MEMORANDUM

To: Josh Shaw, CTA

From: Eliot Rose, ICF International

Date: November 17, 2014

Re: Task 3: Develop and Document Possible Centralized GHG Evaluation Methodology

1. Introduction

The California Transit Association has engaged ICF International to develop a recommended GHG reduction evaluation methodology for the State to use in scoring transit agency applications for Cap and Trade funds. This memo is the third of four memos to detail transit project characteristics and greenhouse gas (GHG) quantification methodologies as applicable to the funding programs outlined under Senate Bills 852 and 862. The first memo provided a catalog of transit projects that reduce GHG emissions and an initial assessment of quantification methodologies that can be used to analyze the benefits of potential projects. The second memo reviewed quantification tools and resources, including the American Public Transportation Association's *Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit* ('the APTA Protocol'), in more depth and recommended resources and quantification methodologies for different project types.

This memo recommends a centralized approach to quantifying GHG reductions due to transit projects and discusses the role of state agencies and transit agencies under this approach. The goals of this approach are to:

- Provide comprehensive guidance on quantifying the GHG reduction strategies that agencies are likely to pursue.
- Minimize the level of effort involved in gathering data, conducting analyses, and reviewing results.
- Allow flexibility for transit agencies to analyze innovative or cross-cutting strategies in a way that better captures their benefits.

The following section describes the recommended approach in detail. Section 3 contains case studies that illustrate how this approach would be applied for different transit projects. Section 4 discusses implementation, including the level of effort involved for both state agencies and transit. The final section assesses the pros and cons of the recommended approach.

2. Recommended Approach

Quantifying the GHG reductions of proposed transit projects consists of two steps:

1. Estimating the impact of the project on the factors that drive GHG emissions (e.g., transit passenger miles traveled, vehicle miles traveled, transit agency fuel use)
2. Converting the results to GHG emissions.

A key finding of the previous memo was that the APTA Protocol, which serves as the guiding document for quantifying greenhouse gas (GHG) emissions from transit systems focuses on the second step, and does not provide adequate guidance on the first.[1] Table 1 summarizes what aspects of GHG quantification are—and aren't—covered by the APTA Protocol.

Table 1: APTA Protocol Coverage of Key GHG Quantification Steps, by Project Category

Project category	GHG quantification steps covered in the APTA protocol	GHG quantification steps *not* covered in the APTA protocol
Expanding or Improving Transit Capacity	■ Applying a mode shift factor to convert ridership to displaced VMT ■ Converting displaced VMT to reduced fuel consumption ■ Converting reduced fuel consumption to GHG reductions	■ Estimating increased transit ridership
Transit Rider Outreach and Incentives	■ Applying a mode shift factor to convert ridership to displaced VMT ■ Converting displaced VMT to reduced fuel consumption ■ Converting reduced fuel consumption to GHG reductions	■ Estimating increased transit ridership
Active Transportation and Land Use Strategies	■ Converting displaced VMT to reduced fuel consumption ■ Converting reduced fuel consumption to GHG reductions	■ Estimating indirect reductions in VMT due to increased bike/ped access to stations or shorter trips that don't involve transit ■ Estimating direct VMT reductions due to increased transit ridership
Improving the Efficiency of Transit Energy Use	■ Converting fuel and energy consumption to GHG emissions	■ Estimating impacts on fuel use and/or energy consumption

The quantification steps not covered by the APTA Protocol—estimating impacts on travel behavior or fuel consumption—are generally much more complex than the fuel and GHG conversions that are. They

[1] Though this memo focuses on the APTA protocol, similar guidance issued by the FTA under its Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER) program (http://www.fta.dot.gov/12351_11424.html) also has the same limitations.

also require in-depth knowledge of the transportation system and local context, which means that transit agencies will need to take responsibility for quantification in order to accurately assess impacts. In order to support transit agencies when applying for Cap and Trade funds and provide funding agencies with a basis for reviewing applications, it will be necessary for the state to create clear and comprehensive guidance that covers *all* aspects of quantifying GHG reductions due to transit.

A variety of existing tools and resources support quantification of GHG reductions for transit projects, but different resources apply to different projects, and most only cover a small number of project types. This section recommends an approach for synthesizing and applying these resources in the process of allocating Cap and Trade funding for transit projects, describing the role that both state and transit agencies would play in the process. Table 2 summarizes the key steps in the process and the role that state and transit agencies would play in each step.

Table 2: Summary of State and Transit Agency Roles in the GHG Quantification Process

Process step	State agency responsibilities	Transit agency responsibilities
Creating framework	■ Convene stakeholders to create framework and scope guidance	■ Participate in stakeholder working groups ■ Contribute resources and best practices
Quantifying GHG reductions of transit projects	■ Draft guidance document, including recommended quantification methods, qualitative criteria for demonstrating GHG reductions, and guidance on complex analyses ■ Create spreadsheet tool to facilitate quantification	■ Input required project data into spreadsheet tool ■ Submit documentation to support tool inputs or qualitative GHG reduction criteria ■ Thoroughly document more complex analyses
Reviewing applications	■ Review calculations and analytical results ■ Verify supporting documentation	

2.1. Creating Framework

In order to create a framework for quantifying GHG emissions due to transit projects, state agencies will need to convene stakeholders in order to:

- Understand the level of guidance needed by transit agencies to estimate the impact of different GHG reduction strategies
- Identify resources and best practices
- Outline standards for the application of agency-specific data and complex analyses (e.g., ridership forecasts, travel models, methods to estimate the impacts of advanced technologies) in GHG quantification

Stakeholder groups should include representatives of transit agencies of different sizes from across California, as well as experts on different steps of the GHG quantification process, such as regional

transportation planners and authorities on alternative fuels and vehicle technologies. The result of this process would be a framework document that specifies which strategies should be incorporated into the guidance, and how.

2.2. Quantifying GHG Reductions

The central element of this recommended approach is a guidance document that specifies in depth how to analyze GHG reductions from transit projects. This would both facilitate transit agencies' analysis of projects and provide a clear standard against which state agencies would review projects. This guidance would be organized by strategy type, and provide detailed guidance on analyzing each strategy included. The guidance would be similar in structure and content to The California Air Pollution Control Officers' Association *Quantifying Greenhouse Gas Mitigation Measures* Handbook[2] (CAPCOA Handbook), which is a comprehensive resource for estimating GHG reductions for land use projects.

Like the CAPCOA Handbook, the guidance would not involve new research, but would collect disparate resources into a unified approach for quantifying GHG reductions. The guidance would organize strategies into three different approaches depending upon the type of resources and tools that are available to support analysis of GHG reductions:

- **Recommended quantification method**: For strategies that are well-covered by existing research and tools, the guidance would outline a simple, straightforward method to quantify GHG reductions, including detailed calculations and assumptions. This guidance would be encapsulated in a spreadsheet tool that includes pre-programmed assumptions and emissions factors and automates required calculations.[3] Transit agencies could submit results from this tool directly to the state when submitting applications, or use the spreadsheet as a screening tool to evaluate the potential effectiveness of different strategies before considering more complex analyses.
- **Qualitative analysis**: For strategies where there is insufficient research to quantify GHG reductions, or where existing research does exist shows limited GHG reduction potential, the guidance would specify criteria for qualitatively demonstrating GHG reductions.
- **Complex quantitative analysis**: A few strategies have the potential to produce substantial GHG reductions, but results are so dependent upon context and project details that it is not possible to outline a uniform approach. For these strategies, the guidance would recommend tools and methods and discuss criteria for accepting analytical results, but would not include detailed calculations.

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[2] http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf.

[3] For an example, see the Transportation Demand Management (TDM) spreadsheet tool created by the Bay Area Air Quality Management District (BAAQMD) to facilitate analysis of the transportation and land use strategies in the CAPCOA Handbook (http://www.baaqmd.gov/Divisions/Planning-and-Research/Smart-Growth.aspx). The default version of the tool is calibrated for local use with data from Bay Area projects, but the assumptions could be modified to ensure that the tool is generally applicable to projects across California.

Table 3 summarizes the transit projects that would likely fall under each of these approaches, based on the review of resources and tools in the Task 2 memo, and describes the responsibilities of state agencies and transit agencies under each approach.

Table 3: Summary of GHG Quantification Approaches

Approach	Projects that would apply the approach	What state agencies would specify in the guidance	Transit agency responsibilities
Recommended quantification method	■ Increase service frequency ■ Enhance travel speeds ■ Transportation demand management programs that reduce fares or provide vouchers ■ Transit oriented development ■ Improved vehicle fuel efficiency ■ Use of alternative fuels (including rail electrification and hybrid vehicles) ■ Renewable energy projects ■ Lighting retrofits	■ Key data inputs to be provided by the transit agency, and required supporting documentation ■ Assumptions on the impact of projects on travel behavior or fuel use drawn from research, with citations ■ GHG conversion factors drawn from California-specific tools (e.g., EMFAC) ■ Step-by-step calculations and examples ■ Potential alternative quantification approaches, if applicable ■ Spreadsheet tool	■ Enter inputs into spreadsheet tool ■ Submit spreadsheet tool results ■ Submit supporting documentation
Qualitative analysis	■ Increase capacity of existing service ■ Extend operating hours ■ Outreach programs ■ Improvements to customer experience ■ Network/fare integration ■ Bicycle and pedestrian connections to transit ■ Carshare at transit stations	■ Qualitative criteria for demonstrating GHG reductions, and required supporting documentation ■ Range of likely GHG reductions from a project that meets criteria ■ Potential alternative quantification approaches, if applicable	■ Confirm that the project meets criteria ■ Submit supporting documentation
Complex quantitative analysis	■ Route expansion ■ Enhance reliability ■ Comprehensive facility energy improvements ■ Projects that involve synergies between multiple strategies (e.g., BRT, which increases speed, frequency, and capacity)	■ Applicable quantification tools and methods (e.g., regional travel models, ridership forecasts, building energy use modeling). ■ Relevant guidance or standards for applying these methods	■ Document quantification methodology and results, including any use of / deviation from relevant assumptions or factors included in the guidance ■ Demonstrate that methodology conforms with relevant guidance or standards ■ Discuss applicability of results to similar projects

The state would also be responsible for reviewing results submitted by transit agencies. For strategies where agencies calculate GHG reductions using the recommended quantitative method or demonstrate GHG reductions qualitatively, the guidance would be very detailed in order to give specific direction to transit agencies and provide the state with a clear standard to apply when reviewing results. The spreadsheet tool would further simplify both quantification and review. It would be prohibitively challenging to provide in-depth guidance on projects that require complex analysis, since the cases in which agencies would apply complex analyses vary so widely. The guidance for these projects would instead focus on how to apply the tools and methods that are likely to be used to quantify GHG emissions, such as travel models, ridership forecasts, and building energy use models. Reviewing results of complex analyses may require more discretion on the part of the state. However, in many cases there are standards or guidelines that govern the use of complex tools to analyze travel behavior that the guidance could refer to in order to clarify the process for transit agencies and reviewers.

3. Case Studies of Sample Projects

The following case studies illustrate the process for quantifying GHG reductions for sample projects under each of the three approaches discussed above. These case studies are based on the recommended methodologies outlined in the Task 2 memo.

3.1. Recommended Quantification Method: Transit Oriented Development

There is an extensive body of research describing the relationship between the "D variables" of land use (density, design, diversity of land uses, destination accessibility, distance to transit) and VMT, and methods for applying this research are outlined in the CAPCOA Handbook.[4] State agencies could draw upon the CAPCOA method to create guidance for quantifying GHG reductions due to transit oriented development (TOD) projects.

In order to estimate GHG reductions for a TOD project on agency-owned land, a transit agency would need to provide information on at least one of the following land use variables for the TOD project:

- Density (in housing units per acre)
- Diversity (area devoted to each of the following land uses: single family residential, multifamily residential, commercial, industrial, institutional, park
- Destination accessibility (distance to downtown or major job center)
- Distance to the nearest transit station

The agency would also supply information on the context in which this development is located (urban, compact infill, suburban center, or suburban). It would input this information into the spreadsheet tool, which would convert these inputs to GHG reductions as follows:

[4] CAPCOA Handbook, Strategies LUT-1, LUT-3, LUT-4, LUT-5.

- Compare inputs to default assumptions from the CAPCOA Handbook to calculate the percent change between the TOD project and conventional suburban, auto-oriented development for the land use variables listed above.
- Apply elasticities from the CAPCOA Handbook[5] to convert land use changes to VMT reductions.
- Cap VMT reductions due to land use changes according to development context, as specified in the CAPCOA Handbook.[6]
- Convert VMT reductions to GHG reductions by applying the appropriate county-specific GHG emissions factor from ARB's EMFAC model.[7]

The transit agency would input land use variables into the spreadsheet tool and provide a saved version of the tool showing the resulting GHG reductions for review. It would also submit plans for the TOD project to document the land use inputs used in the tool. State agencies would then review the results and documentation.

3.1.1. Alternative approaches

The guidance would document the assumptions, elasticities, and conversion factors used in the spreadsheet tool. It would also describe cases in which agencies may want to use an alternative approach to estimate GHG reductions. One potential case is a project in a highly urbanized area where GHG reductions may exceed the caps specified in the CAPCOA document. In this case, the transit agency could compare trip generation forecasts for other TOD projects to forecasts for conventional development to justify raising or removing the cap. It would then use land use variables to calculate VMT reductions and apply GHG conversion factors as specified in the guidance. The agency would then provide documentation of its land use inputs, calculations, justification for altering the cap on VMT reductions, and GHG reduction results. The state would review this documentation to ensure that calculations are correct and that the justification for removing the cap is valid.

Another alternative approach would be to use a regional travel model to analyze the impact of a large or regionally significant TOD project. In this case, the guidance would refer users to the section on complex analyses for more information about how to apply regional travel models to analyze GHG reductions. For a case study of how regional travel models would be applied, see Section 3.3.1.

3.2. Qualitative Analyses: Real-Time Information at Transit Stations

It is not possible to quantify GHG reductions from real-time information at transit stations due to limited research on the topic and wide variety in how these projects are implemented. Instead, a transit agency would qualitatively demonstrate that the project meets one of two criteria, as follows:

For a **project targeted toward high-growth areas identified in an SCS**, the transit agency would submit:

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[5] CAPCOA Handbook, Strategies LUT-1, LUT-3, LUT-4, LUT-5.

[6] CAPCOA Handbook, 59.

[7] http://www.arb.ca.gov/emfac/

- project documents describing the type of real time information systems planned and the routes on which they will be deployed
- route maps showing the location of these routes
- land use maps from the RTP/SCS to demonstrate that routes receiving real-time information serve areas with high levels of planned growth or transit priority areas

For a **project supporting increased transit capacity that serves high-growth areas identified in an SCS**, the transit agency would submit:

- project documents describing the type of real time information systems planned and the routes on which they will be deployed
- A list of relevant capacity-increasing projects included in the RTP/SCS to demonstrate that real-time information systems serve these routes
- policies calling for improved real-time information from the RTP/SCS, to demonstrate that real-time information is a component of the region's GHG reduction strategy

State agencies would review the documentation submitted by the transit agency to determine whether the project meets criteria. If so, the project would receive credit for a range of potential GHG reductions based on research. For example, a recent review of real-time information systems found resulting ridership increases of 0-2%,[8] which would translate into GHG reductions of roughly 0-1%.

3.3. Complex Quantitative Analysis

Certain projects will require more extensive analysis in order to quantify GHG reductions. There is no "one size fits all" approach to quantifying these projects, so we provide brief case studies for two different sample projects. In addition to providing analyses and results for these projects, transit agencies would also describe how findings could apply to similar projects in order to facilitate peers' GHG quantification efforts in the future.

3.3.1. Route expansion

Quantifying GHG reductions due to new transit routes merits more complex analysis, both because the impacts depend on the context of projects and because agencies are likely to have already completed some analysis of significant capital projects that they can draw upon in order to calculate GHG reductions. Three potential approaches to calculating GHG reductions due to route expansion are:

- **Using agency-specific methods**. Transit agencies typically assess potential ridership on new transit routes using their own methods. In order to use this data to demonstrate GHG reductions, the transit agency would document the analysis of new ridership, and convert new ridership to VMT and GHG reductions using mode shift and conversion factors specified in the guidance. State agencies would then review the documentation and results. Assessing whether new ridership is correctly converted to GHG reductions would be a straightforward matter of reviewing transit agency

[8] http://www.citylab.com/commute/2012/03/do-real-time-updates-increase-transit-ridership/1413/

submissions against the guidance, but since ridership forecasting practices vary, reviewing ridership projections may require engaging experts.

- **Using a regional travel model**. New transit lines will typically be included in regional transportation plans. Under SB 375, metropolitan planning organizations (MPOs) are required to use travel models to analyze the GHG impacts of these plans, and the RTP Guidelines specify requirements for model analyses to be considered valid. MPOs typically model a single RTP scenario that includes all projects in the RTP, but some have begun to assess the impacts of individual RTP projects. In this case, the transit agency would refer to this project-level analysis to demonstrate GHG impacts of new routes. Otherwise, the agency would work with the MPO to conduct custom model runs of a scenario that includes only the new routes and compare GHG emissions to the baseline used for the RTP. The transit agency would submit results along with supporting documentation showing that the model exercise was consistent with the modeling used by the MPO in its previous ARB-approved SCS. The state would then review results and documentation. Expert review would only be required if the model assumptions or methodology varied from the approach used under the previous SCS.
- **Using results from an environmental analysis**. New transit lines are typically subject to environmental analysis under the California Environmental Quality Act (CEQA). CEQA requires that these analyses cover GHG emissions impacts, and analysis of GHG impacts can be based on a variety of data sources and tools, including those discussed above and in-depth trip generation forecasting and travel modeling. If a transit agency has completed an environmental analysis of a project, it may be able to use the results to demonstrate GHG reductions.

3.3.2. Energy Efficient Facilities

In order to analyze GHG reductions from new energy efficient facilities or comprehensive improvements to existing facilities, transit agencies would likely work with a consultant to assess improvements model impacts. State agencies could either conduct expert review of the results or work with stakeholders to identify criteria for accepting the results of these analyses. For example, ASHRAE standards on energy-efficient buildings provide guidance on energy use modeling,[9] and California utilities may also have established standards for use when allocating energy efficiency rebates.

4. Implementation of Recommended Approach

4.1. Creating Framework

It will require stakeholder coordination to create a framework for the guidance, including the strategies covered, likely quantification resources, and supporting documentation needed, and to identify the process for reviewing projects. Transit agencies would be responsible for participating in meetings, and state agency staff would both participate in and coordinate meetings. Level of effort for both state agencies and transit agencies will vary depending upon the scope of this coordination. One potential

[9] https://www.ashrae.org/resources--publications/bookstore/standard-90-1

point of comparison for this effort is the SB 375 Regional Targets Advisory Committee,[10] which was responsible for setting GHG reduction targets under SB 375. The RTAC was an interdisciplinary committee with 21 members including representatives of public agencies, universities, advocacy groups, and private consulting firms. It met 13 times over an 8-month period, through a mix of in-person meetings at various locations throughout California and conference calls.

4.2. Creating Guidance

Once there is a consensus over the scope for the guidance, state agencies would need to draft the guidance document and create the associated spreadsheet tool. The level of effort for this would likely be comparable to the level of effort required to create the CAPCOA Handbook. CAPCOA hired a consultant to complete the Handbook, and the base budget for the project was roughly $75,000. This budget did not include a spreadsheet tool, but the CAPCOA Handbook also covers a much wider set of strategies than guidance for transit agencies, which will be focused largely on transportation strategies, so the cost for creating the guidance and spreadsheet tool will likely be comparable if state agencies hire an outside contractor.

4.3. Quantifying GHG Reductions and Reviewing Results

The level of effort required for transit agencies to quantify GHG reductions and for the state to review calculations varies according to the quantification approach used. The quantification and review of projects that involve complex analysis is much more labor-intensive than for projects that apply the recommended quantification method or use qualitative analysis. Creating quantification guidance that is as comprehensive as possible will reduce the level of effort for both transit agencies and state agencies in the long term. Below we estimate range of staff hours required for quantification reviewed on a per-project basis.

For projects where GHG reductions are estimated using the **recommended quantification method**, transit agency staff would spend up to fifteen hours collecting data on the transit project, entering inputs into the spreadsheet, and compiling supporting documentation. State agency staff would spend up to two hours verifying inputs against supporting documentation and reviewing results.

For projects that demonstrate GHG reductions using **qualitative analysis**, transit agency staff would spend up to ten hours compiling and submitting documentation that the project meets the associated criteria. State agency staff would spend up to an hour verifying that the project meets criteria using the documentation provided by the applicant.

For projects that require **complex analysis**, level of effort to quantify GHG reductions and review results will vary. Ridership forecasts and energy efficiency analyses can be quite labor-intensive, but in many cases transit agencies will already have conducted their own analyses prior to applying for Cap and Trade funds, and will simply submit results with their evaluation. Similarly, working with an MPO to conduct a custom travel model analysis of a new transit project can require extensive time from transit agency staff, but MPOs may already have analyzed the GHG impacts of certain projects when preparing

[10] http://www.arb.ca.gov/cc/sb375/rtac/rtac.htm

their SCS. The level of effort for state agency staff to review projects will depend upon the complexity of the analysis and the extent to which guidance and standards apply to the project in question. For projects that quantify GHG reductions using travel models, review could be relatively straightforward due to the extensive state guidance on travel modeling already available through the RTP Guidelines and the SCS review process. However, reviewing results of less commonly-applied analytical methods may require peer or expert review.

5. Assessment of the Recommended Approach

There are several important advantages to the recommended approach outlined above:

- It creates a comprehensive framework for analyzing GHG reductions due to transit projects. The APTA Protocol, which is the most comprehensive resource for analyzing the GHG impacts of transit, does not discuss key aspects of project-level quantification. Creating a framework for analyzing emissions and reviewing results has been a key aspect of other state GHG reduction policies. For example, the State engaged MPOs and other transportation and land use experts in a lengthy effort to set GHG reduction targets and establish quantification methods under SB 375, even though the California Transportation Commission RTP Guidelines already provided a solid foundation for assessing the impacts of regional plans.
- It provides transit agencies with a simple and straightforward method to demonstrate GHG reductions due to the majority of transit projects by consolidating dispersed resources into a single guidance document and providing a spreadsheet tool to support calculation. This would enable transit agencies with limited capacity to easily analyze GHG reductions.
- It offers the freedom for larger transit agencies to conduct more sophisticated analyses.
- It minimizes ongoing effort for state agencies to review projects. Instead of assessing the nuances of *how* GHG reductions were quantified, in most cases state agencies will simply review *whether* an applicant quantified GHG reductions in accordance with the guidance.

The primary challenge with the recommended approach is that it requires substantial effort up front to create guidance. Though this additional time and effort would likely be offset over time by the streamlined quantification and review allowed by the recommended approach, it may require the state to issue interim quantification guidance to support the first round of applications for funding.

Another challenge with the recommended approach is that it may favor larger agencies that have the capacity to conduct complex analyses in cases where these analyses demonstrate larger GHG reductions than the recommended approach or capture projects that the guidance only addresses qualitatively. This is likely to be a shortcoming of any approach that relies on California's diverse transit agencies to quantify GHG emissions. However, requiring transit agencies to document how the results of complex analyses could apply more broadly will build up a library of results that will enable all agencies to analyze a greater variety of projects in more depth over time.