Transportation Research Part A 47 (2013) 153–166

Contents lists available at SciVerse ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Comprehensive evaluation of energy conservation and emission reduction policies

Todd Litman *

Victoria Transport Policy Institute, 1250 Rudlin Street, Victoria, BC, Canada V8V 3R7

ARTICLE INFO

Article history:
Received 8 March 2012
Received in revised form 7 October 2012
Accepted 9 October 2012

Keywords:
Energy conservation
Emission reductions
Mobility management
Transportation demand management
Comprehensive evaluation
Transport policy

ABSTRACT

Various transportation policies can help conserve energy and reduce pollution emissions. Some, called *cleaner vehicle* strategies in this article, reduce emission rates per vehicle-kilometer. Others, called *mobility management* (also called *transportation demand management*) strategies, reduce total vehicle travel. There is disagreement concerning which approach is best overall. Some studies conclude that cleaner vehicle strategies are generally most cost effective and beneficial, while others favor mobility management strategies. These different conclusions tend to reflect different analysis scope. Analyses that favor clean vehicle strategies tend to overlook or undervalue some significant impacts including cleaner vehicle rebound effects and mobility management co-benefits. More comprehensive analysis tends to favor mobility management. This article investigates these issues and provides specific recommendations for comprehensive evaluation.

1. Introduction

In response to concerns about oil dependency, air pollution and climate change risks, many jurisdictions have established energy conservation and emission reduction targets (USEPA, 2012). Since motor vehicles are major petroleum consumers and pollution emitters, transportation policy reforms are important for achieving these goals. Because fuel consumption produces air emissions they are often considered a single objective. There are many potential transport energy conservation and emission reduction strategies (AASHTO, 2009; Morrow et al., 2010; UKERC, 2009). For this analysis they are divided into two major categories: *cleaner vehicle* strategies that reduce fuel consumption and emission rates per vehicle-kilometer, and *mobility management* strategies that reduce total motor vehicle travel, as indicated in Table 1.[1]

There is considerable debate concerning which approach is overall optimal. Some studies conclude that clean vehicle strategies are most cost effective and beneficial, based on the assumption that mobility management is difficult to implement and harmful to consumers and the economy (Cox and Moore, 2011; Hartgen et al., 2011; McKinsey, 2007). For example, Moore et al. (2010) argue,

> "Attempts to reduce VMT [vehicle miles traveled] typically rely on very blunt policy instruments, such as increasing urban densities, and run the risk of reducing mobility, reducing access to jobs, and narrowing the range of housing choice.

* Tel./fax: +1 250 360 1560.
E-mail address: litman@vtpi.org

[1] Mobility management is often called *transportation demand management*, but this is a technical term and the acronym sounds like *tedium*, an unpleasant condition, and so is inappropriate for general audiences. The term *VMT (Vehicle Miles Traveled) reduction* is widely used in the U.S. but is not metric and therefore inappropriate for international audiences. Cox and Moore (2011) calls cleaner vehicle strategies *technological strategies* and mobility management *behavioral strategies*, but those terms are inaccurate since many cleaner vehicle strategies involve behavioral change (such as changing vehicle purchase decisions) and many mobility management strategies involve new technologies (to support telework, automate road and parking pricing, improve user information, etc.). For these reasons I consider *cleaner vehicles* and *mobility management* more accurate terms.

0965-8564/$ - see front matter
http://dx.doi.org/10.1016/j.tra.2012.10.022

Table 1
Examples of transport energy conservation and emission reduction policies (VTPI, 2011).

Cleaner vehicles	Mobility management
Reduces fuel consumption and emission rates per vehicle-kilometer	Reduce total vehicle travel
Encourage or subsidize alternative fuels	Car-free planning and vehicle restrictions
Anti-idling programs and regulations	Commute trip reduction programs
Feebates (special fees on inefficient vehicles and rebates on efficient vehicles)	Distance-based vehicle insurance and registration fees
Fleet management and driver training	Distance-based emission fees
Fuel efficiency standards (such as CAFE)	Efficient parking management and pricing
Fuel quality improvements	Freight transport management
Fuel tax increases[a]	Fuel tax increases[a]
Inspection and maintenance (I/M) programs	Mobility management marketing
Low emission vehicle mandates	Non-motorized transportation improvements
Promote purchase of cleaner vehicles	Ridesharing improvements and incentives
Promote motorcycle and small vehicle use	Road pricing
Resurface highways	Smart growth development policies
Roadside "high emitter" identification	Telework encouragement
Scrapage programs	Transit improvements and incentives
Traffic speed reductions	

This table lists examples of various energy conservation and emission reduction strategies.
[a] Fuel taxes encourage both cleaner vehicles and vehicle travel reductions.

> VMT reduction, in fact, is an inherently blunt policy instrument because it relies almost exclusively on changing human behavior and settlement patterns to increase transit use and reduce automobile travel rather than directly target GHGs. It also uses long-term strategies with highly uncertain effects on GHGs based on current research. Not surprisingly, VMT reduction strategies often rank among the most costly and least efficient options. In contrast, less intrusive policy approaches such as improved fuel efficiency and traffic signal optimization are more likely to directly reduce GHGs than behavioral approaches such as increasing urban densities to promote higher public transit usage."

Other studies conclude that mobility management strategies can provide significant and cost effective energy savings and emission reductions beneficial (Litman, 2008; TRB, 2009; USDOT, 2010; UKERC, 2009).

These different conclusions tend to reflect different analysis assumptions, methods and scope. Comprehensive evaluation, which considers all significant options and impacts, is necessary to identify truly optimal policies.[2] Comprehensive analysis is particularly important for transport policy analysis because transport decisions tend to have more diverse impacts than most other sectors. For example, increasing building insulation does not generally affect accident rates or land use development patterns, so relatively simple cost effectiveness analysis is adequate to determine optimal building weatherization. However transport planning decisions have many indirect economic, social and environmental impacts, so decisions that affect how and how much people travel, require more comprehensive analysis that accounts for these additional factors. Although the importance of comprehensive evaluation may seem obvious, it is not always done. Conventional transport policy analysis often considers a limited set of impacts.

This article investigates these issues. It describes the requirements for comprehensive evaluation of energy conservation and emission reduction policies, investigates current evaluation practices, and discusses various factors that should be considered in such analysis.

2. Comprehensive evaluation guidelines

This section discusses requirements for comprehensive evaluation of transportation energy conservation and emission reduction strategies.

2.1. Options considered

Comprehensive analysis should consider a diverse range of potential energy conservation and emission reduction strategies, such as those in Table 1. Various information sources can help identify these strategies (AASHTO, 2009; Böhler-Baedeker and Hüging, 2012; Litman, 2007; Morrow et al., 2010; VTPI, 2011) and evaluate their impacts (CARB, 2010-11; ITDP, 2010; UKERC, 2009). Critics sometimes argue that mobility management impacts are unpredictable (Cox and Moore, 2011; Moore et al., 2010), but such claims tend to ignore current examples and modeling capabilities (*EPOMM Case Studies*; Johnston, 2006; VTPI, 2011). Some strategies have complementary and synergistic effects (total impacts are greater than the sum of their individual impacts),[3] and so should be implemented as integrated packages.

[2] Various terms are used when evaluating impacts. Undesirable impacts are generally called *problems* in qualitative analysis and *costs* in quantitative analysis. Desirable impacts are often called *planning objectives* in qualitative analysis and *benefits* in qualitative analysis. Additional benefits are called *co-benefits* (Kendra et al., 2007; Leather, 2009).

[3] For example, one study found the elasticity of home-to-work vehicle trips averaged −0.04 overall, but increased fourfold to −0.16 for workers commuting on corridors with the 10% best transit service, suggesting that road pricing and transit improvements are synergist (PSRC, 2005).