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Kaya identity for analysis of the main drivers of GHG emissions and feasibility to implement EU "20–20–20" targets in the Baltic States

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ABSTRACT

The Kaya identity relates the greenhouse gas (GHG) emissions to energy use, economic growth and population growth. Therefore, it can be applied to decompose GHG emissions with respect to the latter terms. European Union (EU) has established the main targets of sustainable energy development in Energy and Climate package 20–20–20. EU member states conformed to achieve in 2020 GHG emission reduction by 20% comparing with year 1990 level, to achieve 20% of renewable energy sources (RES) in final energy consumption and to reduce energy intensity by 20% compared to year 2005 level. As all of these targets are interrelated and have to be achieved together, it is very important to track the changes of GHG emissions in EU member states alongside the changes in energy intensity and increase in the share of renewables in final energy consumption. The Kaya identity and decomposition analysis allow the linking of changes in GHG emissions to changes in energy intensity and carbon intensity of energy which directly reflects the increase of the share of renewables in final energy consumption. The impact of GDP growth on GHG emissions is also assessed by Kaya identity. The paper applies a novel approach in tracking progress achieved in implementing 20–20–20 targets by employing Kaya identity and Shapley value for decomposition analysis. The conducted analysis showed that policies to increase energy efficiency are the most important drivers of GHG emission reduction and achieving EU 20–20–20 targets in Baltic States. Though the share of RES has increased significantly in Baltic States its impact on GHG emissions reduction per capita in Baltic States was insignificant therefore more emphasis on energy efficiency policies is necessary as they are the most effective measures for achieving GHG emission reduction targets.

Contents

1. Introduction

In 2007, the European Union (EU) stepped up its energy and climate change ambitions to a new level. Based on a communication by the European Commission on energy and climate Policy for Europe, the EU Council agreed to:

- An independent greenhouse gas (GHG) emission reduction commitment of 20% by 2020 compared to 1990 levels and an objective for a 30% reduction by 2020 subject to the conclusion of a comprehensive international climate change agreement;
- A mandatory 20% share of renewable energy sources (RES) in Gross Final Energy Demand by 2020 for the EU as a whole

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including a 10% share of renewables in transport for each Member State, and;
– An improvement of energy efficiency by 20% compared to baseline levels by 2020.

From the sole perspective of EU greenhouse gas emission reduction, such a policy instrument mix bears the risk of costly overlapping regulation. In a broader perspective, the policy mix may be justified by multiple targets as stated in the EU "20–20–20" Climate Action and Renewable Energy Package through which the EU pursues a 20% share of renewable energy sources in gross final energy consumption and an increase of energy efficiency of 20% by 2020 along with its greenhouse gas emission reduction target [1,2]. However, while global warming provides a straightforward argument for the policy objective of curbing greenhouse gas emissions, the objectives behind renewable energy quotas and energy efficiency targets are less obvious. Therefore it is important to analyse interrelation of all these targets and to track the changes of GHG emissions in EU member states by relating them to the changes in energy intensity and increase in the share of renewables in final energy consumption. The Kaya identity and decomposition analysis allow this linking of changes in GHG emissions to changes in energy intensity and carbon intensity of energy which directly reflects the increase of the share of renewables in final energy consumption.

Kaya identity and decomposition analysis allow to factorise the GHG emission change. This enables to quantify the underlying factors of change in terms of absolute or relative energy indicators (e.g. energy consumption, carbon emission, GHG emission). There are two broad groups of the decomposition analysis, namely Structural Decomposition Analysis (SDA) and Index Decomposition Analysis (IDA). Hoekstra and van der Bergh [3] compared these two veins of analysis. SDA is based on the input–output analysis, whereas IDA relies on a more simple analysis of statistical data.

The methodology of IDA is discussed by Ang [4] and Xu and Ang and others [5–7] and defined the two groups of the IDA methods, viz. those linked to the Divisia index and those linked to the Laspeyres index. Among indices linked to the Laspeyres index, the Shapley/Sun index is particularly appealing in that it does not feature the property of path dependency. This means that the order the factors enter into an IDA model is not important. Furthermore, the change in the variable of interest is perfectly decomposed (other IDA methods, though, also possess this property). The said index is based on the idea of the Shapley value [8]. Later on, Sun [9] proposed a perfect decomposition index and Albrecht with others [10] employed the Shapley value for decomposition of the Kaya identity [11]. Yet it was only [6] has noticed that the aforementioned studies employed one and the same index—the Shapley/Sun index. The Shapley/Sun index was employed in various studies on carbon emission [12].

Energy use in Lithuania has been analysed by the means of both SDA [13] and IDA [14–16]. Indeed, the previous papers focused on energy use and carbon emission but the impact of energy intensity and carbon intensity on GHG emission reduction were not investigated so far. In addition the Shapley/Sun index has not been applied yet.

The aim of the paper is to employ Kaya identity for analysis of the main drivers of GHG emissions in EU member states and to isolate the impact of increase of the use of renewables and decrease in energy intensity on GHG emission reduction and ability of EU member states to implement 20–20–20 targets.

This paper therefore seeks to employ the Shapley/Sun index for the decomposition of GHG emission in EU member states. The paper analyses the period of 2004–2012. The paper presents analysis of Baltic States in terms of implementing targets for GHG emission reduction, energy efficiency and use of renewable energy sources, briefly describes the research methodology applied for Kaya identity analysis following description of results of Index Decomposition Analysis (IDA) performed for Baltic States and the member states distinguished by the highest and lowest GDP per capita rates (Bulgaria and Luxemburg) and develops conclusions and policy recommendations based on analysis performed.

2. Baltic States and implementation of sustainable energy development targets

The Europe 2020 strategy, adopted by the European Council on 17 June 2010, is the EU's agenda for growth and jobs for the current decade. It emphasises smart, sustainable and inclusive growth as a way to overcome the structural weaknesses in Europe's economy, improve its competitiveness and productivity and underpin a sustainable social market economy. The same indicators addressed by Energy and Climate Package are foreseen in Europe 2020:

- Greenhouse gas emissions to be reduced by 20% compared to 1990;
- Share of renewable energy sources in final energy consumption to be increased to 20%;
- Energy efficiency to be improved by 20%.

Baltic States have implemented ambitious policies aiming to reduce GHG emissions, increase of use of renewables and energy efficiency. The Baltic States economy largely depends on fossil fuels, especially for electricity generation, industry and transport. It may therefore be expected that a decrease in economic activities – as measured by gross domestic product (GDP) – would lead to a decrease in overall GHG emissions. Over the period 2000–2009 the Baltic States economy experienced mostly growth, with the exception of the last year where due to the economic crisis GDP fell sharply. The emissions showed a similar trend of sudden decline in 2009. If less energy is used for each 1000 euro of GDP then the intensity is lower which indicates gains in productivity and improved energy efficiency. EU energy intensity decreased by nearly 12% in 2000–2009 which means that for each 1000 euro of GDP the EU used 12% less energy by the end of the studied decade. There are two possible reasons for this: first, energy may have been used more efficiently; and second, the overall economic structure of the EU may have shifted to less energy intensive economic activities. In the same way that overall energy consumption may be examined in its relation to GDP, total GHG emissions may also be considered in terms of the greenhouse gas intensity of the economy. Besides looking at overall trends, it is possible to analyse the examining situation in the different sectors that comprise the economy however in this paper we look on the general drivers of GHG per capita emissions in the country. The integrated analysis of the same breakdown of economic activities in national accounts was applied in previous papers [13,14]

The Renewable Energy Directive (2009/28/EC) presents Member States with a huge implementation challenge that cannot simply be met by an extension of existing promotional policies for renewables. The Directive required each Member State to submit a National Renewable Energy Action Plan (NREAP) by 30 June 2010, setting out how it plans to achieve its 2020 target [17]. In Table 1 RES targets for Baltic States and achieved progress in implementing RES target is presented.

As one can see from information provided in Table 1 Latvia and Estonia have implemented RES target set for year 2020 in 2012. Lithuania also has shoved good progress in implementing RES