



# Analysis of the relationship between local climate change mitigation actions and greenhouse gas emissions – Empirical insights



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## ABSTRACT

Local actions are seen as of major importance for the achievement of climate change mitigation targets. In the past few years, the number of local action plans towards climate change mitigation has been increasing, and it is essential to analyze their contribution to the achievement of global targets. Even if the relationship between local action plans and the reduction of energy use and GHG emissions is often assumed, this has not yet been validated nor quantified by empirical studies involving a large number of municipalities. Thus, the aim of this paper is to perform an empirical analysis on the link between local action plans and energy use and GHG emissions. The analysis is composed by a test of hypothesis and a regression analysis, performed for the municipalities of three European countries – Portugal, Sweden and United Kingdom. The main conclusion is that, in the context of these three countries, the analysis performed was not able to detect a significant impact related to the existence of local plans on GHG emissions. From the panel data regression analysis, it was possible to confirm that external factors, not directly related to local climate change mitigation actions, have a significant impact on GHG emissions.

## 1. Introduction

Local actions are currently seen, by both academics and policy makers, as of major importance for the achievement of climate change mitigation targets. Both the physical characteristics of local energy systems and the regulatory competences of local authorities prompt local level as an appropriate level for action (Meeus et al., 2011). In the past few years, local authorities and communities have been gradually recognizing this importance of local climate and energy policies (Kern and Alber, 2008). Currently, more than 6000 European municipalities have joined the Covenant of Mayors,<sup>1</sup> despite its voluntary nature. Within and outside the EU, other initiatives have emerged – ICLEI (2016), CIVITAS (2016), C40 Cities (2016), Cities for Climate Protection (Betsill and Bulkeley, 2004) – promoting and supporting policy action at local level. Alongside this increasingly active role of local actors, the academic community as well as policy makers have been developing extensive work regarding local energy planning (see Neves, 2012 for a review) and the relevance of local actions towards climate change mitigation.

As local actions become more and more patent, it is essential to know about the extent of their influence. Are local actions actually contributing to climate change mitigation? A relationship between local climate change mitigation actions and local greenhouse gas (GHG) emissions and local energy use is often assumed. However, even if several academic studies on both local energy planning (e.g. Comodi et al., 2012) and multilevel governance (e.g. Bulkeley and Kern, 2006) (as well as common sense) support the existence of such correlation, this has not yet been validated nor quantified by empirical studies.

Hence, the goal of this paper is to study whether there is any empirical evidence of the link between local actions and the local GHG emissions and energy use. The paper starts with a small review on how the relationship between policy actions and GHG emissions is treated in existing literature. Section 3 presents the research hypothesis tested as well as the methods used to do so, being followed by a description of the empirical data and the reasoning behind it. The obtained results and respective discussion are presented in Section 5. Section 6 summarizes the main results and remarks obtained throughout this work.

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<sup>1</sup> This initiative consists on a voluntary agreement where city authorities commit to reduce their GHG emissions by more than 20% by 2020, compared to 1990 levels (CoM, 2016a). As part of the commitment, city authorities are required to develop a Sustainable Energy Action Plan (SEAP), where they present how they intend to achieve the emissions reduction, and to comply with reporting rules.

## 2. Relationship between policy actions and GHG emissions (in literature)

The positive impact of local level actions on overall climate change mitigation is often assumed and supported by academics. Indeed, the role of local level policies is considered to be crucial for the attainment of the global target of GHG emissions reduction (Corfee-Morlot et al., 2009; Ostrom, 2012; Wilbanks and Kates, 1999). However, even if evaluation of climate and environmental policy has been a subject of inquiry by different stakeholders at several policy levels, the search for empirical evidence on the overall effect of policy actions at the different policy levels is still very limited.

There is a reasonable number of studies that focus on the assessment of isolated policy actions (both ex-ante and ex-post), attempting to identify the effects in that specific case (DG Energy, 2014; Lin et al., 2010; Morlet and Keirstead, 2013). However, this is not sufficient to build an overall picture. Given the universal scope of energy and climate policies, their effects and consequent contribution to climate change mitigation depends on several factors (not directly related with the policies themselves), which hinders the extrapolation and generalization of the results obtained so far (Laurian et al., 2010). For instance, the success of climate and energy policies is strongly related with the willingness to act and level of awareness of local inhabitants, as well as with the competences and resources of the local administration. Additionally, given the numerous amount of factors that lead to change in GHG emissions, the registered reduction of GHG emissions over time is not sufficient to prove the correlation between local actions and GHG emissions reduction. Socio-demographic changes, such as the age of the population and the changes in the employment rate, and autonomous energy savings due to natural technological evolution may lead to significant changes on local GHG emissions (Deshazo and Matute, 2012).

Thus, it is important to understand whether there is a relationship between the existence of local climate change mitigation actions vs. local energy use and GHG emissions. There are a few studies that focus on the relationship of GHG emissions with different economic variables (Sharma, 2011; Sun and Malaska, 1998; Wang et al., 2011), such as economic growth, as well as with technical aspects, as the use of renewable energy sources (Menyah and Wolde-Rufael, 2010) or buildings physical characteristics (Nässén, 2014). However, there is a very limited number of studies that attempt to examine the relationship between local policy actions and local energy use and GHG emissions. A share of the quantitative analysis on local actions focus on the policy mechanisms rather than on their effects, assessing implementation issues and innovation (Broto and Bulkeley, 2013; Bulkeley and Betsill, 2003). On the assessment of local actions' effects, Millard-Ball (2012a) performs a quantitative analysis on the effect of city climate plans by measuring the environmental performance of cities in California, grouped according to the achieved milestones on local climate change mitigation. This author also developed a more detailed work on the definition of the causal relationship between plans and measured effects and on the definition of a proper analytical framework for the evaluation of local actions (Millard-Ball, 2012b). In both works, instead of using GHG emissions inventories, the author uses indicators of local environmental performance, which restricts the scope of analysis to a limited number of local actions. Similarly, Ingram et al. (2009) performs a comparison of cities with and without plan, measuring a set of indicators as an attempt to evaluate outcomes. Pablo-Romero et al. (2016) presented an analysis on the relationship between local actions and electricity consumption for municipalities in Andalusia (Spanish region). Here, the major gap corresponds to restraining the analysis to electricity consumption, while there are other energy sources also responsible for GHG emissions.

The work presented in this paper brings a new perspective on the relationship between local policy actions and local energy use and GHG emissions, by performing a quantitative analysis using the actual values

for final energy use and GHG emissions of a large set of municipalities and their evolution over time. In order to do so, this study starts with a hypothesis test to assess if ongoing and past local actions have an effect on local GHG emissions. Then, it uses advanced panel data regression analysis to provide clear insights on the relationship between local climate change mitigation actions and GHG emissions. Moreover, additional variables were included in the regression model in order to control for the effect of relevant factors - namely local specificities (municipality), national context (country), and the effect of time (year).

## 3. Methodology

As mentioned in the introduction, it would be expected that local actions would have a negative effect on local GHG emissions as well as on local energy use. The assumption that local climate change mitigation actions have an effect (positive or negative) on local energy systems (regarding energy use and GHG emissions) is then the hypothesis that frames this study.

This hypothesis was formalized in two distinct ways. The first can be translated into the following question: "Do local actions have any impact on local energy systems?" Here, the outcome is a YES or NO answer, assessing whether there is statistical evidence on the impact of local actions in the local energy system (in terms of energy use and/or GHG emissions). The second formulation of the considered hypothesis refers to the following question "What is the effect of local actions on the respective GHG emissions?" This formulation implies testing if the relationship between local actions and GHG emissions is statistically significant and whether the impact of the first in the later is negative or positive. The methodological approaches followed within these two main questions are: the hypothesis test and the regression model which are briefly described in the following subsections.

Regarding the geographical scope, this exercise focus on the municipalities from countries belonging to the European Union (EU), as most of the local effort towards climate change mitigation has taken place within the EU. Moreover, the restriction of scope to the EU also guarantees that all municipalities are subject to the same international governance framework. The municipalities of three EU countries (Portugal, Sweden and United Kingdom) were selected taking into account three main criteria: (1) geographical diversity (east-west; north-south); (2) diversity regarding local authorities' competences<sup>2</sup>; and (3) visible compromise of local authorities towards climate change mitigation.<sup>3</sup>

### 3.1. Exploratory data analysis

The first premise to be tested is whether the existence of local climate change mitigation actions has an impact on the municipality's energy system. This hypothesis can be represented by the following expression:

$$\begin{aligned} H_0 &: GHG_{it}(X_1) = GHG_{it}(X_0) \\ H_1 &: GHG_{it}(X_1) \neq GHG_{it}(X_0) \end{aligned} \quad (1)$$

Where:  $GHG_{it}$  – GHG emissions per capita of municipality  $i$  at the year  $t$ ;  $\times_0$  – Absence of a Sustainable Energy Action Plan for municipality  $i$  at the year  $t$ ;  $\times_1$  – Existence of a Sustainable Energy Action Plan for municipality  $i$  at the year  $t$

<sup>2</sup> Within the EU, competences of local authorities significantly differ from country to country. Sweden is one of the countries where local authorities have more autonomy from higher administrative levels, being responsible for most decisions related with energy (namely, district and cooling networks). Local competences in Portugal and in the UK are more moderate.

<sup>3</sup> Within the three countries analyzed throughout this study, there is a significant number of municipalities that have signed the Covenant of Mayors initiative. Moreover, all three countries have municipalities which have been pioneers regarding sustainable energy solutions, such as Porto, Växjö and London.

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