Reductions in Greenhouse Gas Emissions from Land Use Measures in California: Current State of the Literature and Implications for the New Housing Sector.

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1 Background

Governor Schwarzenegger's 2005 Executive Order S-3-05 established climate change emission reduction targets for the state for 2010, 2020 and 2050, and set in motion a process to ensure the targets are met. Assembly Bill 32 (Nuñez and Pavley, Chapter 488, Statutes of 2006) implements the 2020 greenhouse gas emission reduction target.

A 2006 California Environmental Protection Agency (CalEPA) *Climate Action Team Report to Governor Schwarzenegger and the Legislature* posits that 18 million metric tons (MMT) of CO_2e can be reduced by 2020 from the implementation of "smart land use (SLU) and intelligent transportation systems (ITS)". In a draft report released a year later (CalEPA, 2007), that number was revised to 10 MMT of CO_2e. In both cases, details on how these estimates were compiled were not provided. Moreover, the 2006 report mentions that SLU and ITS are "sound but require further analysis and development, and should be allowed to evolve over the next two years". This implies that this quantification of the reduction may not have been fully supported, and may help in explaining the substantial discrepancy between these two estimates.

Following these two Climate Action Team reports, the California Air Resources Board (ARB), in its June 2008 Climate Change Draft Scoping Plan[1], states that 2 MMT of CO_2e can be reduced from "Local Government Actions and Regional GHG Targets". This estimate is exclusive of reductions from increases in vehicle efficiency and decreases in carbon fuel content, and is based on the 2020 forecast of the transportation GHG emissions inventory[2], and an approximate 2% statewide reduction in vehicle miles traveled (VMT) by 2020[3]. The estimate of a 2% statewide reduction in VMT due to land use changes by 2020 is reportedly a conservative estimate based on a literature review of strategies to reduce vehicle miles traveled (Rodier, 2008) (median reduction in VMT of 3.9% for a 10-year time horizon from a combined land-use and transit scenario; range of 1.5% - 5.7% for a 68% study interval; range of 0.4% - 7.7% for a 95% study interval). ARB had decided, in the Draft Scoping Plan, to conservatively use the low end estimate.

In the Proposed Scoping Plan, published October 18, 2008[4], the ARB changed terminology somewhat, increased its estimated savings from smart growth, and qualified it with a reference to SB 375. The new estimate for reductions in GHG from "Regional Transportation-Related Targets" is 5 MMT CO_2e. That is qualified by the statement, "[t]his number represents an estimate of what may be achieved from local land use changes. It is not the SB 375 regional target. ARB will establish regional targets for each

[1] www.arb.ca.gov/cc/scopingplan/document/draftscopingplan.htm

[2] www.arb.ca.gov/cc/inventory/data/forecast.htm

[3] Phone and e-mail communications with Jeff Weir of ARB

[4] www.arb.ca.gov/cc/scopingplan/document/psp.pdf

Metropolitan Planning Organization (MPO) following the input of the Regional Targets Advisory Committee and a public consultation process with MPOs and other stakeholders per SB 375, leaving it unclear as to whether reductions associated with SB 375 are additional to this estimate, or whether this represents ARB's best estimate of what the regional target reductions under SB 375 may be.

The wide range of estimates (2-18 MMT CO_2e) of GHG reductions from land use measures by 2020 further emphasizes that these are based on a preliminary understanding of how land use impacts VMT, and that much uncertainty still exists.

In this paper we discuss the current estimates of GHG reductions from land use measures to VMT reductions from the new housing sector, and provide a brief literature review of some recent research in this field.

2 Relating statewide VMT and GHG reduction estimates to required VMT reductions from the new housing sector

As mentioned, the most current estimate by the California ARB suggests that reductions of 5 MMT of CO_2e are possible by 2020 from land use measures under "Regional Transportation-Related Targets". ARB's estimates of possible GHG reductions are based on the 2020 GHG emissions inventory for passenger vehicles[2] (160.8 MMT), and take into account the effects of the light-duty vehicle GHG standards established under AB 1493[5] (Pavley standards) (31.7 MMT) and the effect of the Low Carbon Fuel Standard[6] (LCFS, 10% reduction in fuel carbon content). The resulting estimate of 2020 GHG emissions from passenger vehicles is then 116.2 MMT CO_2e[7]. Based on the assumption regarding statewide VMT reductions (4% in the proposed scoping plan, based on the median reduction of 3.9% mentioned in Rodier, 2008), this translates, approximately, to a 5 MMT CO_2e reduction.

While it is clear that land use changes can impact VMT associated with new housing, the literature on whether and how land use changes impact VMT associated with existing housing is less clear. If one assumes that VMT can only change with land use planning in new housing, the amount of reductions that this plan would require are quite substantial. In 2004, the most recent year for which state-level GHG emissions data are available, there were 12.8[8] million homes in California and emissions due to combustion of gasoline in light-duty vehicles totaled 135,000,000 metric-tons CO_2e[2]. This implies that each household had associated with it approximately 10.5 metric-tons CO_2e per year due to auto trips. Average annual housing starts in California from 1998 to 2007 (the latest ten years for which data are available) were 163,000 per year[9]. Assuming that there are ten years in which to produce the necessary emissions reductions, from 2010 (allowing time for project planning) to 2020 (the year that AB 32 specifies a target for CO_2e emissions), then there are 1.63 million planned units with which to achieve the reduction goal (163,000 new units per year over 10 years). Dividing the 5 MMT CO_2e by 1.63 million units shows that each new unit must reduce its auto related emissions by 3.1 metric-tons of CO_2e per year in order to equal the required emissions reduction. This

[5] www.arb.ca.gov/cc/ccms/reports/final_pavleyaddendum.pdf

[6] www.arb.ca.gov/fuels/lcfs/lcfs.htm

[7] 160.8 MMT - 31.7MMT, multiplied by a 10% reduction factor

[8] Based on the difference between the number of housing units in California in 2006 (13,174,378 units, based on the U.S. Census Bureau; http://quickfacts.census.gov/qfd/states/06000.html), and the number of housing units built in the 2005-2006 period (373,252 units; www.cbia.org/go/cbia/?LinkServID=FE5ED931-F09E-44C7-96836630388F21F7&showMeta=0)

[9] www.cbia.org/go/cbia/?LinkServID=FE5ED931-F09E-44C7-96836630388F21F7&showMeta=0

translates to a reduction of 29% of the current VMT related household CO_2e emissions (10.5 metric-tons CO_2e per year) from each new housing unit. If we assume eight years of construction (2012-2020), to allow for more realistic planning timeframes, the required reduction per new unit would increase to 3.8 metric-tons CO_2e per year (36% of the current VMT related household CO_2e emissions).

However, these estimates are based on 2004 household VMT related CO_2e emissions, and do not account for the decrease in such emissions due to the future implementation of the LCFS and Pavley standards. The implementation of these two standards will result in a reduction of 27.7%[10] in CO_2e emissions from the on-road fleet by 2020. Taking this into account, by 2020, the VMT related household CO_2e emissions would decrease from the current 10.5 metric-tons CO_2e per year to approximately 7.6 metric-tons per year. Hence, by 2020, the required reduction in household VMT, for meeting the 5 MMT CO_2e goal, would increase from 29% (not accounting for the LCFS and Pavley standards) to 40%, accounting for a full implementation of the LCFS and Pavley standards. Under the scenario considering eight years of construction (2012-2020), the required reduction in household VMT would increase, by 2020, from 36% to 50%, respectively.

[10] 1-0.9*(1-31.7/160.8)

3 Literature review of VMT reductions from land use measures

Based on the estimates presented in this analysis, assuming that all VMT reduction is from new housing, reductions of 29-50% of current household VMT will be required from each new housing unit in order to meet the 5 MMT CO_2e reduction goal (the low end is for a ten year scenario, disregarding Pavley and LCFS; the high end is for an eight year scenario, assuming a full implementation Pavley and LCFS). In this section, these estimates are compared to findings from the professional literature regarding VMT reductions from land use measures.

In an oft-cited research article published on the topic of land use and VMT reductions, Ewing and Cervero (2001) conducted a meta-analysis of all available studies as well as original data to derive the relationship of VMT with project densities, mix of use, street design, and regional accessibility. The results showed a link between characteristics of the built environment and travel behavior. A 10% increase in density and mix of use was associated with only a 0.5% decline in VMT, while a similar increase in street design characteristics (sidewalk completeness, route directness and street network density) was associated with only a 0.3% decline in VMT. The highest effect was for regional accessibility, where a 10% increase in regional accessibility was associated with a 2% decline in VMT. If one were to double all four neighborhood design characteristics, a maximum VMT reduction of 33% can be expected, however, it is not clear whether Ewing and Cervero's relationships would hold across this large a change. Furthermore, is not clear whether they can be added in this manner.

Similar estimates were derived by Holtzclaw et al. (2002), who studied travel behavior and car ownership levels as functions of land-use and transit accessibility characteristics of neighborhoods in Chicago, Los Angeles, and San Francisco. A doubling of residential density was associated with a reduction in household auto ownership and VMT per capita in the 32% to 43% range. An older study by Holtzclaw (1994), using odometer readings at 27 neighborhoods in San Francisco, Los Angeles, San Diego and Sacramento, found that doubling residential density was associated with a 20% reduction in VMT.

Rodier (2008) reviewed studies conducted by regional or state government agencies, academic researchers, and community groups, that reported VMT and/or GHG effects of transit, land use, and auto pricing strategies. Special attention was paid to recent transport, land use, and/or pricing studies conducted by the four major metropolitan planning organizations (MPOs) in California, because of their relevance to the GHG goals of AB 32 and the subsequent executive order. The median VMT reduction for a 10-year time horizon from land use policies across all studies surveyed was 0.5% (range of 0.1% - 2.0% for a 68% study interval; range of 0.0% - 3.1% for a 95% study interval, with the exception of the very aggressive urban growth boundary policy in the

Sacramento region, which has the greatest level of VMT reduction falling outside the 95% range). In analyses of the impacts on VMT of combined land use and transit scenarios, the median reduction for a 10-year time horizon was 3.9% (range of 1.5% - 5.7% for a 68% study interval; range of 0.4% - 7.7% for a 95% study interval).

Land use measures incorporate more than just reductions associated with new housing starts. Examples include emission reductions from goods movement emissions (primarily diesel, rather than gasoline); increasing the use of public transit and decreasing travel altogether from those in existing housing; and using land use design to increase density, commercial access and jobs/housing balance for housing that already exists.

Depending on the overall impact of these measures, fewer emissions reductions may be needed from the new housing sector in order to meet a given land use GHG reduction goal. However, at this point, insufficient information for quantifying the possible GHG reduction from these measures is available, and ARB has not provided a breakdown of the overall reduction goal between new housing starts and other land-use related measures.

4 Summary and conclusions

The required VMT reductions from the new housing sector for meeting the 5 MMT CO_2e goal by 2020 (40-50%, accounting for Pavley and LCFS) substantially exceed the VMT reductions mentioned in the literature as associated with neighborhood design characteristics. In addition, it is unclear whether the relationships identified in the cited research holds across large changes, when the relationships were developed by studying small changes, and how representative these studies are for different communities, locations, and times. Therefore, meeting a 5 MMT CO_2e reduction goal by 2020 solely from new housing starts seems unlikely, given the time frame and number of new housing starts.

In addition, it is important to note the entire analysis presented here is based on data of average housing starts for the period of 1998-2007. Given the recent state of the economy and specifically the housing market, these data may be an overestimate of future new housing starts. In fact, the beginning of a declining trend in new housing starts is evident (Figure 1) in recent years, but the ten-year average housing starts used here (2007 ten year backward average) does not fully reflect this, and is, in fact, the highest of all the ten-year averages based on data from the past 20 years. For example, if new housing starts in the upcoming ten years resemble those of the 1991-2000 period (109,000 new starts per year; the lowest 10 year average based on data from the past 20 years), the required reductions in VMT from the new housing sector would increase substantially to 60-75%. This further compromises the ability to meet a 2020 land use GHG reduction goal based solely on "smart growth" strategies for new housing. In addition, it is important to note that ARB's "Land Use and Local Government" CO_2e reduction goal is based on studies of VMT reductions from combined land-use and transit scenarios (Rodier, 2008). This further indicates that additional reductions, beyond those that are possible from the new housing sector alone, will be required for meeting this goal.

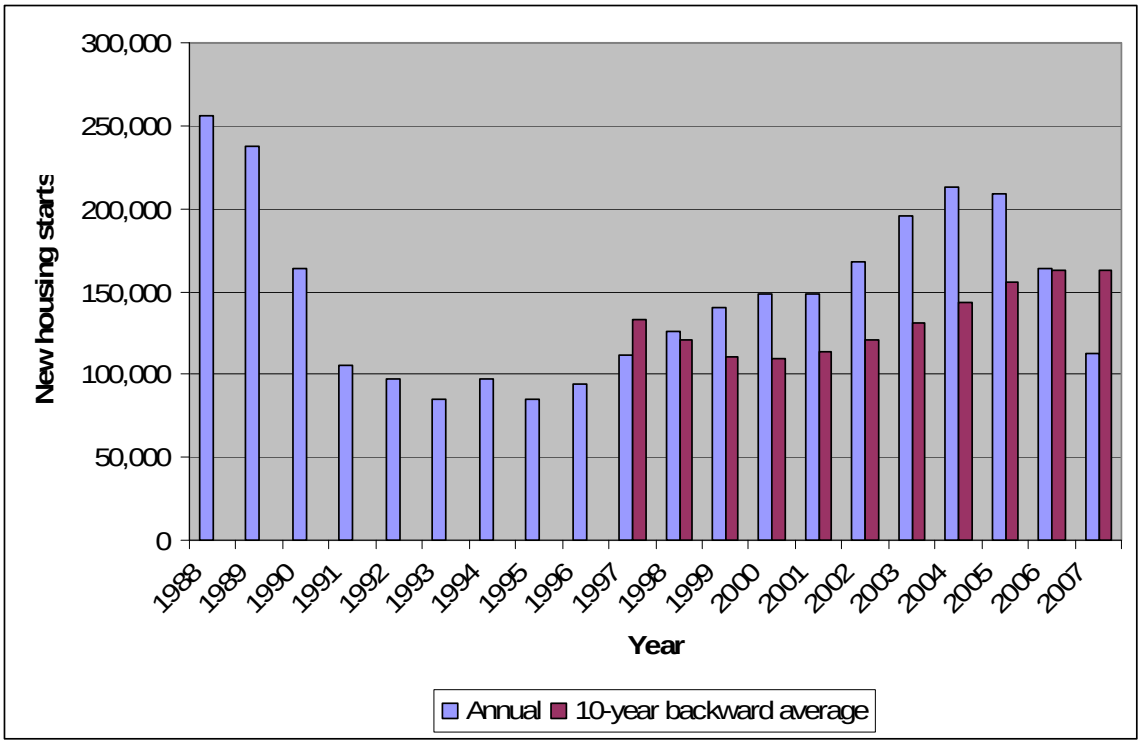

Figure 1: New housing starts in California for the period of 1988-2007 (based on data from www.cbia.org/go/cbia/?LinkServID=FE5ED931-F09E-44C7-96836630388F21F7&showMeta=0)

5 References:

California Energy Commission (2007), The Role of Land Use in Meeting California's Energy And Climate Change Goals, Draft Staff Paper, CEC-600-2007-008-SD.

California Environmental Protection Agency (2006), Climate Action Team Report to Governor Schwarzenegger and the Legislature.

California Environmental Protection Agency (2007), Climate Action Team Proposed Early Actions to Mitigate Climate Change in California, Draft for Public Review

Ewing and Cervero (2001), Travel and the Built Environment: A Synthesis, Transportation Research Record, 1780: 87-114.

Holtzclaw, J. (1994), Using Residential Patterns and Transit to Decrease Auto Dependence and Costs. Natural Resources Defense Council: San Francisco, and California Home Energy Efficiency Rating Systems: Costa Mesa, California.

Holtzclaw, J., Clear, R., Dittmar, H., Goldstein, D., and Haas, P. (2002), Location Efficiency: Neighborhood Socio-Economic Characteristics Determine Auto Ownership and Use: Studies in Chicago, Los Angeles and San Francisco, Transportation Planning and Technology, Vol. 25, pp. 1-27.

Rodier, C. (2008), A Review of the International Modeling Literature: Transit, Land Use, and Auto Pricing Strategies to Reduce Vehicle Miles Traveled and Greenhouse Gas Emissions, Submitted to the 2009 Transportation Research Board Annual Meeting.