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The economics of green transition strategies for cities: Can low carbon, energy efficient development approaches be adapted to demand side urban water efficiency?

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ABSTRACT

Cities are major contributors to global emissions, producers of waste and consumers of resources such as energy, water and food: implementing green development strategies is hence a core challenge of modern city-planning. The attention of research has been focusing on the development of energy efficient, low carbon strategies, yet city decision-makers need truly integrated approaches, as the one proposed by the water-energy-food Nexus. The purpose of our paper is to investigate whether it is possible to take one step in this direction by extending existing approaches to energy efficiency strategies to progressively include other priority resources, in particular water. To test this hypothesis we have taken a robust and well accepted methodology, the ELCC (Economics of Low Carbon development strategies for Cities) developed by SEI and CCCEP, and we have extended it to the case of demand side water efficiency strategies for cities. We have then applied the adapted ELCC framework to the case study of the domestic sector of the city of Bologna (Italy), identifying and prioritizing several efficiency measures. Measures were evaluated through their capital investment, annual values of savings, payback period and reduction in consumption, and then aggregated in different scenarios in order to highlight potential urban investments and to showcase a possible approach to the prioritization of demand side water efficiency measures. The results show that, with an upfront investment of € 17 million, a feasible subset of Bologna's households could be equipped with five selected cost-effective measures, generating annual savings of € 10.2 million and reducing the total domestic water consumption of 34% by 2020 compared to the 2012 initial value. With additional € 28.5 million, households could be equipped with more costly appliances reaching an overall water reduction of 37% by 2020. Our findings confirm that it is possible to successfully extend current approaches to urban energy efficiency strategies to include demand side water efficiency, adding an important building block to the construction of an integrated Nexus-based approach to green development strategies at the city-level. We encourage further tests to confirm the robustness of the methodology.

1. Introduction and background

Implementing effective and innovative green development strategies is one of the core challenges of modern city-planning (CoREU, 2013; Hoornweg et al., 2012; UN Conference on Sustainable Development, 2012; UN-Habitat, 2011). In this view, cities are the essential ground for climate mitigation and adaptation actions: on the one hand they are one of the main causes of global environmental threats, on the other they are equipped with the citizen engagement, technical know-how and policy resources to effectively act on it (Bulkeley, 2010; Bulkeley, 2013; Bulkeley et al., 2011; Romero-Lankao and Dodman, 2011; Schreurs, 2008).

Until recently, research efforts and actions have focused on low carbon, low GreenHouse Gas (GHG) emission and energy efficient development strategies. Several initiatives have been launched at global and regional level in order to support cities in their effort to mitigate the effect of climate change, reduce their emissions and become more energy efficient (*e.g.* Covenant of Mayors, ICLEI, Energy Cities Network, Eurocities, C40 Cities Climate Leadership Group). Yet, the impact of cities goes well beyond the mere contribution to energy consumption patterns and GHG emissions:

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they are rapidly becoming one major cause of concern as consumer of global valuable resources, in particular water and food, as producers of waste and as clients of "ecosystem services" (Bai, 2007).

Integrated approaches which account for the synergy between the so-called water-energy-food Nexus, and adaptive efforts, become thus the key for a successful urban green transition. This, by containing the foreseen impact of climate change, reducing vulnerabilities and fostering resilience (Keskitalo, 2010; Klein et al., 2005; Tol, 2005; Smit and Wandel, 2006). In our paper, we attempt to progress towards the development of such an integrated approach by addressing the following research question: can we extend low carbon, energy efficient approaches to include other priority resources beyond carbon, in particular water?

Many methodological approaches to evaluate the economic implications of low carbon and energy efficiency strategies implementation have been proposed by scholars and practitioners. Their aim is supporting city decision-makers in their effort to make the local economy more energy efficient and lowering urban emissions. In general, these strategies are addressing the problem of city-level mitigation and adaptation by a broad mix of actions aiming to:

1. enhance the sustainability and resilience of city by an integration of "urban planning, architectural design, ICT and energy management" in order to "improve energy efficiency, reduce environmental pollution, provide innovative economically viable means to absorb urban growth, and enhance living conditions" (UNECE, 2013);
2. evaluate the key urban ecosystem services (*e.g.* renewable energies, water provision, waste disposal, access to cleaner air);
3. boost innovation and efficient usage of resources, to increase the overall system efficiency and improving environmental performance of existing services.

These strategies are indeed important components of the governance of urban environment. Nonetheless, they may lack of a clear multi-level system of coordination among actors that would enable a more fruitful engagement of local expertises (Biesbroek et al., 2010). A bottom-up approach, focusing on the specific criticalities of the city under investigation, provides sensible evaluations of the cost and benefits of each action: it may prove to be a crucial tool for effective urban strategies for emissions reduction and for building up local resilience to future adverse climate conditions (Puppim de Oliveira, 2009; Urwin and Jordan, 2008).

There is, therefore, the need to build a usable, effective, holistic methodology applicable at the city-level, apt to increase long term sustainability in terms of a more efficient usage of ecosystem services and resources.

The first building block of such an integrated methodology was the development by the Stockholm Environment Institute of York (SEI-Y) and the Centre for Climate Change Economics and Policy (CCCEP) of a standardised approach to the economics of low carbon, energy efficiency development strategies for Cities, more commonly called the ELCC approach or Mini-Stern Review (Gouldson et al., 2012). Different methodological models were developed to provide a guide to local decision-makers to the adoption of demand side energy efficiency measures. Measures were ranked according to the benefits generated (efficiency performances and CO_2 abatement potential) and their direct and indirect costs (instalment, missing and running costs). The methodology was then successfully tested over several UK urban regions such as: Leeds, the Humber area, Sheffield and Birmingham (for an example, see Gouldson et al., 2012).

In our paper we intend to contribute to the next building block of such methodology by investigating the case of demand side water efficiency strategies at the city-scale.

In particular we focus on two aspects:

1. Verifying if the ELCC approach to the development of low carbon energy efficiency strategies for cities can be extended to other priority resources that are of main concern for urban planners, in particular water;

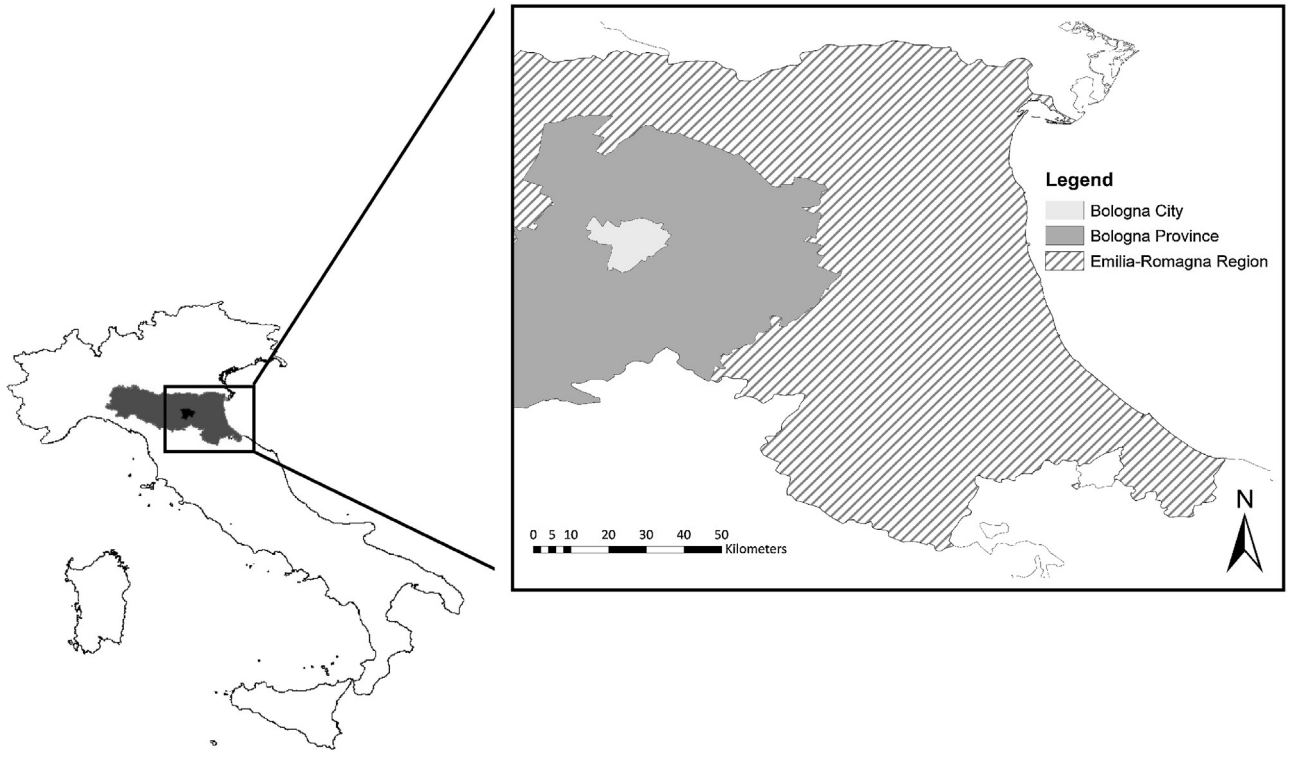

Fig. 1. The geographical localization of the Council of Bologna in Italy and within the Emilia-Romagna Region.