Energy Economics 56 (2016) 499–512

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Baseline projections for Latin America: base-year assumptions, key drivers and greenhouse emissions

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ARTICLE INFO

Article history:
Received 27 August 2014
Received in revised form 30 September 2014
Accepted 5 February 2015
Available online 15 February 2015

JEL Classification:
O13
P28
P48
Q47
N76
O54

Keywords:
Energy
Scenarios
Greenhouse gas emissions

ABSTRACT

This paper provides an overview of the base-year assumptions and baseline projections for the set of models participating in the LAMP and CLIMACAP projects. We present the range in baseline projections for Latin America, and identify key differences between model projections including how these projections compare to historic trends. We find relatively large differences across models in base year assumptions related to population, GDP, energy and CO_2 emissions due to the use of different data sources, but also conclude that this does not influence the range of projections. We find that population and GDP projections across models span a broad range, comparable to the range represented by the set of Shared Socioeconomic Pathways (SSPs). Kaya-factor decomposition indicates that the set of baseline scenarios mirrors trends experienced over the past decades. Emissions in Latin America are projected to rise as a result of GDP and population growth and a minor shift in the energy mix toward fossil fuels. Most scenarios assume a somewhat higher GDP growth than historically observed and continued decline of population growth. Minor changes in energy intensity or energy mix are projected over the next few decades.

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1. Introduction

Since 1880, global mean temperatures have risen by approximately 0.85 °C; another 0.3 °C to 4.8 °C is likely to occur by the end of the coming century (IPCC, 2013). Limiting temperature rise to the lower end of this range will require substantial mitigation effort. Integrated assessment models (IAMs) are often used to support decisions on mitigation policy by developing scenarios that depict possible trends in energy production and emissions, both in the absence of climate policies (i.e. "baseline" scenarios) and in the presence of climate policies (i.e., "policy" scenarios). Baseline scenarios provide useful information for assessing why policies are needed and what the potential cost of policy intervention will be. Key inputs to these baseline scenarios are projections of driving forces such as population, economic activity, and assumptions on technology change, which can differ significantly across models. As a result, key model outputs from baseline scenarios, including projections of energy use and emissions over time in the absence of climate policy can differ significantly as well.

The purpose of this paper is to provide background information on model baseline assumptions and projections which will allow us to

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[1] The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

http://dx.doi.org/10.1016/j.eneco.2015.02.003
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explain differences in model results explored in subsequent papers in this special issue. More information on the model comparison project described in this special issue can be found in van der Zwaan et al. (2015). Specifically, we provide an overview of core baseline projections for countries in the Latin American region. Previous work has assessed baseline scenarios in Asia (Blanford et al., 2012) and Africa (Calvin et al., 2013). We follow a similar methodology to those studies and use the results from a set of models participating in a recent model intercomparison exercise: the CLIMACAP-LAMP project.[2] As part of our study, we present the range in core baseline projections for Latin America across participating models, identify key differences between model projections, and compare these projections to historic trends. Finally, we compare base-year data sources used to parameterize the models in order to better understand base-year differences across the models. Additional information on the scenarios and models included in this study is available in subsequent papers in this special issue—i.e., van der Zwaan et al. (in this issue) on technology transformation; Calvin et al. (2016–in this issue) on agriculture and land use; and Clarke et al. (2016–in this issue) on the response to climate policy.

The geographic focus of this study is the Latin American regions that are most widely represented in the set of participating models: Brazil, Mexico, the full region of Latin America (including the Caribbean), and the world. A smaller set of models also provides results for Argentina, Colombia and Chile which can be found in the Electronic Supplementary Material (ESM). We refer the reader to other studies in this special issue for more detailed information on Argentina (Di Sbriovacca et al., 2016–in this issue), Brazil (Lucena et al., 2016–in this issue), Colombia (Calderon et al., 2016–in this issue), and Mexico (Veysey et al., 2016–in this issue). This study covers the period of 2005–2050, with results for the longer term (up to 2100) provided in the ESM. The models participating in the CLIMACAP-LAMP project are ADAGE (Beach et al., 2011), EPPA (Paltsev et al., 2005; Paltsev et al., 2014), GCAM (Wise et al., 2014), IMAGE (Stehfest et al., 2014; van Vuuren et al., 2007), iPETS (O'Neill et al., 2012), LEAP-UNAM, MEG4C (Alvarez et al., 2014; DNP et al., 2014; MLED, 2013; World Bank and DNP, 2015), MESSAGE-Brazil (Nogueira et al., 2014), Phoenix (Daenzer et al., 2014), POLES (Criqui et al., 2015; Griffin et al., 2014; Kitous et al., 2010; Markandya et al., 2014), TIAM-ECN (Kober et al., 2014; Van Der Zwaan et al., 2013) and TIAM-WORLD (Kanudia et al., 2014; Labriet et al., 2013).

The paper is organized as follows. Section 2 discusses the base-year data and model assumptions. Section 3 presents the model core baseline projections for the participating models and compares these projections to historical trends. In Section 4 we provide results from a Kaya-factor decomposition analysis to identify the key factors driving changes in emissions and variation across models. Finally, Section 5 provides a closer examination of historic trends in Latin America and how these trends compare to the core baseline scenario projections.

2. The starting point: base-year data

A number of sources exist for historical data on population, GDP, energy use and emissions. It is common for these variables to differ across data sources. While the models partly use the same data sources (see Table 1), still differences exist, which contributes to differences in the base-year as presented in Section 2.2. Furthermore, models use different base years, so that differences may exist even if the same data sources are used. Finally, data is regularly updated. We focus our comparison of base-year data on the year 2005, as this is the most commonly adopted base year (i.e., eleven out of thirteen models participating in the CLIMACAP-LAMP project). The goal of this section is to highlight the differences in estimates across external datasets as it helps to explain why there are differences in the reported base year data for the CLIMACAP-LAMP models. Given the larger scope of this paper, we do not attempt to explain why these differences exist in the published data. Section 2.1 reviews the data (published by a number of sources) used to parameterize the models, and Section 2.2 examines the variance in base-year estimates submitted to the CLIMACAP-LAMP scenarios database.

2.1. Variation across historical databases

Fig. 1 compares 2005 base year variables across data sources, many of which are used by the models participating in the CLIMACAP-LAMP project.[3] The figure shows deviations in 2005 values for GDP, CO_2 emissions, population, and primary energy use from different data sources relative to one source, often the source most commonly used by the models. In some cases (e.g., GDP), values are compared across a number of unique data sources. In other cases, values are also compared across different versions of a single source. In the figure, values for 2005 are provided for each of the individual CLIMACAP-LAMP regions (Argentina, Brazil, Chile, Colombia, and Mexico) as well as for the aggregate Latin American region (LAM) which includes the Caribbean, and Central and South America.

As shown in Fig. 1, the lowest variation across data sources is found with GDP. It is less than 1% for the reported countries and sources. The widest range of variation across data sources exists in the case of the aggregate LAM region. The value of GDP from the World Bank and the UN match, but the IMF and IEA GDP estimates are approximately 4–5% lower.

The spread in population data is similar to the spread observed for GDP. In the case of Brazil and Columbia, the data for population are mostly in agreement. Population estimates for Mexico are similar across all data sources except for the 2013 UN revision (the data source of reference) which is 4–5% higher. This increase in the estimation for Mexico's population goes back to 2050 in the 2013 UN report and coincides with higher estimates for crude birth rate during that same 55-year period. In the case of LAM, the three data sources are consistently lower than the reference data source, with a range of estimates of 1–5%.

The 2007 IEA primary energy estimates are within $\pm 5\%$ of the 2013 data, but there is no consistent story across regions. The 2007 estimates for Argentina, Brazil, and LAM are lower than current estimates, while they are higher for Chile, Colombia, and Mexico. This partly explains why also models may produce different base year estimates while using data published by a single agency.

The reference data for CO_2 emissions from the CDIAC include emissions from natural gas flaring and cement production while the three comparison sources do not. As a result, reference source emissions are higher in all regions. Aside from this, there are no discernable patterns in the data. For LAM, Argentina, Chile, and Mexico, the CDIAC emissions estimate without flaring and cement is higher than the IEA estimate, but for Colombia, these emission estimates are lower than the IEA emission estimates by a few points. In the case of Brazil, the CDIAC emission estimates without flaring and cement matches the current IEA estimates. There are notable differences between the two versions of the IEA data: the current version shows higher emissions from LAM and Argentina, but lower emissions for Brazil, Chile, Colombia, and Mexico.

2.2. Variation across models

Across the four key reporting variables – GDP, population, primary energy, and CO_2 emissions from fossil fuel combustion and industrial

[2] The Integrated Climate Modelling and Capacity Building Project in Latin America (CLIMACAP) is a European Commission funded effort focused on analyzing the effects of mitigation strategies in key Latin American countries. The Latin American Modeling Project (LAMP) is a similar effort funded by the U.S. Environmental Protection Agency and the U.S. Agency for International Development. Coordinated effort between these two projects has allowed for the development of a multi-model comparison project focused on mitigation in Latin America. More information on the two projects is available at: https://tntcat.iiasa.ac.at/CLIMACAP-LAMPDB/.

[3] For a detailed description of why these differences exist, see Chaturvedi et al. (2012), which reviews data sources used in the Asian Modeling Exercise.

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