Journal of Cleaner Production 103 (2015) 837–846

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

Disaggregation of energy-saving targets for China's provinces: modeling results and real choices

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ARTICLE INFO

Article history:
Received 30 March 2014
Received in revised form
8 September 2014
Accepted 22 September 2014
Available online 30 September 2014

Keywords:
Burden sharing
Energy-saving target
Regional allocation

ABSTRACT

Starting with the 11th Five-Year Plan (FYP) and continuing in the 12th FYP, quantitative and binding targets have been set for energy-efficiency improvement in China. Drawing on international experience in burden-sharing on climate change, this paper presents a framework for provincial-level disaggregation of energy-saving targets in China. Based on principles of equity and efficiency, four scenarios have been established by weighting different choice preferences of responsibility, capacity, and potential. In addition, nonlinear and linear allocation models have been developed by considering or ignoring marginal energy-saving cost. When this framework was applied to the disaggregation of the national energy saving target of 16% during the 12th FYP, the results show that the final allocation schemes are largely determined by the policy maker's choice preferences. The extreme reduction target of 37.26% fell to Shanghai under responsibility preferring (RP) using the linear allocation method, while the capability preferring (CP) scenario considering marginal energy-saving cost is the closest to the actual scheme accepted by the 30 provinces. Development of such a framework may serve as a feasible policy instrument to help China achieve its conservation targets in a cost-effective way and in accordance with its regional development strategies.

1. Introduction

Confronted with a large population but deficient resources, China started energy conservation work in a planned and organized way in the early 1980s and achieved the goal of quadrupling economic growth while doubling energy consumption by the late 1990s (Wei and Rose, 2009; Xia et al., 2014; Zhang, 1995). To promote energy conservation further with the aims of transforming economic development patterns and optimizing economic structures as well as coping with climate change, the Chinese government has made energy conservation a national strategic policy and promulgated and implemented the *Medium- and Long-term Special Plan for Energy Conservation*, setting goals for energy-consumption reduction during the 11th Five-Year Plan (FYP, 2006–2010) and sharing out the tasks and responsibilities to the various provinces, autonomous regions, and municipalities directly under the central government, as well as to key enterprises (Andrews-Speed, 2009; DRCSC, 2003; Xia and Chen, 2012; Zhang et al., 2014a). Following on the success of the 20% improvement target for economic energy intensity (energy/GDP) of the 11th FYP and in support of the 2020 target to reduce carbon intensity by 40%–45% against 2005 levels, the State Council proposed a new intensity target for the 12th FYP (2011–2015). Under the new target, energy intensity (energy consumption per unit of GDP) will be reduced by 16% over the next five years (State Council, 2011).

As with other burden-sharing mechanisms, energy-saving targets must be allocated sub-nationally to provinces, municipalities, and autonomous regions to achieve the overall national goal. For both the 11th and 12th FYPs, provincial targets were set based on rapid assessment and administrative negotiation, and most were set close to the national target (Ohshita and Price, 2011). Specifically, the central government set a target for energy conservation and preliminarily allocated this target to the responsible entities, the provinces, which were structured into five groups based on the economic development and energy-intensity savings achieved in the 11th FYP. Then the responsible entities would give feedback on the allocation and negotiate with the central government until all the participants accepted the scheme (China Energy News, 2011). Fig. 1 shows the final assigned provincial energy-intensity improvement targets for the 12th FYP. Nonetheless, a more detailed explanation of how this overall burden-sharing scheme among regions was achieved has not yet been clearly given.

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http://dx.doi.org/10.1016/j.jclepro.2014.09.079
0959-6526/

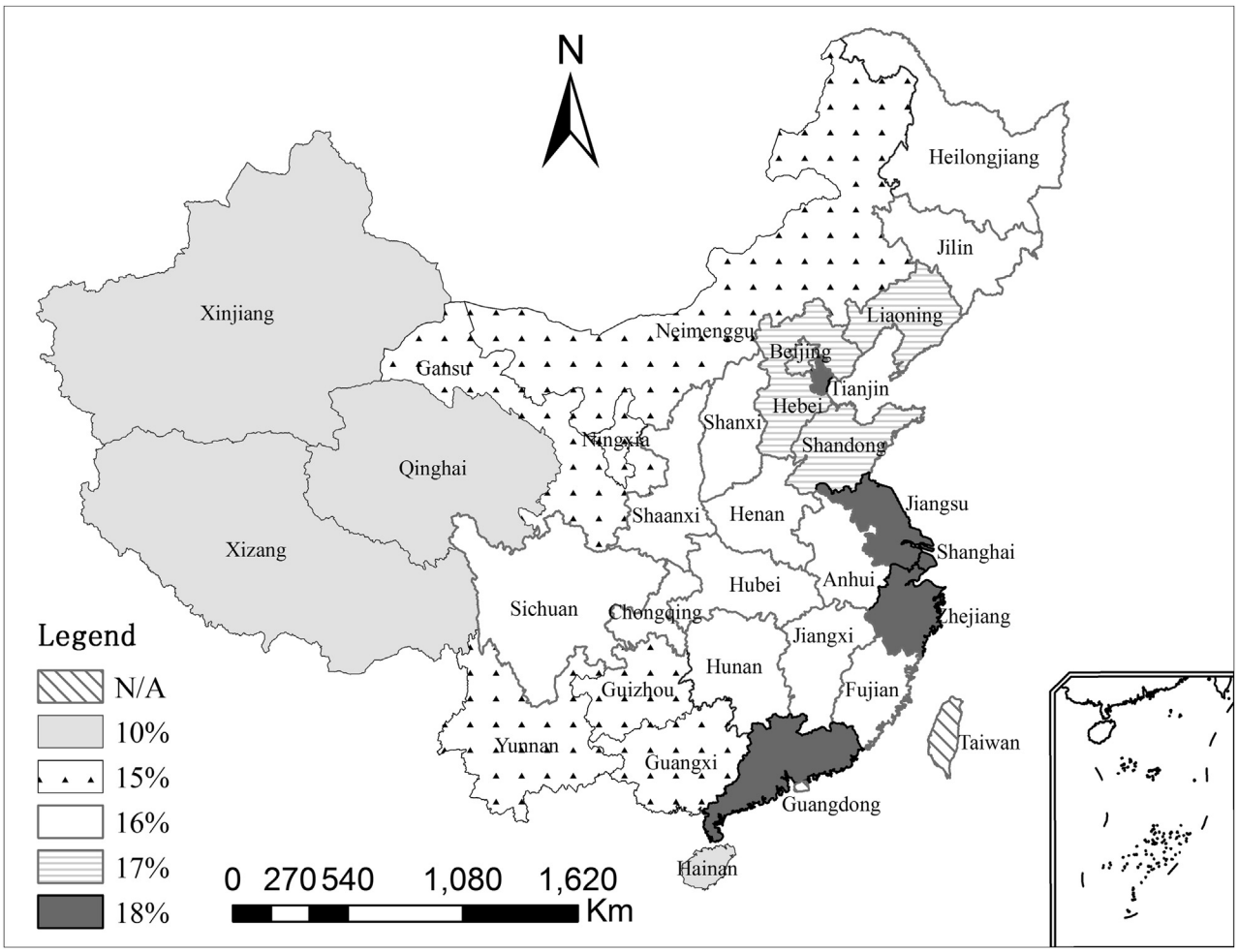

Fig. 1. Energy intensity improvement targets for 31 provinces in Mainland China in the 12th FYP.

China is one of the countries with the sharpest discrepancies of population, resource distribution, and economic development among different regions in the world (Zhang et al., 2014b, 2011, 2009). This has raised the issue of how to allocate the energy-saving target regionally using an equitable, reasonable, and jointly acceptable solution. In the last two decades, researchers and stakeholders have proposed various resource-allocation and burden-sharing plans for energy conservation and emission reduction from different perspectives (Chen and Chen, 2013; Shao et al., 2013; Winkler et al., 2006; Zhang et al., 2014c, 2012). Wei and Rose (2009) built a nonlinear programming model to minimize total energy-conservation cost and then proposed an inter-regional energy conservation-quota trading scheme in an efficient and equitable manner for China. Ohshita and Price (2011) provided a sectorial methodology for allocating national energy-intensity targets among China's provinces in the 12th FYP which draws on international experience with the European Union (EU) Triptych approach for allocating Kyoto carbon targets among EU member states. Actually, the majority of existing burden-sharing research studies are associated with emission-reduction allocations for greenhouse gases (GHG) (Grubler and Fujii, 1991; Gupta and Bhandari, 1999; Ringius et al., 2002, 1998). It is worthwhile to note that the Triptych approach was originally developed at the University of Utrecht to distribute the emission allowances of the first commitment period under the Kyoto Protocol within the European Union (Phylipsen et al., 1998), an approach which has been widely accepted and applied with some modifications in accordance with specific situations (Elzena et al., 2008; Ohshita and Price, 2011; Wang et al., 2013). In particular, the Swedish Stockholm Environment Institute proposed a greenhouse development rights plan that includes a comprehensive analysis index to quantify ability and responsibility to allocate global emission-reduction costs (Baer et al., 2008). Within China, a top-down model was developed to allocate the national CO_2 intensity-reduction target among regions based on choice preferences for emission-reduction capacity, responsibility, and potential (Yi et al., 2011); Using an extended Slacks-Based Measure (SBM) model incorporating an undesirable output, the CO_2 reduction potential and marginal abatement costs are estimated for 29 provinces of China over the period 1995–2007 by Wei et al. (2012). Moreover, various equity principles have been proposed which have largely focused on the fairness of resource allocation and burden-sharing across nations (Miketa and Schrattenholzer, 2006; Ringius et al., 1998; Rose et al., 1998). All these studies provide a sound methodological basis for disaggregation of China's energy-saving target among provinces or regions, especially the perspectives and principles developed through equity and fairness arguments. Although the cost-optimization approach, which favors the most cost-effective reduction strategy, has gained relatively low acceptance in international negotiations, it is a very important principle for achieving overall efficiency within a sovereign state. Therefore, the allocation of the intensity target at the provincial level may take into