Development of marginal abatement cost curves for the building sector in Armenia and Georgia

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A B S T R A C T

Armenia and Georgia are taking climate change agenda seriously and contributing to efforts for mitigating global climate change through various ways including preparation of low carbon development strategies for their future economic growth. The improvement of energy efficiency is one of the key elements of the low carbon development strategies. This study develops a methodology to estimate marginal abatement cost (MAC) curve for energy efficiency measures and apply in the building sector in both countries. The study finds that among the various energy efficiency measures considered, the replacement of energy inefficient light bulbs (i.e., incandescent lamps) with efficient light bulbs is the most cost effective measure in saving energy and reducing greenhouse gas (GHG) emissions from the building sector. Most energy efficiency improvement options considered in the study would produce net economic benefits even if the value of reduced carbon is not taken into account. While the MAC analysis conducted demonstrates the cost competitiveness of various energy efficiency measures in Armenia and Georgia, the study also offers a caution to policy makers to have supplemental analysis before prioritizing the implementation of these measures or introducing policies to support them.

1. Introduction

1.1. Background

Armenia and Georgia are small countries in the Caucasus region located between the Black Sea, Russia, Turkey, Azerbaijan and Iran thereby connecting Eastern Europe to Western Asia. Both countries are currently developing low carbon strategies\textsuperscript{1} for their economic development while promoting economic growth and prosperity. The strategies aim to reduce the growth of greenhouse gas (GHG) emissions. The low carbon strategies are also important because both countries depend on imports for their oil and gas supply. Both countries submitted their Intended Nationally Determined Contributions (INDCs)\textsuperscript{2} in response to the decision made by the UNFCCC in its 19th Conference of Parties in Warsaw, Poland in 2013 (UNFCCC, 2013). The Paris Agreement reached at the 19th Conference of Parties in Paris in December 2015 (UNFCCC, 2015) implies that these countries will take actions to implement their INDCs. In the past, both countries provided an indicative list of options to reduce GHG emissions in their National Communications (NCs) to UNFCCC, and also in preparation of nationally appropriate mitigation actions (also referred to NAMAs\textsuperscript{3}) in accordance with an agreement made in the 16th Conference of Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun, Mexico in 2011 (UNFCCC, 2011).

The low carbon strategies, NAMAs, NC and INDC all present list of potential options that could be implemented to reduce GHG emissions. While various approaches could be adopted to prioritize GHG mitiga-
tation options, the tool often used in low carbon strategies, NAMA and NC, is the marginal abatement cost (MAC) curves. Energy efficiency options are the most common GHG mitigation options identified in a MAC curve analysis. These options are often found as the cheapest ones with negative costs of GHG abatement in most existing literature on green growth and low carbon strategies (see e.g., World Bank, 2014; 2013; Cervigni et al., 2013; de Gouvello et al., 2010; Johnson et al., 2009; McKinsey and Company, 2009, 2010, 2011). However, the economies of energy efficiency vary across countries depending on the rate at which future energy consumption is expected to increase, the current level of inefficiency and awareness of the availability of the best practice technologies to improve energy efficiency.

The concept of MAC curves has been used in the literature for a long time in determining potential for GHG mitigation from various options in different economic sectors (production sectors, buildings, transportation sectors). Examples of early studies using MAC curves include UNEP (1992), Jackson, (1991, 1995), Timilsina and Lefevre (1999), Timilsina et al. (2000). Apart from academia, private companies, such as McKinsey & Company (McKinsey and Company, 2009, 2010, 2011), Bloomberg (Bloomberg, 2010); and international institutions, such as World Bank (World Bank, 2014; World Bank, 2013; Cervigni et al., 2013; de Gouvello et al., 2010; Johnson et al., 2009) have been widely using the concept the MAC curve to prioritize climate change mitigation options/technologies in various countries.

1.2. Knowledge gap in literature

In this sub-section, we briefly discuss literature review on MAC curves. Since in-depth review of literature on the strengths and weaknesses of MAC approach is already available. For example, Kuik et al. (2009) presents a meta analysis on MAC approach. Similarly, Kesicki and Strachan (2011) and Ekins et al. (2011) critically assess the MAC approach. Our study focusses on some technical issues embodied in methodologies in MAC. For example, should an MAC curve analysis compare potential GHG mitigation options in a static fashion as if all mitigation potential of an option can be exploited now, or should the MAC curve be based on analysis over a time period in which the GHG mitigation option, such as improvement of energy efficiency, is implemented gradually? The latter approach can be interpreted as a dynamic MAC curve analysis and it would be more realistic because it is impractical to assume that the full GHG mitigation potential of a measure is ready for exploitation in a short interval of time. Another issue is: if the investment costs of GHG mitigation be the same when: (i) an energy inefficient device or process already installed in an existing facility be replaced with new energy efficient device or process and (ii) when consumers face a choice between energy efficient and inefficient device/process to install in a new facility (e.g., choice of roof and window insulations in a building to be built). Further, what assumptions are to be made regarding the penetration of a GHG mitigation measure in the baseline where no policy measures are introduced to incentivize the implementation of the measure?

Existing studies have used different approaches to address these issues. Most existing studies do not differentiate between the existing and new facilities while developing MAC curves and thus use the same opportunity costs in both cases. Therefore, MAC curves produced by various studies are not comparable and the use of the same opportunity costs is misleading. Moreover, existing studies use different assumptions on penetration rate of GHG mitigation measures in baseline as well as climate change mitigation scenarios. This also leads to different calculations of GHG mitigation potential of the same measure. This paper aims to present a methodology to contribute in resolving these issues. The methodology is then implemented to calculate the MAC curve for selected energy efficiency measures in the building sector in Armenia and Georgia. One of the key contributions of the methodology developed here is that it distinguishes between the existing buildings and new buildings. This is critically important because the likelihood of adoption of energy efficient appliances is higher in the new buildings due to several reasons, such as awareness of consumers and already introduced energy efficiency standards. Moreover, the probability of adopting energy efficient measures that require major reconstruction/remodeling of existing buildings would be low. For example, households might not be willing to dismantle walls of their houses to replaces them with energy efficient walls. Existing studies are not found to take into account these important issues, they assume all energy inefficient devices and processes are replaced and thus likely to overestimate GHG mitigation potential of a GHG mitigation option.

The study also differentiates between existing stock of appliances and new stock of appliances especially when they make assumptions on the cost of an appliance. The use of an incremental costs (i.e., the difference between the capital costs of an efficient appliance and its inefficient counterpart that would have been considered in the baseline) approach when the existing stock of inefficient appliances is replaced with their efficient counterparts and thus underestimates the MAC of that energy efficiency measure. Our study suggests to use the full cost of the new efficient appliances instead of the incremental costs in such a situation. This is because normally there does not exist markets for already used energy inefficient technologies. Building owners might need to pay disposal costs when they want to discard their old appliance. Our study has accounted all these issues, which are often neglected in the existing literature.

Our focus in this study is to develop a methodology to address some of the limitations of MAC curves to analyze energy efficiency measures or options in the building sector. Please note that MAC approach has some fundamental limitations. First, it follows a partial equilibrium approach or engineering benefit-cost analysis approach. This approach does not account indirect effects of a measure. Different tools or techniques would be needed to capture the indirect effects. Normally, a macroeconomic or computable general equilibrium (CGE) model that captures the interlinkages between various economic agents (households, firms, governments) and various sectors (e.g., electrical appliance industries, cement industry, mining industry, Finance and commercial service industries) would be needed to capture the indirect impacts. MAC analysis is a quick and less data intensive tool that can help to rank GHG mitigation measures from an investor’s perspective. If policy makers are interested to prioritize GHG mitigation measures from the perspective of the whole economy of a country, a hybrid model (Fortes et al., 2013; Tomaschek, 2015) where MAC is linked with a CGE model, would be needed. For example, World Bank (2011) and World Bank (2014) have used the hybrid approach for Poland and Macedonia, respectively. Moreover, the MAC approach we used here does not incorporate the barriers to energy efficiency, such as financial barriers, technological barriers, institutional barriers because of lack of surveys and other data to quantify those barriers. Ekins et al. (2011) and Ekins et al. (2011) highlighted these and several other limitations of MAC approach. Addressing those theoretical limitations of MAC approach is beyond the scope of this study.

Please see Timilsina et al. (2016) for quantification of energy efficiency barriers in Ukraine.

Please see the series of low carbon studies produced by the World Bank over the last few years (World Bank, 2014; World Bank, 2013; Cervigni et al., 2013; de Gouvello et al., 2010; Johnson et al., 2009).
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