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Evaluating the impacts of the clean cities program

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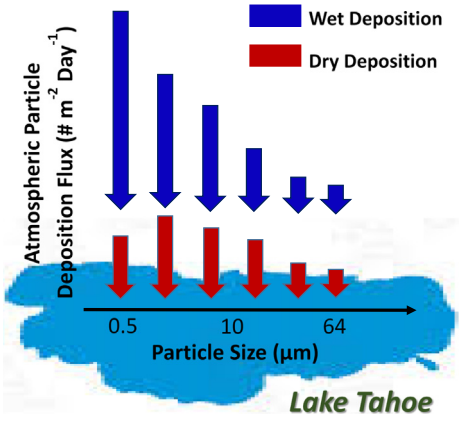
HIGHLIGHTS

- The clean cities program is effective in promoting alternative fueling stations.
- The program has potentially shifted travel behaviors from driving to riding transit.
- Counties in the program experienced larger improvements in air quality.
- In these counties, fewer commuters drive to work and more use transit.

GRAPHICAL ABSTRACT



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ABSTRACT

The Department of Energy's Clean Cities program was created in 1993 to reduce petroleum usage in the transportation sector. The program promotes alternative fuels such as biofuels and fuel-saving strategies such as idle reduction and fleet management through coalitions of local government, non-profit, and private actors. Few studies have evaluated the impact of the program because of its complexity that include interrelated strategies of grants, education and training and diversity of participants. This paper uses a Difference-in-Differences (DiD) approach to evaluate the effectiveness of the program between 1990 and 2010. We quantify the effectiveness of the Clean Cities program by focusing on performance measures such as air quality, number of alternative fueling stations, private vehicle occupancy and transit ridership. We find that counties that participate in the program perform better on all these measures compared to counties that did not participate. Compared to the control group, counties in the Clean Cities program experienced a reduction in days with bad air quality (3.7%), a decrease in automobile commuters (2.9%), an overall increase in transit commuters (2.1%) and had greater numbers of new alternative fueling stations (12.9). The results suggest that the program is a qualified success.

1. Introduction

The transportation sector contributes about 50% of all smog-forming volatile organic compounds (VOCs), nitrogen oxide (NOx) emissions, and toxic air pollutant emissions, and about 75% of all carbon monoxide

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(CO) emissions in the U.S. (United States Environmental Protection Agency, 2007). Petroleum-based products such as gasoline and diesel account for much of this pollution. Federal policies have focused on reducing petroleum consumption in the transportation sector by promoting alternative fuels, reducing vehicle miles traveled (VMT) and increasing fuel efficiency of automobiles (Congress of the United States & Congressional Budget Office, 2002; Gallagher et al., 2007; Knittel, 2012). Part of this effort is supported by the Department of Energy's Clean Cities program, which promotes petroleum reduction in American cities. Created by the U.S. Department of Energy (DOE) in 1993, the Clean Cities program aims to reduce petroleum consumption in transportation through alternative and renewable fuels, fuel economy improvements, idle reduction, and other fuel-saving technologies and practices (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016a). Clean Cities Coalitions (CCCs) are public-private partnerships comprised of businesses, fuel providers, state and local agencies, and community organizations (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016a). Because the program is complex and consists of interrelated pollution mitigation strategies, evaluation has hitherto relied on accounting for displaced petroleum consumption from alternative fuel fleet adoptions and mitigation factors associated with strategies such as idle reduction (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016b). Little is known about the impact of the program on air quality or petroleum demand reduction as data are hard to obtain and establishing causal relationships is challenging.

This study provides an initial characterization of efficacy of the Clean Cities program. The program's impacts are evaluated by comparing the difference in various outcome measures between counties located inside and outside the boundaries of CCCs between 1990 and 2010, while controlling for meteorological, sociological, and demographic factors. We focus on different outcome measures such as air quality, alternative fuel use, commuters using automobile and transit. We find that the Clean Cities program is positively associated with a decrease in the number of days with bad air quality. Moreover, counties that are part of CCCs have more alternative fueling stations than counties that are not. Finally, our results suggest that the Clean Cities program discourages driving to work and encourages transit ridership, potentially yielding a reduction in transportation-related air pollution.

2. Background

The 1992 Energy Policy Act required certain vehicle fleets (e.g. federal and state fleets in metropolitan areas excluding emergency and law enforcement) to acquire Alternative Fuel Vehicles (AFVs). The DOE established the Clean Cities program in 1993 to provide resources to these fleets and other voluntary adopters (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016a). The program provides resources and information to help transportation stakeholders evaluate options and achieve goals related to alternative fuels, advanced vehicle technologies, and other strategies to curtail petroleum use. A formal designation occurs when a local champion, such as a county government, local non-profit, or city agency working with the DOE, assembles local stakeholders and develops a program plan for the coalition. The local coalitions provide opportunities for transportation stakeholders to coordinate their actions with one another to reduce petroleum use. CCC designation occurs on voluntary basis; however, the coalition has the capacity to identify a healthy marketplace for alternative fuels and other petroleum reduction strategies, establish a clear organizational structure, and maintain strong partnerships with relevant government departments (United States Department of Energy, 2016). The designation process can take anywhere from one to three years. When the Clean Cities program commenced, six local coalitions were formed (United States Department of Energy, 2016) and by mid-2016, this number grew to 84 CCCs nationwide, encompassing more than half of all U.S. counties (see Fig. 1) (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016c). The central aim of the Clean Cities program is to decrease petroleum consumption in the U.S. by 2.5 billion gal per year by 2020 (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016b).

The Clean Cities program aims to build partnerships among state and local actors within both the public and private sectors to overcome critical barriers that have impeded the acquisition of AFVs and use of alternative motor fuels. These barriers include the low price of gasoline and diesel, insufficient availability of alternative fuel refueling infrastructure, and the relatively high cost of AFVs (Santini et al., 1995; Whalen et al., 1999; Rubin & Leiby, 2000). The program's main strategies are 1) to encourage a voluntary approach to AFV development and acquisition; 2) to implement and oversee major activities such as grants for installation of idle-reduction technologies and technical training through local designated coordinators; 3) to pay attention to niche markets, such as airport, transit, and government fleets; 4) to enable and encourage development of refueling infrastructure; 5) to involve federal and state governments in developing and supplying funding, information resources, and technical assistance (Zhao & Melaina, 2006).

In 2013 alone, the Clean Cities program claims to have saved about 1 billion gal of petroleum through alternative fuels and vehicles (70.5%), increased adoption of electric vehicles (13.7%), reductions in VMT (6.7%), idle reduction (5.3%), and improved fuel economy (2.8%) (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016b), which is equivalent to preventing 5.7 million tons of Greenhouse Gas (GHG) emissions (Johnson & Singer, 2014). However, these effects are estimated through simulations based on tools developed by Argonne National Labs (e.g. GREET Model, the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model). Evaluations of other outcomes, such as air quality improvements, are scant in the literature.

Studies have found that alternative fuels differ in their advantages and disadvantages for air quality compared to petroleum (Lave et al., 2000; Schell et al., 2002; Frey et al., 2009a). For example, biodiesel can reduce particulate matter (PM), CO and total hydrocarbon (HC) emissions significantly (Haas et al., 2001; Morris & Jia, 2003; McCormick, 2007; Lapuerta et al., 2008; Janaun & Ellis, 2010), but may increase NO_x emissions upwards of 80% compared to petroleum diesel (Haas et al., 2001; Hansen et al., 2006). Electric vehicles are able to eliminate emissions of CO and HC and greatly reduce NOx emissions, while they are reported to increase emissions of sulfur oxide (SO_x) and PM (DeLuchi et al., 1989; Wang & Santini, 1992; Lave et al., 1995; Jacobson et al., 2005; Brady & O'Mahony, 2011). Although propane is found to increase mercury (Hg) emissions (Won et al., 2007), it has the potential to decrease the emissions of Ozone (O_3), PM, NO_x, CO, and HC (Chang et al., 2001; Ristovski et al., 2005). Additionally, the air quality benefits of alternative fuels such as ethanol (Knapp et al., 1998; Hsieh et al., 2002; Niven, 2005; Anderson, 2009) and natural gas (Goyal, 2003; Ravindra et al., 2006) are still under debate. CCCs promote a range of alternative fuels that suit regional and local needs. For these reasons, it is more appropriate to evaluate the attendant air quality benefits of a comprehensive alternative fuels program broadly, rather than evaluating the effects of individual fuels separately.

In addition to the alternative fuels strategy, the Clean Cities program aims to reduce petroleum consumption through idle reduction, VMT reduction, and other fuel-saving practices (United States Department of Energy, Energy Efficiency & Renewable Energy, 2016d). Idling wastes fuel and is associated with local pollutant emissions (Frey et al., 2009b). According to Argonne National Laboratory, idling can waste up to 0.5 gal of fuel per hour for passenger vehicles resulting in criteria pollutant and GHG emissions (Gaines et al., 2012). VMT reduction projects have been reported by 76 percent of the CCCs in 2014. These projects include promotion of carpooling, mass transit, non-motorized travel, car sharing, telecommuting, and the compressed work week (Johnson & Singer, 2014). VMT reduction is an official goal of U.S. policy and is referenced in the Clean Air Act, the Intermodal Surface

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