Energy Policy 92 (2016) 124–138

Contents lists available at ScienceDirect

Energy Policy

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

Opinion paper

The next generation of urban MACCs. Reassessing the cost-effectiveness of urban mitigation options by integrating a systemic approach and social costs

Mathieu Saujot [a,*], Benoit Lefèvre [b]

[a] Institute for Sustainable Development and International Relations (IDDRI), 27 rue Saint-Guillaume, 75337 Paris Cedex 07, France
[b] World Ressource Institute, 10 G Street NE Suite 800, Washington, DC 20002, USA

HIGHLIGHTS

- Local climate policies lack scientific understanding for prioritizing mitigation actions.
- We develop a method to evaluate cost-effectiveness of urban transportation actions.
- This method combines urban modeling and MACCs to inform urban planning.
- Abatement costs from its application to a mid-sized city are presented.
- The impact of the inclusion of co-benefits is analyzed.

ARTICLE INFO

Article history:
Received 27 May 2015
Received in revised form
18 December 2015
Accepted 19 January 2016

Keywords:
Local greenhouse gas abatement policies
Cost effectiveness
Urban modeling
Transportation
Urban planning

ABSTRACT

Many cities are implementing policies and climate action plans. Yet local climate policies suffer from a lack of scientific understanding and evaluation methods able to support the definition of efficient mitigation strategies. The purpose of this paper is to build on classical approaches in the energy policy field that exist at the national and international level to propose an urban MACCs methodology able to fulfill this lack and inform local debates. The methodology is an extension of static "expert-based" MACCs; it combines a land use transport integrated model and an abatement cost methodology that integrates co-benefits, and takes into account the spatial and systemic dimensions of cities. The methodology is implemented for the transportation sector of a mid-sized European city (Grenoble, France). Our results present the cost-effectiveness and political feasibility of several proposed measures. We find that the inclusion of co-benefits can profoundly change the cost-benefit assessment of transport mitigation options. Moreover we underline the key parameters determining the cost-effectiveness ranking of mitigation options. These urban MACCs aim to serve as a bridge between urban planning and mitigation policies and can thus contribute to strengthen and align sustainable and climate change agendas at the local level.

1. Introduction

1.1. A lack of knowledge to support local climate action plans

Climate action at the local level is widely recognized as vital for effective emissions mitigation efforts (GCEC et al., 2014). However a review of existing literature reveals that although we have a good understanding of the scale of the challenge at the local level and plenty of literature on "what to do", we do not have enough literature on "how to do it" (Rosenzweig et al., 2010; Dhakal and Shrestha, 2010). One particular area with limited research is assessing mitigation costs and benefits at the local or city level. Indeed, existing climate and energy research has generally been focused on the national level (Keirstead and Schulz, 2010). Debates on policy making at the national and international level rely on evaluation methods which do not adequately represent local systems, include local sectoral analysis or incorporate the spatial dimension of cities, even when they use macro modeling (Kahn Ribeiro et al., 2007; Clarke et al., 2014, GCEC, 2014). In this context, the IPCC identifies in local mitigation policies a "lack of scientific

Abbreviations: LUTI model, land use transport integrated model; BRT, Bus rapid transit

* Corresponding author.
E-mail addresses: mathieu.saujot@iddri.org (M. Saujot), blefevre@wri.org (B. Lefèvre).

http://dx.doi.org/10.1016/j.enpol.2016.01.029
0301-4215/

understanding of how cities can prioritize climate change mitigation strategies, local actions, investments, and policy responses that are locally relevant" (Seto et al., 2014, p. 78).

This lack of understanding is clear for the transport sector, which accounts for 19% of global energy use and 23% of energy related CO_2 emissions (International Energy Agency, 2009), and is the sector with the fastest increase in energy consumption and CO_2 emissions (Ajanovic et al., 2012). Yet the cost benefit analysis for climate initiatives in the urban transport sector is generally focused on technological solutions and not the urban dimension (Smoker et al., 2009a, 2009b; Kahn Ribeiro et al., 2007; Kok et al., 2011; Sims et al., 2014).[1] This limits our understanding of effective local mitigation policies since the spatial organization of a city determines the level of GHG emissions and the optimal mitigation options (Newman and Kenworthy, 1998; Lefèvre, 2008). Several noteworthy abatement cost studies go further and try to consider the urban transport sector as a spatial system with different transport modes and interactions with land use (Wright and Fulton, 2005; Cambridge Systematics, 2009; Silva-Send et al., 2013; Yang et al., 2015). Nevertheless these studies mostly rely on exogenous hypotheses to evaluate the effect of the urban policies[2] and do not effectively simulate and test them. Thus to improve our understanding of effective mitigation policies for the urban transportation sector, energy analysis should be better linked to urban planning, notably through urban modeling. This is the goal of our study, along with other recent studies that also bridge urban policies and carbon pricing analysis through modeling (Avner et al., 2014; Grazi and Waisman, 2015).

1.2. Two specific challenges faced by climate action plans

Thousands of cities in both the developed and the developing world have announced their Climate Action Plans and have signed up to voluntary frameworks to develop their mitigation strategy (Seto et al. 2014, p. 8; Reckien et al., 2013; Millard-Ball, 2012). These plans are important to promote climate action, coordinate with other policies, and identify efficient strategies, but they also face several challenges.

First, these plans are not yet well connected to important urban planning policies such as land use planning or transport planning (Yalcin and Lefèvre, 2012), instead, they focus on individual actions and energy efficiency, ignoring the lasting changes that occur in a city because of land use policies or other cross-sectoral policies (Reckien et al., 2013; Seto et al., 2014). Consequently, the climate action plans generally exist in isolation as standalone documents and are seldom integrated into the larger urban planning framework. The challenge is to mainstream climate action plans into the rest of urban policy and planning (Viguié and Hallegatte, 2012).

However tools exist to overcome this difficulty and those identified in Section 1.1 and to take the urban spatial dimension into account. Indeed, examples show the interest of urban modeling tools to evaluate energy policies at the local level through land use transport integrated models (Lefèvre, 2008; Mitchell et al., 2011), complementary to energy models. LUTI models were developed to inform urban planning (Wegener, 1994; Batty, 2009). All LUTI models represent the evolution of different markets[3] but differ in terms of modeling theories and methods, e.g. aggregated or agent based, based on market equilibrium or dynamic processes (Jin and Wegener, 2013). Contrary to classical and widely used traffic models, which consider the urban structure as an exogenous input to simulate the mobility system, LUTI models are able to inform long term strategies because they simulate both the land use system and the transport system, as well as their interactions (Fig. 3).

Lefèvre (2008) uses the TRANUS model to analyze the long term energy consumption of urban transportation in Bangalore. Mitchell et al. (2011) use the Meplan model to assess the energy and climate impacts of several urban trajectories considering transportation, dwellings and commercial spaces in three regions of the UK.

A second obstacle relates to the lack of understanding of how cities can prioritize mitigation actions. As Lazarus et al. (2013) observe, although cities have ambitious long-term emissions reduction goals, "few have articulated how to reach them", moreover "targets are often arbitrary or aspirational, and reflect neither mitigation potential nor implementation" (Seto et al., 2014, p. 71). In the context of limited resources, which makes it necessary for cities to carefully select and sequence their actions to meet their emissions targets, a cost-effectiveness approach would be useful. However, while literature on national and international climate policies places a large emphasis on economic analysis, the literature on local climate action plans, as well as the plans themselves, say little about economic methodology or cost-benefit analysis, and instead emphasize other aspects (stakeholder support, communication) (Bertoldi et al., 2009; Wheeler, 2008[4]; Reckien et al., 2013). Currently the most common methodologies used to support Climate Action Plans are benchmarking, planning process guides and prospective analysis, which identify possible policies and their potential contribution to mitigation targets, but do not support the necessary prioritization of actions (Lazarus et al., 2013; Lechtenböhmer et al., 2009; Gomi et al., 2010).

The adaptation of the well-known Marginal Abatement Cost Curve (MACC) methodology at the local level responds to this gap. MACCs are widely used for the analysis of national and international mitigation policies because they are seen as a convenient and simple way to represent the cost effectiveness of different measures and to identify a cost-efficient strategy (Kesicki and Ekins, 2012; Wächter, 2013; Vogt-Schilb and Hallegatte, 2014). Nevertheless, few applications have been made at the city level (McKinsey, 2008; World Bank, 2013).

The McKinsey (2008) study of London's climate strategy was an interesting first local application of this method. With this methodology, the costs and mitigation potential of each measure are assessed individually and then ranked in order to create a cost-effective sequence of actions. However, this first generation reveals a few limitations of the MACCs methodology for urban analysis. Travel time and air pollution, two key characteristics of urban transport are not taken into account as co-benefits. The sum of the measures does not constitute a complete urban scenario to evaluate but rather a technical roadmap; the mitigation policies are not integrated with other urban policies, which limits the potential dialog with urban planners. Indeed, none of the measures considered in the McKinsey study have an impact on the urban system because the study only considers technical issues (Fig. 1), whereas cities have little power over technological issues as they mainly fall under national control. The World Bank (2012) observes that

[1] For example in WG3, Chapter 8 Transport (8.6 Costs and potentials, p. 32), there is no mention of modal shift for cost assessment, and the authors observe that "The number of studies assessing potential future GHG reductions from energy intensity gains and use of low-carbon fuels is larger than those assessing mitigation potentials and cost from transport activity, structural change and modal shift, since they are highly variable by location and background conditions."

[2] For example, a study will make the assumption, based on literature or policies targets, that if land use policies or transit investment are implemented, the vehicle miles traveled will decrease of *X*%. With an urban modeling one can effectively simulate these policies and evaluate the effect on vehicle miles traveled.

[3] Land, housing, transport, labor.

[4] On the 64 states, large cities and small cities selected for his analysis of climate change plans in the US, only 15 have a comprehensive cost estimation of the measures included in their plans. Among the 18 large cities, none has a comprehensive estimation of costs, 2 on 17 for small cities plan.