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The impact on air quality of energy saving measures in the major cities signatories of the Covenant of Mayors initiative

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ABSTRACT

This study is a first attempt to evaluate how the major efforts made by several European cities in the frame of the Covenant of Mayors (CoM) initiative can impact the air pollution levels in the participating cities. CoM is by no mean one of the major cities initiatives aimed at mitigating climate change, supporting local authorities in the implementation of their climate action plans. Energy savings measures reported in the CoM cities' action plans have been analysed from the air quality perspective in order to find quantitative relations in the way local authorities deal with mitigation and how these practices are expected to have consequences on the air quality at urban level and finally positively impacting the citizens' health.

In the paper, the air quality 2713 energy saving measures proposed by 146 cities located in 23 countries in the frame of the CoM are selected and their co-benefits for air quality and public health estimated by means of SHERPA, a fast modelling tool that mimics the behaviour of a full physically-based Chemical Transport Model. Besides evaluating the overall benefits of this subset of mitigation measures for the air quality, the study also investigates the relevance of some factors such as the implementation sector, the city size and the pollution levels in achieving the highest possible co-benefits. The results presented refer to the special field covered by the study, i.e. energy saving measures and are not automatically referable to other types of measures. Nevertheless, they clearly show how climate mitigation and air quality policies are deeply interconnected at the urban level.

1. Introduction

1.1. The Covenant of Mayors initiative and its tools

Recognizing the key role of cities and towns in the fight against climate change, and following the adoption of the 2020 EU Climate and Energy Package in 2008, the European Commission (EC) launched the Covenant of Mayors (CoM) initiative, to encourage local authorities to implement sustainable energy policies within their territories. CoM signatories, voluntary adhering to the initiative, commit at the moment of the adhesion to the initiative to reduce the levels of CO_2 emissions in their territories by at least 20% in 2020 or by at least 40% by 2030, through the implementation of a climate action plan, called Sustainable Energy Action Plan (SEAP). Recently, in addition to actions on mitigation also action on adaptation (climate risk assessment) have been included, leading to the so called Sustainable Energy and Climate Action Plan (SECAP) (Bertoldi et al., 2018). In this contribution we focus on climate mitigation action plans with commitment targets for 2020, i.e. the SEAPs.

The CoM framework foresees a three steps approach: carrying out an emission inventory, setting mitigation target as well as drawing a climate action plan and lastly, monitoring the progress towards the targets. The philosophy underpinning the CoM is that, based on the emission related to final energy consumption, local authorities are able to tailor the necessary actions for implementing energy savings and increasing the renewable energy deployment in their territories (Bertoldi et al., 2010).

The inventory for accounting the emissions, named Baseline Emission Inventory (BEI) sets the principles and the minimum requirements on: the sources (activity data and related emissions in the building and transport sectors); the type of gases (only CO_2 reporting is mandatory, but also they can report emissions of methane (CH_4) and nitrous oxide (N_2O)) and the boundary of the inventory.

Regarding the action plan, the SEAP comprehends the overall strategy for mitigating climate change by 2020, which is translated into a set of planned actions reported in the CoM platform. For each planned action, the signatories report the area of intervention (e.g. energy efficiency in buildings, equipment and facilities, transportation, renewable deployment, urban planning, etc.), indicating the policy instrument (distinguishing between the national/regional and the local ones)

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the responsible body (specific department of the local authority or other private or public entity responsible for the action) and the quantitative indicators. The qualitative indicators per each action refer to: the implementation costs, the planned energy savings and renewable production, and the estimated CO_2 emissions reduction by 2020. At the moment of writing, 5491 SEAPs were already submitted mainly from European cities (Kona et al., 2016).

In this contribution, we will analyse a sample of 173 CoM signatories with > 50,000 inhabitants, with a submitted emission inventory (i.e. BEI) and an action plan (i.e. SEAP) as of September 2016 in the CoM framework.

1.2. Study rationale and novelty

Recently, efforts have been made at international and European level to implement air quality and climate policies in an integrated manner (Amann et al., 2011), although such an integrated approach is still far from being implemented at local/urban scale (Viaene et al., 2016). This paper represents a first attempt to contribute to this debate by addressing for the first time the issue of co-benefits and trade-offs of the Covenant of Mayors initiative on local air quality.

Strictly speaking, some CoM signatories have already discussed synergies and trade-offs between Climate Change (CC) mitigation and Air Quality (AQ) policies in their SEAP (e.g., Barcelona in Spain, Ghent in Belgium, Bristol in United Kingdom and others). However, this study takes a more general approach, as synergies and trade-offs are looked for not in a single city, but in a large set of cities among the major CoM signatories. The overall goal of the study is to find quantitative relations in the way local authorities deal with CC mitigation and how these practices are expected to have consequences on the AQ at urban level and finally on the citizens health. For the first time to our knowledge, the mitigation measures proposed in the SEAPs of the selected signatories have been evaluated from the AQ perspective and their co-benefits for urban air pollution have been quantified, in terms of both reduced key pollutants concentrations and positive impact on public health.

More in detail, the study develops an "air quality co-benefits" indicator for a precise subset of measures detailed in the SEAPs of major CoM signatories and explores the coherence of the CC mitigation measures with the possible AQ benefits and the AQ situation of the signatories. In particular, the study focuses on the measures that mitigate CC through a decreased energy consumption pattern. For these measures, the correlation between the amount of energy saved and the AQ benefits will be assessed and a linear model will be proposed.

The relatively large number of CoM signatories included in the study, selected from the major ones, assures a robust basis to the statistical analysis performed.

The results of the study are analysed from the point of view of cities willing to develop emission reduction plans. The conclusions drawn from this study can be of support to local administrators willing to deepen and better exploit the interplay between air pollution control measures and mitigation measures in their area of responsibility.

1.3. Structure of the paper

Section 2 introduces the methodology of the study: available data and their sources are presented and a subset of CC mitigation measures, suitable for the analysis is defined. Finally, indicators are defined to investigate synergies between CC, AQ and public health consequences of the selected SEAPs measures.

Section 3 provides a general overview of SEAP mitigation measures together with a few statistical elaborations on the related GreenHouse Gas (GHG) avoided emissions, to be used as a basis for further investigations carried out in the following sections.

Section 4 is the core of the study. AQ and CC benefits are investigated at the sectorial level by means of the indicators introduced in Section 2. The analysis also clarifies the importance of some context variables (namely size of the cities and pollution level). Finally, the last paragraph of this section is devoted to quantifying the overall benefits of the selected mitigation measures in terms of public health gains, putting them in the context of the air pollution health impact in Europe.

Discussion and conclusions, in Sections 5 and 6, focus on the main findings and discuss the challenges of moving towards a more complete analysis in future studies and emphasise the added value of the study for city planners.

The Appendix A provides additional details on data preparation and sources.

2. Data preparation, indicators definition and study methodology

2.1. Cities selection

In order to concentrate on larger urban areas where GHG emission control policies are expected to result in a tangible impact on background air quality, a subset of the largest CoM signatory cities was selected, on the basis of the following criteria:

-the signatory has presented a full SEAP including a BEI;

-the signatory belongs to the list of cities and greater cities in Europe,[1] Norway and Switzerland;

Following these criteria, 231 CoM signatories have been selected which also belong to the Eurostat datasets of Cities and Greater Cities. i.e. 28% of the total number of cities, representing 56% of the Cities and Greater Cities' population in 2011. For each of these cities the latest available data on population (2011) and the geographical location (lat/lon) of the cities' "centroid" was obtained from the Eurostat database. It is worth noticing that, although the cities selected are among the largest ones, the population of this sample of cities still varies considerably, ranging from about 49,000 to 6.6 million inhabitants.

2.2. Data preparation

A brief overview of the main data sources employed in the study and data preparation for the study follows. The Appendix A provides a detailed description of data record extracted from the listed database and more details on their merging.

2.2.1. The CoM databases

The Joint Research Centre (JRC) of the European Commission has the task of checking and validating the information uploaded to the CoM platform by signatories.

The SEAP database contains a detailed description of the proposed measures and is built on information provided directly by the signatories based on their own estimates of the actual implementation and impact of the measures. Experience has shown that, due to the voluntary nature of the initiative, the difficulty of adapting local specificities to the CoM reporting framework, and the occurrence of data entry errors, not all the information collected on the Covenant platform can be considered complete and reliable. For this reason the cleaning algorithm described in (Kona et al., 2016) was preventively applied to the SEAP database before extracting the data used in this study.

The CoM related datasets also contain quantitative summaries of the Baseline Emission Inventories submitted by the CoM signatories.

2.2.2. The AQ Database

This database contains values of annual average urban background concentrations of nitrogen dioxide (NO_2) and particulate matter of diameter smaller than 2.5 μm ($PM_{2.5}$) for most of the selected cities. This is an internal JRC database produced using SHERPA (Screening for

[1] The greater city is an approximation of the urban centres when this stretches far beyond the administrative city boundaries.