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Carbon Pricing Revenues Could Close Infrastructure Access Gaps

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Summary. — Introducing a price on greenhouse gas emissions would not only contribute to reducing the risk of dangerous anthropogenic climate change, but would also generate substantial public revenues. Some of these revenues could be used to cover investment needs for infrastructure providing access to water, sanitation, electricity, telecommunications, and transport. In this way, emission pricing could promote sustainable socio-economic development by safeguarding the stability of natural systems which constitute the material basis of economies, while at the same time providing public goods that are essential for human well-being. For a scenario that is consistent with limiting global warming to below 2°C, we find that domestic carbon pricing (without redistribution of revenues across countries) has substantial potential to close existing access gaps for water, sanitation, electricity, and telecommunication. However, for the majority of countries carbon pricing revenues would not be sufficient to pave all unpaved roads, and for most countries in Sub-Saharan Africa they would be insufficient to provide universal access to all types of infrastructure except water. If some fraction of the global revenues of carbon pricing is redistributed, e.g., *via* the Green Climate Fund, more ambitious infrastructure access goals could be achieved in developing countries. Our paper also bears relevance for the design of climate finance mechanisms, as it suggests that supporting carbon pricing policies instead of project based finance might not only permit cost-efficient emission reductions, but also leverage public revenues to promote human development goals.

Key words — carbon pricing, infrastructure, economic development

1. INTRODUCTION

Recent research has furthered our understanding of the dangers of continued global warming (IPCC, 2014a). A projected increase of the global mean temperature of 4°C or more in 2100 would entail potentially serious consequences for sea-level rise, water availability, agricultural productivity, and human health, in particular in developing countries (World Bank, 2012). In order to prevent these impacts, considerable reductions of greenhouse gas (GHG) emission will be required, not only in industrialized, but also in developing economies (Jakob & Steckel, 2014). The Kyoto Protocol included internationally binding commitments to reduce emissions for industrialized (Annex-I) countries, whereas developing and emerging (non-Annex-I) countries participated in a voluntary way under the principle of "common but differentiated responsibilities". With the Durban Agreement, states have agreed that a future climate treaty should entail efforts from all parties (UNFCCC, 2011). All countries are requested to declare their intended efforts to reduce emissions (at least compared to projected future emissions) in the form of Intended Nationally Determined Contributions (INDCs). The most recent INDCs include targets by 187 countries, including all major emerging economies as well as numerous developing and least-developed countries. [1]

At the same time, poor countries face immediate challenges related to poverty reduction. For instance, globally many people lack access to basic infrastructure, including electricity, water, and sanitation. In view of these pressing issues, it is paramount to formulate climate policies in a larger sustainable development framework, which considers climate targets in combination with other development goals (Halsnæs & Garg, 2011).

This paper examines the potential of carbon pricing revenues to finance infrastructure access. We argue that such an approach would constitute a promising option to advance sustainable development by mitigating greenhouse gas emissions and at the same time advancing socio-economic development. Hence, the results of this paper are closely linked to the discussion on Sustainable Development Goals (SDGs), and in particular the question of how to finance the post-2015 development agenda.

The rest of the paper is organized as follows: Section 2 reviews the literature, and Section 3 explains how we calculate revenues from carbon pricing and the costs to close infrastructure access gaps. Section 4 presents the results highlighting the implications of our proposal for different regions. Section 5 carries out a sensitivity analysis and Section 6 discusses caveats of our analysis as well as possible implementation issues. Section 7 concludes and presents policy implications.

2. LITERATURE REVIEW

In order to reduce greenhouse gas (GHG) emissions to a level that keeps the associated risks of climate change at a

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manageable level, a price on emissions is frequently emphasized as the most efficient policy (Edenhofer, Flachsland, Jakob, & Lessmann, 2014). Popular approaches for carbon pricing include emission taxes and tradable permit schemes, as well as hybrid schemes (Goulder & Parry, 2008). This paper argues that carbon pricing would not only contribute toward climate change mitigation, but could also advance human well-being by providing the financial means to promote access to basic types of infrastructure, including water, sanitation, electricity, telecommunication, and transport.

This paper is related to several strands of literature. First, it follows previous studies estimating infrastructure investment needs. The dominant method in the literature to estimate investment requirements is to regress infrastructure investments on GDP (or vice versa), and then either project investment needs using growth forecasts, or estimate the level of investment that would maximize economic growth. Clearly, these estimates would not be suitable for our analysis, which focuses on universal access. In addition, the costs of reaching certain access goals, such as the Millennium Development Goals, are frequently provided on a regional instead of the country level. For these reasons, we build our own cost estimates instead of relying on already existing ones. Earlier studies, on which our analysis builds, have examined the financial needs to provide universal electricity access (Pachauri *et al.*, 2013) and the investments in water and sanitation required to achieve the Millennium Development Goals (Hutton, 2012), without focusing on the question of how these investments could be financed.

Second, our paper draws on the literature on carbon pricing. Most of this literature is concerned with the optimal choice of policy instrument, i.e., under which conditions it is more favorable to employ a price or a quantity instrument (Goulder & Parry, 2008). Some recent studies have also highlighted the benefits of using revenues to either lower other (distortionary) taxes, e.g., on labor and capital (Goulder, 2013), or for productive public investment (Edenhofer *et al.*, 2015). Third, our paper is in line with contributions that emphasize the importance of combining natural boundaries with socio-economic limits into a broader notion of sustainable development (Griggs *et al.*, 2013). For instance, taxing resource use and environmental externalities to finance infrastructure investments has been discussed as an approach to balance environmental and social objectives (Edenhofer, Kadner, von Stechow, Schwerhoff, & Luderer, 2014; Jakob & Edenhofer, 2014), and the potential of fossil fuel subsidy reform to finance infrastructure access is explored in Jakob, Chen, Fuss, Marxen, and Edenhofer (2015). Fourth, our paper is related to literature on climate finance as well as development finance. Most analyses of climate finance (e.g., Bowen, 2011; Haites, 2011; Jakob, Steckel, Flachsland, & Baumstark, 2015) are primarily concerned with the question of how to raise revenues to finance mitigation and adaptation in developing countries. Our study relates to this literature by addressing the possibility of sizable financial transfers resulting from a global climate treaty that allocates the bulk of the costs of climate change mitigation to industrialized countries. However, we do not analyze the case in which carbon pricing revenues from industrialized countries are used to finance mitigation in developing countries, but focus on the case in which financial resources generated by means of carbon pricing within countries are employed to expand access to basic infrastructure. From this perspective, we follow the literature on innovative sources of development finance. For instance, Jha (2004) explicitly considers carbon taxes as a potential mechanism to raise resources. Likewise, a recent World Bank (2013) report on post-2015 development finance identifies carbon pricing as a promising mechanism to generate new funds.

Our paper is to our knowledge the first to empirically link the revenue raising aspect of carbon pricing with estimates of infrastructure investment needs. In particular, our calculations show what fraction of carbon pricing revenues would be required to achieve universal access to water, sanitation, electricity, telecommunication, and to pave all hitherto unpaved roads at the level of individual countries. Even though we present results for all countries for which data are available, the focus of our analysis is on developing countries, where infrastructure access gaps are most pronounced (industrialized countries in general display very high access rates for all types of infrastructure under consideration).

3. METHODOLOGY AND DATA

This section outlines the climate scenarios and their implied revenues from carbon pricing, as well as the data on infrastructure access and the associated costs to close access gaps across all world regions. [2]

(a) *Scenarios of climate change mitigation under different policies*

Estimating potential revenues from carbon pricing requires the use of scenarios of future emissions as well as carbon prices. Integrated Assessment Models (IAMs) constitute the most frequently employed tool to generate such scenarios (Luderer *et al.*, 2011), which are inter alia used as a basis for the assessment of the Intergovernmental Panel on Climate Change (IPCC, 2014b). These models include a detailed description of the techno-economic characteristics of the energy system. Technological transformation pathways and mitigation costs are calculated by comparing business-as-usual projections (that assume no climate change mitigation will occur) with scenarios that impose a constraint on the atmospheric concentration of greenhouse gases (or the associated radiative forcing or temperature increase).

In order to identify differences as well as robust insights across a variety of IAMs, model comparisons are frequently carried out. The scenarios presented in this study are based on results from seven models used in the EMF-27 model comparison (Blanford, Kriegler, & Tavoni, 2014; Krey, Luderer, Clarke, & Kriegler, 2014; Kriegler *et al.*, 2014). [3] As the individual models use different regional aggregates, EMF-27 results are available for four macro-regions, namely Asia, Latin America and the Caribbean (LAM), Middle East and Africa (MAF) as well as the members of the OECD in the year 1990 (OECD90).

Figure 1 provides an overview of carbon prices and emissions in the year 2020 for the 450 ppm-CO_2-eq. [4] (ppm denote parts-per-million, i.e., the ratio of molecules of CO_2 relative to other gases in the atmosphere) stabilization scenario, which has an even chance of achieving the 2°C target. The scenarios assume a globally harmonized carbon price and full availability of low-carbon energy technologies (such as renewables, nuclear, and carbon capture and storage (CCS)). The models project roughly similar emissions [5] in 2020 (x-axis) for a given region (with the exception of negative emissions in two regions for the GCAM model [6]), but a large variation in carbon prices (y-axis), which range from less than US$ 20 to more than US$ 120 per ton of CO_2 (throughout the analysis, we use constant year 2005 US$). This broad span is mostly explained by differences in technological assumptions (e.g., on technology costs

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