleaning the remaining stormwater before it is discharged into waterways. Proper plant material selection is critical to the success of these measures. The effective use of LID techniques can significantly reduce the cost of providing stormwater management by eliminating the use of costly stormwater management infrastructure including ponds, pipes, curbs, gutters and roadway paving, among others. In fact, LID can reduce stormwater and site development design construction and maintenance costs by 25-30% compared to conventional approaches (Prince George's County Department of Environmental Resources).
  Applicability: Parking lots

- *Green Roofs*. Some developers of parking structures are beginning to incorporate green roofs on parking structures to retain and naturally filter stormwater runoff, thereby improving water quality. According to Roofscapes, Inc., green roofs can retain 50-60% of the total annual runoff volume of a roof, reducing the need for costly stromwater management systems. Underground parking structures often have lawns and parks planted on top. Above ground parking structures could also incorporate roof systems of vegetation, soil, drainage, and waterproof membranes to alleviate environmental problems including storm water runoff and the urban heat island effect. Additional benefits of greenroofs include improved livability of the urban environment by buffering noise, reducing glare, and offering an aesthetic alternative to asphalt roofing. Green roofs are more costly than traditional roof systems; however, the associated costs could be offset by the reduced need for stormwater facilities.
  Applicability: Parking structures

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OBJECTIVE: Encourage vibrant street level activity.

Local jurisdictions and developers often view parking facilities as generators of economic development, as adequate parking can enhance the marketability of development projects to tenants and customers. However, the inappropriate location and unattractive design of parking facilities can actually constrain economic development, creating dead gaps of inactivity in what otherwise might be vibrant commercial environments. Local jurisdictions and developers should seek ways in which the necessary parking can be accommodated, at the same time as the street activity is enlivened. The following are some best practices that might be considered.

- *Provision of On-Street Parking*. On-street parking can play a vital part of a streetscape, fostering a more vibrant pedestrian commercial environment. More specifically, on-street parking provides a mental and physical buffer between pedestrians on a sidewalk and cars on a busy street. The public safety aspects of on-street parking are discussed in greater detail under the following objective on creating a safe and comfortable environment for pedestrians and bicyclists as well as vehicles.
  Applicability: On-street parking

Bethesda Row, a mixed-use retail and entertainment project in Bethesda, Maryland, incorporates on-street parking to foster a more vibrant pedestrian commercial environment.

- *Location*. Parking lots and structures should be located behind buildings rather than in front of them so they do not dominate street frontage, thereby creating a more welcoming pedestrian-friendly streetscape. The location of parking facilities was discussed in greater detail under the objective on designing sites such that vehicles are not the dominant feature.
  Applicability: Parking lots and structures

- *Retail and Commercial Uses*. Parking structures with frontage along streets should provide retail and commercial uses along the street in order to enhance the pedestrian experience and create street level activity. Newsstands and coffee shops typically are successful, in addition to government offices, particularly public safety and police sub-stations, which act as crime deterrents. Incorporating retail and commercial uses in parking structures has the added benefit of generating additional sources of revenue through the lease or sale of space. This is discussed in greater detail in the section on parking financing.
  Applicability: Parking structures

Washingtonian Center in Gaithersburg, Maryland, incorporates retail and commercial uses on the first floor of the parking structure.

OBJECTIVE: Create a safe and comfortable environment for pedestrians and bicyclists as well as vehicles.

Cars are typically at odds with pedestrians and bicyclists on the roadway—and this is no different in parking facilities. Local jurisdictions and developers should seek design strategies to ensure pedestrian and bicycle safety, without compromising the safe and expeditious movement of cars. The following are some best practices that might be considered.

- *Provision of On-Street Parking*. On-street parking is typically used in tandem with other street design elements to ensure the safe co-existence of vehicles, pedestrians, and bicyclists.

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Such street design elements are commonly referred to as traffic calming measures. Traffic calming is a method of reducing traffic speeds and volumes and/or cut through traffic by instituting both physical measures such as traffic circles, speed humps, chicanes, and chokers, and operational measures such as increased police enforcement, speed displays, and community speed watch programs. Ultimately, these traffic calming measures are intended to reduce the negative effects of motor vehicle use and improve conditions for non-motorized street users such as pedestrians and bicyclists. On-street parking is one type of traffic calming measure and can be used in tandem with other measures to slow vehicle traffic and provide a buffer between moving cars and pedestrians and bicyclists.
Applicability: On-street parking

- *Limit Curb Cuts*. Curb cuts tend to increase pedestrian exposure to moving vehicles, limit opportunities for landscaping, eliminate on-street parking spaces, and aggravate traffic control. Limiting the number of curb cuts can help ensure pedestrian and bicycle safety, while allowing for safe and expeditious movement to and from the street system.
Applicability: Parking lots and structures

- *Pedestrian Corridors*. Pedestrians should not have to walk through parking facilities where they must be on constant guard for moving vehicles. Parking facilities should incorporate a clearly defined pedestrian pathway from the public sidewalk, bus stops and on-street parking, through parking lots, to building entrances. The pedestrian pathway should be landscaped and or delineated by non-asphaltic material in a different color or texture from the parking area to enhance pedestrian safety and improve the appearance of the parking lot. Pedestrian pathways through parking areas to stairwells and elevators should also be incorporated in parking structures.
Applicability: Parking lots and structures

Surface parking lots at King Farm in Rockville, Maryland, incorporate brick pavers to distinguish pedestrian walkways from the parking area.

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- *Pedestrian and Bicycle Entrances*. Enhancing the pedestrian and bicycle entry to parking lots and structures helps buffer pedestrians and bicyclists from cars and reduce the relative importance of the vehicle entry.
Applicability: Parking lots and structures

- *Bicycle Parking*. Providing for bicycle parking in prominent, convenient, and secure locations, might encourage people to bike between places as opposed to driving their personal automobiles.
Applicability: On-street parking and parking lots and structures

- *Signage*. Parking guidance systems can help alleviate congestion and enhance pedestrian safety. A parking guidance system that shows drivers where they can find available parking spaces in a given area or parking structure can help drivers pay more attention to pedestrian and bicyclists instead of focusing on looking for an available parking space. Parking guidance systems also help people avoid the stress and frustration involved with driving around looking for parking.
Applicability: Parking lots and structures

Absent adequate bicycle parking facilities, bicyclists may park their bicycles in improper locations.

- *Lighting*. The way parking lot lighting is designed can make the difference between an attractive and safe place or a neighborhood eyesore. Parking lots should utilize low-angle, cut-off fixtures to better direct light to those areas where it is needed. Parking lot lighting often involves balancing the need to provide adequate lighting to ensure personal safety with the concerns of neighboring property owners about glare and spillover lighting. Low-angle, cut-off fixtures minimize glare, spillover effects, and light pollution, at the same time as ensuring there is adequate lighting. Adequate lighting creates a safe environment for pedestrians and vehicles, particularly at night, and can add an aesthetic quality to a project.
  Applicability: On-street parking and parking lots

Challenges to Smart Parking Design

As a major urban land use, the design and layout of parking facilities should be of primary importance to local planners. However, local jurisdictions have actually inhibited innovative parking design through a bewildering mix of shortsighted and outdated regulations that govern the development process. These regulations, codified in various documents, including zoning ordinances, parking and street standards, and stormwater management guidelines, are difficult to decipher and sometimes contradictory. As a result, regulations can discourage developers from incorporating innovative parking design in development projects, as they are concerned about the time and money it might cost to navigate through the approval process. Developers recognize that the construction, operation, and maintenance of parking facilities are costly components of development projects, and that innovative design solutions can translate into reduced development and maintenance costs and allow projects to operate at a greater floor area ratio, thereby increasing the profitability of the project. Local planners need to take a closer look at the regulations that govern parking design to enable and encourage innovation. Developers can pressure local governments to do so and continue to seek innovative design solutions that may cost more money upfront but could translate into higher densities and more successful projects.

Possible Strategies

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This section has provided recommendations to developers and local governments on the integration of parking facilities into the urban fabric to minimize environmental and aesthetic impacts. Although these recommendations have been structured under the specific objectives they aim to achieve, many of these recommended design strategies actually support multiple objectives. The chart on Page 28 summarizes the recommended strategies and illustrates the respective objectives and types of parking facilities to which each recommendation applies.

The following is a list of recommendations for local governments to consider that support the recommended innovative parking design strategies discussed in this section:

- Adopt minimum setbacks from street to parking lot to encourage placement behind buildings
- Reduce minimum parking requirements for structures and lots placed behind buildings
- Revise parking design guidelines to require screening for parking lots and architectural treatments for parking structures
- Revise design guidelines to require landscaping (ratio of trees to parking spaces or certain % canopy cover at maturity)
- Revise street standards to require on-street parking where applicable
- Reduce minimum parking requirements if on-street parking accessible
- Reduce minimum parking requirements for structures
- Revise stall dimensions
- Require a certain percent of spaces designated for compact cars

- Allow tandem/stacked parking and valet parking to meet minimum parking requirements
- Revise stormwater management guidelines to enable and encourage innovative stormwater management systems
- Reduce minimum parking requirements for implementation of innovative stormwater management systems (alternative pavers, swales, bioretention areas, open sections, green roofs)
- Reduce minimum parking requirements for incorporation of retail and commercial uses in parking structures
- Require bicycle parking
- Reduce minimum parking requirements for bicycle facilities
- Revise design guidelines to require pedestrian pathway landscaped or delineated by non-asphaltic material
- Revise design guidelines to require low-angle, cut-off lighting fixtures

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	Objectives					Type of Parking Facility		
	Design sites such that vehicles are not the dominant feature	**Provide parking without large expanses of pavement**	**Minimize runoff from parking facilities**	**Encourage vibrant street level activity**	**Create a safe and comfortable environment**	**On-Street Parking**	**Parking Lot**	**Parking Structure**
Locate facility behind building	X			X	X		X	X
Integrate facility into site topography	X	X	X				X	X
Screen facility through landscaping or architectural treatments	X			X			X	X
Landscape interior parking areas	X	X	X				X	
Provide on-street parking		X		X	X	X		
Construct parking structures	X	X						X
Build automated parking structures	X	X						X
Reduce stall dimensions		X	X			X	X	X
Provide compact car spaces		X	X			X	X	X
Incorporate tandem/stacked or valet parking		X	X				X	X
Use alternative pavers		X	X				X	
Break up large parking lots	X	X	X				X	
Utilize open sections		X	X				X	
Incorporate vegetative swales and bioretention areas on-site		X	X				X	
Construct a green roof			X					X
Incorporate retail and commercial uses	X			X				X
Limit curb cuts				X	X		X	X
Provide clearly defined pedestrian corridors					X		X	X
Enhance bicycle and pedestrian entrances	X				X		X	X
Provide bicycle parking facilities					X	X	X	X
Implement a parking guidance system					X		X	X
Utilize low-angle, cut-off lighting					X	X	X	

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PARKING FINANCING

The cost of constructing, operating, and maintaining parking facilities has an enormous impact on development patterns and on the feasibility of smart growth projects. The type of parking facility constructed in a development project is usually determined by balancing the cost of land versus the cost of constructing parking. Parking structures can cost more than five times as much per space as parking lots. Therefore, in suburban and rural areas, the relatively low cost of land makes surface parking more cost-effective than building a garage. On the other hand, in urban areas, parking garages are more economical since land costs are at a premium. More specifically, according to the Victoria (Canada) Transport Policy Institute, structured parking typically becomes cost effective when land prices exceed about $1 million per acre. Even though parking garages are more economical in urban locations than in suburban locations, projects aimed at infill and redevelopment of urban areas might still be cost-prohibitive given minimum parking requirements and the high cost of constructing parking structures.

Absent creative financing mechanisms, suburban locations will continue to enjoy a significant competitive advantage over urban locations and vast expanses of parking will continue to dominate the American landscape. Surface parking is clearly not the most efficient and best use of land, having detrimental impacts on both neighborhood character and the environment. Structured parking can significantly reduce impervious cover by reducing acreage converted to parking and has less of a visual impact than surface parking. However, it is unlikely that structured parking will become the norm, outside of urban environments where land costs are high, absent significant incentives to defray the cost of constructing structured parking. This section discusses both traditional and creative financing mechanisms and incentives for the construction of both privately- and publicly-owned and operated parking structures.

Privately-Owned Parking Structures

The development of privately-owned and operated parking structures is typically financed through conventional construction financing through private banking institutions. There are various ways in which developers recoup these expenses including bundling the costs of parking into the rents and purchase prices of the uses the parking is serving, assessing parking fees on users, and leasing or selling space incorporated in the parking structure itself.

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- *Bundled Parking*. Developers typically bundle the costs of parking into the rent or purchase price for residential and commercial units and buildings. Through this practice, visitors to the development project can typically park for free, while the tenants and owners bear the costs of parking through increased rents or purchase prices. Tenants and owners can in turn pass the costs on through higher priced goods for retail uses or lower employee salaries for office uses. While bundled parking has been a common practice and serves as a way to help cover costs related to the construction of parking facilities, bundling parking costs with rents and purchase prices is not a recommended strategy since it encourages automobile ownership and is a disincentive for using alternative transportation modes, as discussed in the section on parking management.

- *Parking Fees*. Another way in which developers can cover the costs of constructing, operating, and maintaining parking structures is by levying parking fees directly on the users of the parking facility. Parking rates can be set to defray the cost of constructing and operating a parking facility, or could be set to cover only the operating costs. The parking rates should be carefully structured to achieve a balance between the costs to be covered and the impact the fee may have on the demand for the facility.

- *Leases and/or Sell Space*. Structured parking facilities provide numerous opportunities to capture ancillary sources of revenue. Developers can incorporate retail or office space into lower levels of parking facilities and lease or sell this space to help pay for the costs of constructing, maintaining, and operating the parking facility. Developers could also sell development rights, including air rights over the parking facility, if the parking facility does not take full advantage of the permissible development rights.

In addition to these parking-related revenues, private sector developers can sometimes receive incentives from the public sector to help cover the costs of constructing structured parking facilities. These incentives include reduced development fees, land acquisition and assemblage assistance, reduced parking

requirements, density bonuses, and real estate tax abatements. Reduced minimum parking requirements, density bonuses, and real estate tax abatements are discussed in greater detail below:

- *Reduced Minimum Parking Requirements*. Local jurisdictions can help incentivize structured parking facilities by reducing minimum parking requirements for development projects that incorporate structured parking as opposed to surface parking. Reduced parking requirements allow development projects to operate at a higher floor area ratio, thereby increasing the profitability of the development project.

- *Density Bonuses*. Density bonuses are a tool used by local jurisdictions to allow a development project to have a floor area bonus to help offset the costs of constructing structured parking. For example, both the City of Suffolk, Virginia, and the City of San Antonio, Texas, offer density bonuses as incentives for converting surface parking to structured parking—in both cities, for each 100 spaces of surface parking converted to structured parking on an area not exceeding 20% of the site area, an additional 20,000 feet of non-residential space may be constructed. The City of Sioux Falls, Iowa, allows for density bonuses that vary according to the percent of required parking that is within a structured parking facility. For example, if 100% of the required parking is within a parking structure, the project receives a 10% density bonus; if 50% of the spaces are within a structure, the project receives a 5% density bonus. As with reduced minimum parking requirements, density bonuses allow the project to operate at a greater floor area ratio, thus increasing the profitability of the project.

- *Payment in Lieu of Taxes Agreements*. A payment in lieu of taxes (PILOT) agreement is essentially a real estate tax abatement that allows a developer of a specific type of real estate project, as typically defined in state and local statutes, to substitute for an established period of time the annual real estate taxes due on a property with a negotiated payment. With respect to parking facilities, PILOTs typically enable the development of parking facilities that otherwise might not be built since the private returns on parking facilities might be inadequate to assume the risk associated with constructing such facilities. Although PILOT agreements have been successful in getting parking facilities constructed, these agreements are not without their drawbacks. PILOTs can become very costly subsidies since the public sector may end up foregoing millions of dollars in property taxes during the term of a PILOT agreement.

Payment in Lieu of Taxes in Baltimore City

Expanding Baltimore City's payment in lieu of taxes (PILOT) program to include off-street parking facilities is one approach the City is using to help alleviate the downtown parking shortage, which was commonly viewed as one of the contributing factors in companies' decisions to relocate to the suburbs where there is plentiful and free parking.

In 1999, the State of Maryland expanded the PILOT authority in Baltimore City to enable the City to offer PILOTs for economic development projects that achieve a clear and well-documented public purpose, including the construction of downtown parking facilities (Tax Property Article, Section 7, Subtitle 5). To qualify as an economic development project, the parking facility must be located in a downtown urban renewal area, as defined by city ordinances, and contain at least 250 parking spaces. In addition, the developer or owner of the facility must invest at least $2.5 million in private capital and must pay property taxes on the original value of the land and a minimum of 5% of the incremental property taxes that would otherwise be due absent the PILOT agreement.

Developers or owners of proposed parking facilities that meet the above criteria may negotiate a PILOT agreement with the Baltimore Development Corporation (BDC), the quasi-public agency charged with overseeing the economic development of the city. In negotiating the agreement, BDC conducts an economic analysis of the project that includes identification of funding sources, projected returns to the developer, and the projected benefits of the project. including number of jobs created and other tax revenues generated by the project. The PILOT agreement must be approved by the City Council and the Board of Estimates. Construction must commence within eighteen months of the PILOT, otherwise the agreement will no longer be valid. The term of the PILOT agreement must not exceed 25 years, and full property taxes must be paid each year after the expiration of the agreement.

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Although private developers typically rely on conventional financing, they are increasingly looking to local jurisdictions and state governments to help gain access to long-term capital markets through bond financing, rather than relying on construction financing through private banking institutions. Through state and local governments, private developers can gain access to private activity bonds for the financing of parking structures.

- *Private Activity Bonds*. Private activity bonds are bonds issued by a government entity to provide financing for projects used by a private or non-governmental entity. Private activity bonds are generally backed by project-related revenues. With respect to bonds issued for the construction of parking facilities, the interest on the bonds is usually taxable since privately-owned parking facilities typically do not meet the requirements for tax-exempt status established by the Internal Revenue Code—that is, they do not keep private use and private payment below the specified 10% threshold. In some cases, such private activity bonds may be tax-exempt, namely when government entities issue the bonds to provide financial assistance for projects that advance specific public policies such as urban redevelopment. For example, many local jurisdictions provide Enterprise Zone Facility Bonds to businesses located in designated enterprise communities or empowerment zones, low-income areas in which special tax credit programs and incentives are targeted to stimulate economic development. Enterprise Zone Facility Bonds provide tax-exempt financing to enterprise zone businesses to finance, refinance, and reimburse costs of a wide variety of capital projects. Eligible Enterprise Zone Facility Bond projects include the construction of parking facilities for customers and employees. The State of Maryland offers several different tax exempt and taxable private activity bond financing programs. With respect to parking facilities, the Maryland Transportation Authority provides bond financing for the development of parking structures in priority funding areas.

Maryland Transportation Authority Smart Growth Parking Program

In 2001, the Maryland General Assembly enacted legislation that authorizes the Maryland Transportation Authority to finance, construct, operate, maintain, and repair vehicle parking facilities in Priority Funding Areas. This legislation enables the Authority to issue revenue bonds to finance parking facilities. The bonds may be backed by a variety of sources including private and government grants and parking revenues. These revenues must be used to pay all operating and maintenance costs and debt service until the Authority bonds are retired. Authority participation is limited to the amount that can be covered by the revenue stream. Minimum debt coverage ratio to be attained is 1.25 times the debt service after operating costs. The Authority bonds are "stand-alone issues" whose cost is dependent on the financial feasibility of the project. The Authority cannot make a financial investment into the project. Project costs over the amount the Authority can finance through bonds must be covered by project partners. The Authority will retain an ownership interest in the facility for the term of the bonds, which may not exceed 30 years. The Authority's ownership interest will revert to the project partners with the retirement of the Authority bonds. This legislation requires the Authority to give priority to projects located within a transit-oriented development area.

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Publicly-Owned Parking Structures

Publicly-owned parking structures are typically financed through the issuance of municipal bonds that are in turn repaid through a variety of sources including parking related revenues and tax revenues. The interest earned on these bonds is usually exempt from federal taxes, and may be exempt from state and local taxes as well. As a result of this tax exemption, municipal bonds carry relatively low interest rates. Therefore, the issuing entity benefits by paying lower interest rates and the investors benefit from tax-free interest income. With respect to the bonds issued for the financing of publicly-owned parking facilities, under the Tax Reform Act of 1986, 90% of the available parking spaces must be made available to the general public to be exempt from federal taxes. Bonds used to finance publicly-owned parking facilities that provide less than 90% of the spaces to the general public are subject to federal taxation.

Municipal bonds issued for the construction of parking facilities can be backed by either parking related revenues, including user fees and fines, lease or sale of development rights, parking taxes and development impact and in-lieu fees, or tax revenues, including ad valorem property taxes, special assessments, and tax increment financing. The public sector can rely on a variety of bonds, depending on which of these

repayment sources are used to back the bond—including general obligation bonds, special assessment bonds, revenue bonds, double-barreled obligations, and tax increment finance bonds. This section discusses the various types of municipal bond financing and the repayment methods.

- *Revenue Bonds*. Revenue bonds are one of the most commonly used forms of financing for parking facilities. Revenue bonds are bonds issued to finance revenue-generating uses, such as toll roads, bridges, airports, water and sewage treatment facilities, and hospitals. The principal and interest of revenue bonds are paid exclusively by project revenues such as tolls, charges, or rents paid by users of the facility. Therefore, revenue bonds are generally not backed by the credit or taxing power of the issuing entity. With respect to revenue bonds issued for parking facilities, the principal and interest is typically repaid from parking fees and other parking related revenues such as parking taxes and leases, among others. Revenue bonds, particularly for parking facilities, are not risk-free—that is, a parking facility financed with a revenue bond might not generate the projected revenue. In light of revenue shortfalls, revenue bonds typically have a reserve fund from which to draw. The following is a description of some of the repayment sources for revenue bonds issued for the construction of parking facilities.

    - *Parking Fees and Fines*. As in privately-owned and operated parking facilities, parking fees are common means of generating revenue for public parking development and maintenance. Parking rates can be set to defray the cost of constructing and operating a parking facility, or could be set to cover only the operating costs. The parking rates should be carefully structured to achieve a balance between the costs to be covered and the impact the fee may have on the demand for the facility. Moreover, the public sector can generate revenue through enforcement and the issuance of parking citations—these fees are generally used for parking-related maintenance and improvements.

    - *Leases and/or Sell Space*. As in privately-owned and operated parking facilities, the public sector can help cover the costs of constructing public parking facilities by capturing ancillary sources of revenue such as the lease or sale of retail or office space incorporated into the parking structure or the sale of development rights, including air rights over the parking facility.

    - *Parking Taxes*. The public sector can generate revenue by levying parking taxes on privately-operated parking structures to help fund the construction of public parking facilities. Parking taxes are taxes levied on operators of off-street parking facilities. For example, as was cited earlier, in the City of Baltimore, the Parking Authority collects a parking tax equal to 11% of a parking facility's gross transactions and a flat rate of $14 per month per monthly user.

    - *Development Impact and In-Lieu Fees*. The public sector can help finance centrally located, public parking facilities that offer shared parking opportunities through development impact fees or parking in-lieu fees. Development impact fees are fees paid by a developer as a condition of issuance of a building or zoning permit by a unit of government to fund public facilities, including parking structures, necessary to serve the new development. In-lieu fees are fees paid by a developer in exchange for reductions in minimum parking requirements. Parking impact fees, a specific type of development impact fee, are typically based on a flat fee per square foot of floor area and vary by land use. Therefore, parking impact fees are assessed regardless of how much parking is provided on site. On the other hand, parking in-lieu fees are based on the parking deficit generated for a specific development project. For example, the Town of Westport (Connecticut) Zoning Regulations allow for developers to pay fees-in-lieu of providing all or a portion of the off-street parking spaces required for projects located in a designated Historic Design District. In this example, the fee-in-lieu of parking is set at $2,000 per deficit parking space and must be paid in full by the applicant prior to the issuance of a zoning permit.

- *General Obligation Bonds*. Prior to the increasing popularity of revenue bonds, general obligation bonds were the primary way in which local jurisdictions financed public parking facilities. General obligation bonds are bonds secured by the full faith and credit of the issuing entity and backed by the issuer's taxing power. The principal and interest of general obligation bonds are typically repaid through an ad valorem property tax, a property tax levied across an entire jurisdiction to help fund

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public improvements. General obligation bonds typically have the lowest possible interest rate or cost of borrowing since they have less risk than other type of bonds, particularly revenue bonds, as the debt-service is tied to the tax base rather than a revenue stream.

- *Special Assessment Bonds*. Like general obligations bonds, special assessment bonds are backed by a jurisdiction's taxing authority; however, special assessment bonds are backed by proceeds derived from a special tax levied on specific taxpayers that directly benefit from the public improvement, as opposed to an ad valorem tax levied across the jurisdiction. Special assessments are commonly used for such public works projects as street paving, drainage, water and sewer systems, and parking facilities. Special assessment bonds place a major share of the burden of financing on those individuals receiving the greatest benefit from the improvement. Depending on the cost a particular special assessment bond, the bond might be secured by the full faith and credit of the issuing entity.

Special Taxing Districts in the State of Maryland

The Annotated Code of Maryland authorizes ten counties—Anne Arundel, Calvert, Charles, Frederick, Garrett, Howard, Montgomery, Prince George's, Washington, and Wicomico—and all municipalities to create special taxing districts, issue tax-exempt bonds to finance infrastructure improvements in these designated districts, and levy ad valorem or special taxes to repay the issued bonds. The purpose of this authority is to provide financing, refinancing, or reimbursement for the cost of infrastructure improvements, including parking facilities. In order to implement this authority, a petition must be filed with the local jurisdiction by at least two-thirds of the property owners located within the district by number and by assessed valuation. Upon receipt of this petition and before issuing bonds, the governing body of the jurisdiction must designate by resolution an area or areas as a special taxing district, create by resolution a special fund into which the special taxes are to be deposited, and provide for the levy of an ad valorem or special tax on all real and personal property within the designated district at a rate designed to provide adequate tax revenues to pay the principal, interest, and redemption premium on the bonds and to replenish any reserve funds.

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One example of the use of special taxing districts in Maryland is Montgomery County. In 1994, Montgomery County enacted the Development District Act, Chapter 14 of the Montgomery County Code, which authorized the County to provide financing, refinancing, or reimbursement for the cost of infrastructure improvements necessary for the development of land in areas of the County of high priority for new development or redevelopment by creating development districts in which special assessments, special taxes, or both may be levied. The Act also authorized the issuance of tax-exempt bonds or other obligations of the County payable from special assessments or special taxes collected, or tax increments created, in a development district, and specified the procedures to be followed in creating a development district, issuing bonds, and assessing and enforcing the collection of special assessments or special taxes in such a district. In accordance with Chapter 14 of the County Code, the County Council created two development districts in 1998—the Kingsview Village Center Development District and the West Germantown Development District. With respect to the West Germantown Development District, the District was created in an unincorporated area of Montgomery County, encompassing approximately 672 acres. Various transportation, public park, and sewer infrastructure improvements are intended to be constructed by developers and acquired by the County at completion. On April 11, 2002, Montgomery County issued approximately $16 million in special revenue bonds to fund the improvements. On May 23, 2002, the County Council approved a special tax of $0.224 per $100 of assessed value on all real property located in the District and a special benefit assessment on undeveloped residential property located in the District of $744.96 per equivalent dwelling unit. These rates were set at rates sufficient to pay the principal of, interest on, and any redemption premium on any special obligation bonds issued with respect to the District, and to replenish any related debt service reserve fund.

- *Double-Barreled Bonds*. Government entities sometimes issue a hybrid of general obligation bonds, special assessment bonds, and revenue bonds to finance capital projects—such bonds are called double-barreled bonds, as they are backed by two or more repayment sources. Double-barreled bonds used to finance parking facilities are backed by both parking related revenues and tax revenues. Typically, the parking related revenues are the first repayment source; should these not be sufficient, tax revenues can be utilized. Double-barreled bonds are typically used when the projected revenue stream is uncertain.

- *Tax Increment Finance Bonds*. Tax increment finance bonds are bonds backed by recapturing, for a time, all or a portion of the increase in property tax revenues generated by new development (both public and private) in a specified area. That is, the rationale behind tax increment financing is that an initial public investment in a defined area will increase property values in that area, which in turn will generate additional tax revenue that can then be used to pay off the loans issued to pay for the initial public investment. Tax increment financing is used by cities and redevelopment authorities to finance certain public redevelopment costs including acquiring properties, rehabilitating publicly-owned structures, demolishing buildings, relocating occupants, cleaning up contamination, constructing public improvements, and administrative costs. The construction of public parking facilities is typically an authorized use for tax increment financing since the construction of parking facilities is commonly viewed as an economic development generator that will spark commercial development and increase area property values. Tax increment financing enables municipalities to revitalize blighted communities without raising local property taxes or depleting general revenues.

With budgetary constraints and limited bonding authority, local jurisdictions are turning to alternative financing arrangements for projects traditionally funded through municipal bonds. Two such methods that are becoming increasingly popular are public-private partnerships and lease purchase financing.

Tax Increment Financing in the State of Maryland

The Tax Increment Financing Act of 1980 authorizes all counties and municipalities in the State of Maryland, except for Baltimore City, to establish tax increment finance districts and pledge property taxes on the increased assessed values in those districts toward payment of bonds used to finance development in the districts. According to the Act, tax increment financing can be used to finance certain public redevelopment costs including acquiring properties, rehabilitating publicly-owned structure, demolishing buildings, relocating occupants, and constructing public improvements including parking facilities. In 1994, State legislation provided Baltimore City with similar authority to utilize tax increment financing, but did not allow the City to use tax increment financing for parking facilities. In 2001, this legislation was amended to authorize the City to use tax increment financing for parking facilities that are either publicly or privately owned but serve a public purpose. The State legislation is enabling only, and counties and municipalities must implement the provisions of the Tax Increment Financing Act by local ordinance or resolution.

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- *Public-Private Partnerships*. Government entities are increasingly looking to the private sector to assist in developing capital projects, including parking facilities. Public-private partnerships can leverage scarce funding resources by allowing private firms to own or operate a facility or service developed with public funds. More specifically, through public-private partnerships, a public entity and a private organization come together to plan, finance, and construct capital projects, in so doing, sharing responsibility for raising capital and project risks, and also sharing project rewards. By sharing these responsibilities, the public entity is able to reduce the direct costs of the project to the government, leverage private investment, and increase project viability. In public-private partnerships, public sector involvement is vital since it typically guarantees the tax-exempt status of bonds used to finance the project, thereby making what might otherwise be an infeasible project viable. An example of such a public-private partnership is the Hollywood and Highland project in Hollywood, California. This project is part of a redevelopment plan for a larger area and consists of a mixed-use redevelopment combining retail and entertainment uses, public spaces, and a hotel. The feasibility of this $300 million project hinged on the need for $80 million in public funds to finance a multi-story subterranean parking garage with 3,000 spaces to service the project and the surrounding area. In response, the City issued tax-exempt parking revenue bonds to generate the

$80 million. The tax-exempt public financing of the structure made what would have been an otherwise infeasible parking structure, which would have stalled the overall redevelopment project, feasible. The bonds are to be repaid by parking revenues collected from parking lots and meters citywide.

Public-Private Partnerships: Joint Development

Joint development is a specific type of public-private partnership in which government entities market publicly-owned, transit-oriented properties to private sector developers with the objective of developing commercial, residential, or mixed-use development projects that ultimately have a direct impact on increasing transit ridership. Joint development allows public entities to sell excess land around transit stations and use the proceeds to defray the capital costs of transit projects. This excess land, in many cases, is underutilized surface parking lots that serve the transit station. Therefore, one of the key features of joint development projects is a parking structure that replaces the parking that was previously accommodated in the surface lots. Finding innovative ways to finance these parking structures is critical in making joint development projects feasible. One such funding source is federal grants such as Congestion Mitigation and Air Quality (CMAQ) funds. That is, through joint development, the involvement of the public entity enables the use of CMAQ funds, which would not be otherwise available to private developers. CMAQ funds are funds provided by the federal government to State DOTs and local governments to invest in projects that reduce transportation related emissions in nonattainment and maintenance areas for ozone, carbon monoxide, and small particulate matter. Joint development is typically an eligible activity for CMAQ funds since it aims to create transit-oriented, high-density, mixed-use development that results in increased transit ridership. Moreover, the 1998 reauthorization of the CMAQ program provides greater flexibility for public-private partnerships, specifically joint development projects, by allowing States to allocate CMAQ funds to private and non-governmental agencies. Federal transit capital funds are also eligible for use in TOD projects when the project is physically proximate to the transit facility and the project will contribute to transit ridership.

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The Washington D.C. Metropolitan Area Transit Authority (WMATA) operates the second largest commuter rail system in North America. The Metrorail system extends 103 miles and includes 83 stations on five separate lines. The $10 billion system carries over a half a million people each weekday and is clearly a tremendous asset to the Washington Metropolitan region. WMATA has a very active joint development program to seek public and private sector partners to develop WMATA-owned real property at and around transit stations. The four main goals of the joint development program are: 1) to promote transit-oriented development; 2) to attract new riders to the transit system; 3) to create a source of revenue for the Authority to operate and maintain the transit system; and 4) to assist local jurisdictions to recapture a portion of their past contributions. WMATA's participation in joint development projects typically includes either the sale or lease of excess WMATA-owned or controlled real property interests, including air rights, or the provision of direct physical connections, including pedestrian, vehicular, and visual connections, to WMATA facilities from adjoining private development. To date, WMATA has completed over 20 joint development projects.

- *Lease Purchase Financing*. A relatively new method of financing municipal parking structures is lease purchase financing. In a typical lease purchase agreement, a non-governmental party will construct or purchase a facility, as opposed to the local jurisdiction, and the local jurisdiction will make lease payments to the party. Lease purchase financing is typically structured as a series of one-year renewable obligations spread out over the life of an asset. Jurisdictions are turning to lease purchase financing as an alternative to the issuance of bonds, as it enables jurisdictions to finance capital projects, including public parking facilities, without incurring long-term debt obligations. The most commonly used form of lease purchase financing is Certificates of Participation (COP). Under COP arrangements, the private entity raises funds for the construction or purchase of the facility through the sale of COPs to multiple investors, who buy shares of the anticipated lease revenues rather than purchasing a bond secured by those revenues. The jurisdiction pays yearly lease