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The consistency of China's energy statistics and its implications for climate policy

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ABSTRACT

Reliable energy statistics serve as the foundation and starting point for understanding the climate policies of any country. As the most comprehensive sources of energy data for China, China Energy Statistics Yearbooks (ESY), published by the National Bureau of Statistics (NBS), underwent three major revisions since 2005. This paper analyzes how these three major revisions correspond to data on China's energy use from 1996 to 2012, and theirs impacts on CO_2 emissions, emission intensity and the share of non-fossil energy in total energy consumption, which are key indicators of China's climate policies. Some notable changes include CO_2 emissions for 2012, which increased by 594 Million tons – a figure equivalent to South Korea's annual emissions, which implies that China's emissions at peak level will be higher than previous estimation. Meanwhile, revised emission intensity data show a higher amount and lower decreasing rate, which means that China's achievements in decreasing emission intensity during 2005–2012 have been overestimated, while future difficulties for achieving the goal of 40–45% reduction will be greater. On the share of non-fossil fuel energy in China's total energy mix, the adjustments increased the indicator by 1.26%, reflecting the fact that China's effort in developing non-fossil energy had been underestimated. Discrepancies in reported scattered coal in different statistics versions are the main contributors to these changes. To further enhance the reliability of its energy statistics, and thereby its climate policies, China should remove incentives for misreporting through legal means, and make the technical system for data collection more comprehensive and accurate, with particular emphasis on scattered coal.

1. Introduction

Climate change caused by increasing greenhouse gas (GHG) emissions is one of the biggest issues facing the world today. To mitigate climate change, the 2015 Paris Agreement set a long-term goal of "holding global warming to well below 2 °C compared to pre-industrial levels, and of pursuing efforts to limit warming to 1.5 °C," and established a global stocktakes mechanism to assess collective progress towards meeting that target (UNFCCC, 2015). In response, China, the world's largest emitter of carbon dioxide (IEA, 2017), has set corresponding goals to mitigate its contribution to climate change in its Intended Nationally Determined Contributions (NDRC, 2011a, 2015). Key targets include: achieving peak carbon dioxide emissions by around 2030 (while making best efforts to peak early), lowering carbon dioxide emissions per unit of GDP by 60–65% from the 2005 level at the same time, and increasing the share of non-fossil fuels in primary energy consumption to around 20%. Due to its dominant share of global GHG emissions, China's mitigation efforts are becoming more and more important for meeting global decarbonisation goals.

GHG emissions inventories serve as the foundation for measuring emissions status quo and tracking mitigation efforts. As the essential data for estimating emissions inventories, energy statistics is of great concern because it contributes greatly to the uncertainties in estimates of GHG emissions, especially for large and rapidly growing emitters such as China. Unfortunately, the reliability of China's energy statistics has come under growing skepticism in recent years (Holz, 2004; Liu and Yang, 2009; Liu et al., 2015; Sinton, 2001), which has not only created considerable uncertainties in the estimation of China's and even the world's GHG emissions, but also confused the understanding of China's mitigation efforts.

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Considering these serious consequences, the reliability of China's energy data has been widely debated (Guan et al., 2012; Li et al., 2016; Liu et al., 2015; Ma et al., 2014; Qi and Wu, 2013; Shan et al., 2016; Sinton, 2001; Wang, 2011). The most well-known controversies about China's energy statistics quality is the inconsistencies between provincial-level and national-level statistics (Ma et al., 2014; Shan et al., 2016). In 2005, the aggregated national energy consumption based on provincial statistics was 11.6% higher than that based on nation-level accounting, and the gap between the two numbers increased to 22.5% in 2012 (Li et al., 2016). The industrial sector and raw coal consumption are the major contributors to these discrepancies (Ma et al., 2014). These have further led to significant discrepancies in carbon emissions estimates. For 2010, CO_2 emissions calculated on the basis of the two energy datasets differed by 1.4 gigatonnes (Guan et al., 2012). According to existing research, institutional factors such as political incentives to local governments, rather than technical factors such as statistical coverage and data collection methods, are the decisive reasons for the mismatch between national and provincial statistics (Li et al., 2016; Liu and Yang, 2009; Ma et al., 2014).

By exploring the consistency of energy statistics from 1990 to 2000, Sinton (2001) concluded that China's energy statistics were relatively accurate and reliable at the beginning of the 1990s, but their quality has declined since the mid-1990s. That conclusion has been confirmed by later studies. Liu et al. (2015) found a higher annual growth rate of energy consumption than official national statistics between 2000 and 2010, and re-estimated China's carbon emissions based on the re-estimation of energy consumption and emission factors. Hong et al. (2017) also found increasing discrepancies in China's energy statistics during 2004–2012 and estimated their impacts on the emissions of SO_2, NO_x, VOC, PM2.5 and CO_2.

The existing literature has convincingly illustrated the cross-sectional and temporal inconsistencies of China's energy statistics, explained the reasons underlying the discrepancies, and analyzed the consequences of pollution emissions. However, the impacts of frequent data revisions on the key indicators of China's climate policies, such as CO_2 emissions, emission intensity and the share of non-fossil energy in total energy consumption, are still poorly understood. The frequency and scale of the revisions have made it more difficult to understand the efforts of China's climate change mitigation actions, and may have considerable consequences for the stocktakes of Intended Nationally Determined Contributions starting from 2023.

This paper presents a more systematic analysis of China's three major energy statistics revisions and theirs impacts on estimates of CO_2 emissions, emission intensity and the share of non-fossil energy in total energy consumption. In this paper, we adopted the 'apparent consumption' approach to calculate China's energy consumption, based on the different versions of China's energy statistics. To compile China's CO_2 emissions from 1996 to 2012, we followed the reference approach outlined by the IPCC's emissions accounting standards. Furthermore, we assess the consequences of these energy statistics revisions on the three key indicators of China's climate mitigation action: CO_2 emissions, emissions intensity and non-fossil energy share.

This paper is structured as follows: Section 2 compares the different versions of China's official energy statistics versions; Section 3 describes the corresponding methods for measuring CO_2 emissions, emission intensity and the non-fossil energy; based on these analyses, Section 4 analyzes the impact on the measurement of China's progress towards its key climate change mitigation targets; Section 5 discusses the weaknesses of the current energy statistics system and their policy consequences. Section 6 provides concluding remarks.

2. A brief overview of China's official energy statistics revisions

In 1986, the National Bureau of Statistics (NBS) published the first *China Energy Statistics Yearbook (ESY),* in which energy production and consumption data were traced back to 1953. Since then, the NBS has regularly published detailed sectoral energy statistics and provincial and national energy balances in the ESYs. These official energy statistics provide the irreplaceable basis for analyzing China's energy issues, used not only domestically but also by international organizations and researchers (Sinton and Fridley, 2002).

Currently, China has established a periodic system for releasing and revising energy data. China's national primary energy consumption is first published, but in preliminary and abbreviated form, in the annual *Statistical Bulletin for National Economic and Social Development* published in early spring. This is followed by the release of detailed energy statistics in the annual *China Statistical Abstract* in late spring. Usually, China publishes the *China Energy Statistical Yearbook* in autumn or winter, in which preliminary statistics are revised and further-elaborated energy statistics, including energy balance sheets, are introduced. Generally, the differences from the preliminary data to the first ESY are negligible. Since 2004, China has conducted three national economic censuses covering all economic units, based on which the NBS made three major revisions to energy statistics, detailed in ESY 2005, ESY 2009, and ESY 2014 (Hong et al., 2017; Mi et al., 2017a). ESY 2005 revised energy data for the 1999–2003 period; ESY 2009 revised energy data for the 1996–2007 period, and ESY 2014 revised energy data for the 2000–2012 period (NBS, 1996-2015).

The successive revisions indicated that China's energy production and consumption were much higher than originally reported, and even changed the overall trend (Table 1). For instance, the total energy consumption in 2000 was 1303 Million tons coal equivalent (Mtce) according to the preliminary ESY, but was raised to 1385 Mtce in the *ESY 2005* revision. Consequently, the originally reported decline of 19.2 Mtce in 1998–2000 became an increase of 63.4 Mtce. This was followed by two further revisions in *ESY 2009* and *ESY 2014*, when energy consumption for the year 2000 was again revised upward, to 1455 Mtce and 1470 Mtce respectively. Overall, the discrepancy between the final and initially reported values was over 10% for the years 2000–2012.

In the successive energy consumption revisions, the adjustments made to coal accounted for more than 85% of total adjustments (Fig. 1S). Compared with the adjustments made to coal consumption, the adjustments made to crude oil and natural gas were minimal, while the statistics for primary electricity were relatively consistent. In other words, the initial consumption statistics for electricity, crude oil and natural gas were more reliable than those for coal.

The significant adjustments made to coal statistics resulted in the low consistency of coal-intensive energy consumption sectors. We compared the adjustments made to seven final consumption sectors in ESY 2014 (Fig. 2S). In terms of absolute size, the adjustment made to the industry sector was by far the largest, accounting for around 64.45% in 2004, 78.44% in 2008 and 80.70% in 2012. In terms of relative size, the adjustment made to the "wholesale and retail trade, hotel and restaurants" sector was over 27.59% in 2012, and adjustments for the agriculture and industry sectors reached 21.02% and 19.84%, respectively. Although the adjustments made to the residential consumption sector was around 10%, the relative size of the adjustment for urban consumption was below 3%. Due to lower coal consumption and more accurate household metering systems for electricity, natural gas and heating, the reliability of statistics for urban consumption was far higher than that for rural consumption statistics.