



Commuting and energy consumption: toward an equitable transportation policy

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ABSTRACT

Like other major metropolitan areas, the urban complex that extends from Los Angeles to Orange County faces numerous transportation challenges. Daily traffic congestion, reduced productivity and loss of income, air pollution, environmental degradation and significant energy consumption are only a few outcomes of the millions of miles travelled every day on the region's highways and streets. An important response to this significant urban challenge has been the desire for further expansion of an efficient public transportation network and increasing densities in particular areas within the larger metropolitan region. In this paper, we estimate the current energy consumption patterns in various communities, arguing that policy attempts to achieve higher density and better jobs-housing balance should fully consider the social geography of our metropolitan areas and their close relationship with energy consumption patterns.

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1. Introduction¹

Over the last few decades, a number of publications have analyzed commuting patterns in the U.S., documenting their relationship with land use patterns (e.g., [Murphy, 2012](#); [La Greca et al., 2011](#); [Sung and Oh, 2011](#); and [Layman and Horner, 2010](#)), employment geography ([Horner and Schleith, 2012](#) and [Modarres, 2011](#)), socioeconomic characteristics of commuters ([Kim et al., 2012](#) and [Villeneuve and Rose, 1988](#)), and various behavioral issues ([Abrahamse et al., 2009](#)). Through ongoing research, the urban transportation literature has illustrated how mobility (as related to realized travel) could be reshaped through better land use and transportation planning relationships, transportation management systems, congestion pricing ([de Palma and Lindsey, 2011](#); [Juan et al., 2008](#)), and investments in public transportation infrastructures, including high occupancy vehicle systems ([Kwon and Varaiya, 2008](#)). Throughout these analyses and interventions, the aim has been to reduce vehicle miles travelled, decrease auto-dependency, and increase the use of public transportation. Additionally, an efficient transportation planning/management hopes to affect mobility, decrease the adverse economic impact of congestion, and reduce air pollution. Over the last two decades, attention to the issue of transportation-related energy consumption has received

additional attention, with many of the articles on this topic appearing in the pages of this and other journals (e.g., [Newman and Kenworthy, 1989](#); [Jones, 1991](#); [Bownstone and Golob, 2009](#); [Poudenx, 2008](#); [Travisi et al., 2010](#); [Marquie and Reiter, 2012](#); [Marique et al., 2013](#)). While some of the literature on this topic turn to traditional solutions for reducing the overall energy consumption levels (e.g., mode shift and vehicle miles reduction), others have pointed to built environment solutions, including prioritizing mixed land use planning ([Marquie and Reiter, 2012](#)).

In this paper, we include density, socio-demographic characteristics and transportation mode to examine commute-related energy consumption levels in Los Angeles and Orange Counties in Southern California. Our aim is to show that, given the social geography of American cities, spatial patterns of energy consumption are as much functions of density and travel mode as they are functions of race, ethnicity, and socioeconomic status. In other words, we expect to see lower per capita energy consumption in inner city neighborhoods where minorities live (regardless of their distance to work and density patterns), compared to other regions of the metropolitan area. Contrary to the findings of [Newman and Kenworthy \(2006\)](#), we will also show that it may not be density alone that affects travel modes and energy consumption, but who lives in the high density neighborhoods.

This will illustrate the nature of the apparent spatial variation in energy consumption and suggest that policy interventions should consider this geography. As we will illustrate, since the geography of race, ethnicity, and income are related to the geography of energy consumption, designing an area-based policy will be logical. In this manner, those geographies that consume more will be

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assigned higher reduction levels than those that do not, either by relying on public transit, walking, bicycling, or shorter commute distances.

2. Literature review

In the aftermath of the 1973 oil embargo, concerns regarding transportation-related energy consumption began to increase. At that time, it was estimated that about 50% of the crude oil in the U.S. was used to fuel automobiles (Leach, 1973).² However, starting in the 1980s, this concern became more explicit and its connection to urban travel patterns and urban form were more readily documented (e.g. Keyes, 1982). By then, planning interventions for establishing more efficient urban mobility through clusters of high-density development began to be recommended. The logic behind this idea was to reduce vehicle miles traveled by providing a better job-housing balance and shorter commutes to work. For example, Frost et al. (1998) documented the connection between trip length and urban form and, as a result, the level of fuel consumption in British cities. However, their findings indicated that the increasing levels of energy consumption in work travel were more strongly linked in medium-sized, rather than larger, cities, where employment patterns had become more dispersed.

More recently, Muniz and Galindo (2005) confirmed that in the case of the Barcelona Metropolitan Region, urban form appeared to be a major explanatory factor in determining the variations in ecological footprints among the area's 163 municipalities. In other words, by focusing on commuting patterns, they were able to show that net population density had a greater impact on energy consumption than average family income and job ratio. Hence, policies that improved densification and shortened trip lengths would yield positive results for energy consumption. Similarly, Su (2011) has shown that in the case of 50 urban areas in the U.S., households in high-density urban areas consume less gasoline. Conversely, those in areas with a higher road density (i.e., freeway lane miles) and annual delays per peak-hour traveler consume more fuel. The importance of job-housing balance and density are also confirmed by other recent studies in various international settings (e.g., Zhao et al., 2011; Dujardin et al., 2012; Marquie and Reiter, 2012; Morikawa, 2012; and Marique et al., 2013).

Despite the apparent agreement regarding the positive influence of high density and urban form on fuel consumption, a number of researchers have found this to be difficult to verify and have challenged the assumptions regarding the relationship between urban form and energy consumption (e.g. Mindali et al., 2004). Breheny (1995) went so far as to suggest that densification of cities, at least in the UK, might not result in a significant level of reduction in energy consumption. Liu and Shen (2012) found that while urban form did not directly affect vehicle miles travelled and the resulting energy consumption, socioeconomic characteristics, as well as gender and patterns of automobile ownership, did. Similarly, Boussauw and Witlox (2009) cast doubt on some of the emerging transportation policy directions. Through mapping and analysis of energy consumption levels for commuting, their study of the administrative regions of Flanders and Brussels suggests that travel modes had little impact and that proximity between home and work locations is more important in determining energy consumption patterns. In other words, in a polycentric urban environment, local job-housing balances are important in the reduction of fuel consumption.

Despite these contrarian perspectives, commitment to the density solution remains strong. For example, Newman and Kenworthy

(2006) examined 58 higher-income metropolitan areas around the globe and concluded that beyond a threshold of 35 persons and jobs per hectare, car dependency and energy consumption drop. They also examined data on Los Angeles planning zones, suggesting that density explains 96 percent of the variation in per capita transit use. However, it is not clear whether, in their data, they considered the fact that many of the high-density areas in Los Angeles are occupied by low-income population. For example, while the central business district (CBD) may offer a significant number of jobs, many are not obtainable by the community members that have historically lived in and around the CBD. The most recent urban development in this area is targeting those who work there as opposed to those who have lived there. In other words, the aim is to bring those who work in the CBD to live there. The new developments are hardly affordable by the low-income, multi-generational communities who have historically lived there. As Zhou et al. (2012) illustrated, in the case of Los Angeles, income seems to be an important factor in achieving better job-housing balance. However, this is not exclusive to Los Angeles. In the case of Leon County, Florida, where Tallahassee is located, Horner and Schelith (2012) have shown that lowest income population has the greatest job-housing balance.

What Newman and Kenworthy (2006) do emphasize, however, is the importance of urban services (as does Poudenx, 2008). This leads the authors to indicate that in cities like Melbourne, "poorer households drive more, while using public transport and walking less" (pp. 41–42). As we will show in this paper, the case of Los Angeles is entirely different. Poorer households, particularly the foreign born and minority population, are more likely to use transit while commuting long distances to work. Additionally, what Newman and Kenworthy (2006) offer as their solution, which simply creates polycentric cities with balanced job-housing and adequate densities around each, have already been formed in Los Angeles. At this point, the metro region has 20 or more major employment centers (Modarres, 2011); many of them offering better urban services than inner city regions and report shorter commute times, which mostly result from better job-housing balance.

A topic less explored is the socio-spatial patterns of commute-related energy consumption. This is particularly troubling in the case of American cities, since a significant majority of low-income racial and ethnic communities live in high-density metropolitan areas (Bownstone and Golob, 2009). Is it possible that, in the case of cities like Los Angeles, the relationship between fuel consumption and density is partially (or mostly) driven by socioeconomic class and its particular geographic pattern?

The answer to this question is particularly important for large metropolitan regions such as Los Angeles where over 20 major employment centers can be identified (Modarres, 2011). In such an urban complex, any emphasis on density must consider the decentralized nature of employment opportunities and the fact that not all densities share common socioeconomic characteristics. However, de-centralization of jobs alone could be the reason why Bownstone and Golob (2009) concluded that creating the level of densities that would significantly affect fuel consumption would be difficult in an urban environment such as Southern California. Nonetheless, we believe that while "who" and "how" are important in understanding patterns of energy consumption, it is "where" (at smaller geographies than the whole metropolitan area) that will help disentangle the socio-spatial puzzle of transportation-related fuel consumption.

In this study, we build on the recommendation of Bownstone and Golob (2009), who advocated that future research on this topic focus on a geographic analysis of energy consumption. We also follow Boussauw and Witlox (2009) in developing a more detailed understanding of commuting and energy consumption as they relate to smaller units of space and their varying commuting

² The journal *Energy Policy*, where Leach's article appeared, started in 1973, coinciding with the oil crisis.

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