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Can regional transportation and land-use planning achieve deep reductions in GHG emissions from vehicles?

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ABSTRACT

The Intergovernmental Panel on Climate Change estimates that greenhouse gas emissions (GHG) must be cut 40–70% by 2050 to prevent a greater than 2 °Celsius increase in the global mean temperature; a threshold that may avoid the most severe climate change impacts. Transportation accounts for about one third of GHG emissions in the United States; reducing these emissions should therefore be an important part of any strategy aimed at meeting the IPCC targets. Prior studies find that improvements in vehicle energy efficiency or decarbonization of the transportation fuel supply would be required for the transportation sector to achieve the IPCC targets. Strategies that could be implemented by regional transportation planning organizations are generally found to have only a modest GHG reduction potential. In this study we challenge these findings. We evaluate what it would take to achieve deep GHG emission reductions from transportation without advances in vehicle energy efficiency and fuel decarbonization beyond what is currently expected under existing regulations and market expectations. We find, based on modeling conducted in the Albuquerque, New Mexico metropolitan area that it is possible to achieve deep reductions that may be able to achieve the IPCC targets. Achieving deep reductions requires changes in transportation policy and land-use planning that go far beyond what is currently planned in Albuquerque and likely anywhere else in the United States.

1. Introduction

The fifth assessment report by the Intergovernmental Panel on Climate Change (IPCC) estimates that greenhouse gas (GHG) emissions must be cut 40–70% by 2050 from 2010 levels to prevent a greater than 2 °Celsius increase in the global mean temperature; a threshold that may avoid the most severe climate change impacts (IPCC, 2014). In the United States, the transportation sector accounts for 27% of GHG emissions, and transportation's share is growing relative to other sectors (US EPA, 2017). Therefore, reducing GHG emissions from transportation should be an important public policy goal in the United States for avoiding potentially severe climate change impacts.

Prior research generally finds that improving vehicle energy efficiency and widespread adoption of low carbon fuels are the strategies with the greatest potential for achieving deep GHG reductions in the transportation sector (Greene and Plotkin, 2011; Kay et al., 2014; Leighty et al., 2012; Lutsey and Sperling, 2009; McCollum and Yang, 2009; Melaina and Webster, 2011; Olabisi et al.,

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2009; Williams et al., 2012; Yang et al., 2009; Yuksel et al., 2016) and perhaps the only feasible route to achieving cuts that are congruent with IPCC targets. Most studies also acknowledge that no single strategy, alone, can achieve the deep GHG reductions required to meet the IPCC targets. Strategies that encourage more compact and mixed-use development, increase the cost of driving, and shift vehicle trips to lower emitting modes of transportation are also important for achieving deep reductions (Greene and Plotkin, 2011; Kay et al., 2014; Mashayekh et al., 2012; McCollum and Yang, 2009; Melaina and Webster, 2011; Yang et al., 2009); however, without substantial increases in vehicle energy efficiency and fuel de-carbonization, prior studies suggest that even aggressive combinations of these non-technology based strategies will only provide a relatively small portion of the needed reductions (Cambridge Systematics, 2009a; Ewing et al., 2007; Greene and Plotkin, 2011; TRB, 2009).

In this study we evaluate reductions in GHG emissions from vehicle traffic that a metropolitan area may be able to achieve using an extremely aggressive portfolio of strategies that are generally available to state and local governments. These strategies include increasing the amount of compact and mixed-use development, reducing highway capacity, increasing transit capacity and performance while reducing transit costs, implementing a per-mile tax on driving, and increasing the share of trips made by bicycle. While there are certainly other strategies available to local and state governments, we believe that these span the range of the available options and are among those that are likely to be the most effective.

We exclude strategies that aim to increase the energy efficiency of vehicles or increase the use of lower carbon fuels beyond what is expected to occur under currently adopted federal policy. The potential of these technological solutions has been widely reported elsewhere. Additionally, energy efficiency and fuel de-carbonization strategies require strong public policy support to overcome a variety of market failures caused by externalities, loss aversion, and the inability of firms to capture the full benefits of technological innovation (Greene and Plotkin, 2011). Policies such as fuel economy and GHG emissions standards, low carbon fuel standards, and subsidies to encourage the development and adoption of new technologies would be most effective at the federal level. States and local governments with the exception of California are also preempted by federal law from adopting their own fuel economy and vehicle emission standards. Therefore, if the federal government fails to act these technological solutions could be much more difficult to implement in a timely manner.

In our study land-use is indirectly affected by transportation policies and transportation infrastructure and directly by municipal land-use zoning rules. We evaluate how changes in land-use and development density affect GHG emissions through modifying travel behavior. Changes in land-use and development density also affect GHG emission rates from buildings. Prior research generally finds that more compact development is linked with lower residential GHG emissions and energy use due to smaller homes and the greater thermal efficiency of attached dwelling units (Brown et al., 2009; Ewing and Rong, 2008; Lee and Lee, 2014); however, this relationship may be complex and influenced by varying climate conditions, the source of electric power, and type and age of the building stock (Brown et al., 2009; Jones and Kammen, 2014). Prior research has also considered the potential of compact development to reduce GHG emissions from transportation and buildings more holistically by considering lifecycle emissions. For example, Chester et al. (2013) and Nahlik and Chester (2014) use lifecycle analysis in two case studies of transit oriented developments in Los Angeles, California and Phoenix, Arizona. GHG emission reductions from building construction, building energy production, building energy use, vehicle manufacturing, vehicle fuel production, and vehicle fuel use are evaluated for transit oriented and business-as-usual development strategies. The results show that transit-oriented development can reduce GHG emissions from transportation and buildings. In our study we focus on maximizing vehicle emissions reductions and therefor exclude additional GHG emission reductions that would likely result from scenarios that increase development density.

Our study is similar in its aims and methods to Brisson et al's (2012) study of "what it would take?" to achieve the City of San Francisco, California's GHG emission reduction goal of an 80% reduction below 1990 levels by 2050 using strategies under the municipality's control. In that study, the authors conclude that achieving San Francisco's GHG emission reduction goals is impossible without policies that would have to be adopted at a higher level of government. Like Brisson et al. (2012), our study fills an important gap in the literature by evaluating the potential to achieve deep GHG emission reductions from transportation using policies under the control of local and regional governments, in the setting of an actual urban area. The main difference in our study is that we consider an entire metropolitan region (the Albuquerque, New Mexico metropolitan area), which is a region that is more representative of most urban areas in the United States than San Francisco. The Albuquerque metropolitan area has a relatively low density and sprawling development pattern and as a result over 93% of trips are made using a personal automobile. Transit mode share is only 1%. Our study also evaluates even more aggressive implementation of each strategy since prior studies generally find that deep GHG emission reductions are not possible without advanced technology. Other than Brisson et al. (2012), all prior studies that we are aware of have been conducted at a much more aggregate, usually national, scale or have not taken a "what would it take" approach, instead constructing scenarios based on what seems relatively feasible to implement.

Our study is motivated by two observations that suggest to us that there is a very large gap between the emission reductions expected from current regional long range transportation plans and those required to achieve deep GHG emission reductions congruent with the IPCC targets. In California, state law (SB 375 – The Sustainable Communities and Climate Protection Act of 2008) requires that metropolitan planning organizations (MPOs) meet per-capita GHG emission reduction targets ranging from 5% to 18% below 2005 levels by 2035 (California Air Resources Board, 2017). However, California's population is expected to grow by 22% between 2010 and 2035, with much higher growth rates in the most urbanized areas (e.g., 33% in Los Angeles and 38% in San Francisco Counties) according to projections from the State of California Department of Finance. This level of population growth exceeds, often by large margins, the per-capita GHG emission reductions expected in each metropolitan area. This means that total GHG emissions are expected to increase, rather than decrease. The MPO per-capita reduction targets and projections in California do not account for potential state-wide policies that may increase vehicle efficiency (something only California is allowed to do under federal law), de-carbonize fuel or enact some form of road user pricing.

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