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Trend analysis of energy and climate policy environment: Comparative electricity production and consumption benchmark analyses of China, Euro area, European Union, and United States

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ABSTRACT

This study conducts a "reality check" on the electricity production and electricity consumption trends in China, in the U.S. and in the Euro area and in the EU. Most of our analyses cover years 1961–2011. The data is based on the World Bank's database with supplementary IEA database (2013).

In this article we perform various trend analyses, which are linked to electricity production and consumption developments. These regions are major players in global climate change and climate policy. Our trend analyses indicate in many ways that China is now a global trend-setter in climate change and climate policy. Upwards sloping trends were evident in the Chinese energy economy. However, U.S. and the EU are still very important players. Trend analyses of this article indicate that the structures of electricity production and energy mixes are changing. Our benchmarking studies indicate that the role of renewables is increasing in electricity production and the role of oil-based electricity production has drastically decreased. The "Golden age" of nuclear energy in electricity production seems to be over: at least, turning points can be found in trend developments. Empirical trade-off analyses of the study verified conventional research results about high linear correlation coefficients (regression models) between electricity production and GDP as well as between population and GPD in all regions. Correlation coefficients measure the strength of association between two variables. What was interesting is that our comparative analyses revealed some remarkable differences in linear regression equation coefficients. One of them was that the coefficient between population and electricity production is much lower in China than in the U.S. or in the EU. Second finding was that the coefficient of the regression model describing linear relationship between GDP and electricity production is highest in China in comparison to the other regions.

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1. Introduction

Global warming is one of biggest environmental issues that have caught the attention of global policy-makers in recent decades. As generally agreed upon, global warming is an unequivocal result of anthropogenic emission of greenhouse gases (GHG) [1]. Trends of

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energy economy are closely linked to the key problems of climate change. There is a need to stabilise greenhouse gas concentrations in the atmosphere to a level that would prevent dangerous anthropogenic interference with the climate system [2].

As climate change problems rise in public policy agendas around the world, the need for robust science to inform policy designs and purposes increases. While the production of climate science has steadily increased, its usability remains relatively limited in terms of decision support and policy designs [3]. In the context of climate science, we want to serve the usability of trend information/knowledge. For decision-makers, who are partly trend-setters and changers of trends, this kind of updated trend information is often value-added information and knowledge. For example, "thinking globally while acting locally" is not possible without knowledge about trends and anti-trends [4].

The aim of this article is to benchmark key variables relevant for energy economy and climate policy analysis. This article is based on statistical observations and World Bank's [5] and IEA's electricity databases [6–9]. These databases are considered to be very reliable and they have been used in many studies of energy economics and energy planning. We can classify the methodology as a so-called white box methodology, because we use real data observations. In the field of benchmarking studies the use of real data observations is a recommended way to perform benchmarking analyses. Other energy benchmarking methods are grey/black methods. Energy benchmarking includes process of collecting, analysing and relating energy performance data of comparable activities with the purpose of evaluating and comparing performance between or within entities. In this case we use regional entities and the four specified regions are China, U.S., Euro area, and European Union. The euro area consists of those Member States of the European Union that have adopted the euro as their currency. Thus the European Union is a larger regional entity than the Euro area. One specific research task of this paper is to analyse potential differences between the Euro area and the European Union.

In this article we present various performance benchmarking analyses with some strategic benchmarking analyses, which involve observing how others compete see [10–12]. Many policy fields are in transition after the Kyoto Protocol era [13,14]. The next decades are going to be critical for the global energy economy. Energy sufficiency of many countries is not guaranteed because of rapid growth in BRICSA countries. We shall meet many challenging strategic, moral, and fairness issues. Adaptation to global warming is going to be a very challenging process on global and local levels [15,16]. Shaping of new policies in European Union, China and U.S. are in a "re-framing" process after the Kyoto Protocol era. Total emission reduction requires that acceptable alternatives are found for every use of fossil fuels, including various niche applications. That will be an expensive project – and the economic benefits are quite low. Thus benefit-cost analysis cannot justify a complete elimination of carbon dioxide emissions, even if such is favoured by the UNFCC [17–22].

The second aim is to describe the most critical trends of electricity production and consumption in some influential countries (China, U.S., and the European Union). Our study is a combination of benchmarking and statistical trend analysis approaches. In a typical benchmarking analysis, processes and performance metrics are analysed and compared. This article presents a process benchmarking study with a focus on years 1961–2011. Benchmarking helps identify best "champions" and less successful players. In ideal cases benchmarked actors start to improve their performance towards the performance level of a benchmarked champion. The battle to reduce fossil fuel consumption to avert climate change has only recently begun and our hopefully study helps decision-makers to understand the severity of the situation in energy and climate policy.

Shortly put, we present comparative benchmarks and trend analyses. Our pragmatically oriented aim is to serve many stakeholders in the fields of energy policy and climate policy-making.

We pay particular attention to trends associated to low-carbon strategies and fossil fuel addiction of economies. Addiction to fossil fuels can be compared to the behavioural economic model of cigarette addiction. There are various strategies to end fossil fuel addiction: (1) gradual or cold turkey quitting, (2) the individual decision to reduce fossil fuel usage and (3) the collective decision to reduce fossil fuel usage [23]. All these strategies can be used. If the consequences of global climate change seem very disastrous and disruptive, the probability to adopt "cold turkey quitting strategy" increases due to the severity of social and economic problems that force policy-makers to "do something." Other strategies are probably used if policy-makers expect there is enough time to solve the problems.

The political arena of energy policy is changing rapidly because of China and its economic growth. Other BRICSA counties such as Russia, South Africa, and Brazil are also in a dynamic phase of economic and social development. This paper helps understand major trends and transitions in relation to old economic giants, the U.S. and European Union. We also analyse the energy and climate change policy trends of the Euro area. From the perspective of global climate change policy, the future roles of these benchmarked regions are very important.

The databases used in this benchmarking study are the World Bank's regional database [5] and IEA databases [6–9]. The paper is organised in the following way: in Section 2 we analyse the trends of energy economy, in Section 3 we focus on trends relevant for global climate change policy, in Section 4 we present policy-relevant trade-off analyses, and finally, Section 5 provides a summary of findings and results of the earlier sections.

2. Trends in energy economy

In this section we shall analyse some key trends in the energy economies of China, U.S. and the Euro area. The dynamic development of Chinese economy is a key trend in the global economy as visible in Figs. 1, 3 and 4. In particular, US-China trade has been seen as a key driver of economic growth in China [24,25].

First in Fig. 1 electricity production in China, the U.S., the European Union, and the Eurozone are visualised. This figure tells that there is huge, on-going growth in Chinese electricity production. In other regions, electricity production is in a saturation phase. One key empirical finding is that China has reached U.S. in the volume of electricity production.

In Fig. 2 energy use per 1000 dollar GDP is reported in the benchmarked countries. We can see the declining trends of these regions.

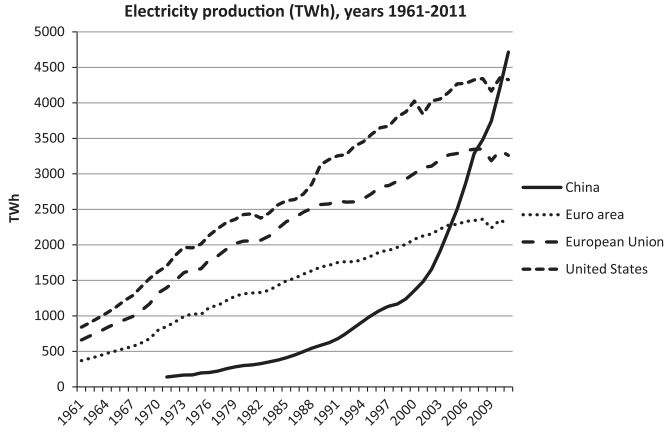

Fig. 1. Electricity production (TWh) in China, the U.S., the European Union, and the Eurozone.