



Governing energy consumption in China: a comprehensive assessment of the energy conservation target responsibility system

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Abstract

The governance of energy consumption in China is of environmental significance from the standpoints of preventing local air pollution and global climate change. At the heart of China's energy governance system is the energy conservation target responsibility system (ECTRS). This article examines this important governance instrument from three key aspects. First, it explains the role of the ECTRS in China's authoritarian yet decentralized governance system. Second, it traces the development of the ECTRS over the last decade, with a specific focus on the reforms introduced in the 13th 5-Year Plan (2016–2020), particularly the energy caps. Third, it analyzes the limitations of the ECTRS and provides a policy outlook in the context of growing domestic and international interests in energy conservation.

Keywords Energy conservation · Energy policy · Target responsibility system · Energy caps · China

Introduction

China's much-publicized economic miracle is sustained by equally astounding growth in energy consumption. The economy's reliance on industrial growth, especially in the energy-intensive sectors, contributes to China's energy consumption increased from just below 1 Gigatons of standard coal equivalent (Gtce) in 1990 to 4.36 Gtce in 2016 (Fig. 1). China's per capita energy consumption increased steadily from 0.86 tce in 1990 to 3.15 in 2016, although energy intensity, measured by energy consumption per unit of GDP, declined from 1.19 Mtce/billion USD to 0.46 Mtce/billion USD over the same period (Fig. 2). While the pace of growth has slowed recently, energy consumption is likely to increase until at least 2035–2040 to peak at 5.2–5.4 Gtce, with per capital energy consumption projected to peak at 4 tce [1].

The rapid rise in energy demand raises several environmental concerns. China's energy mix remains dominated by coal despite the rapid growth of renewable energy, nuclear energy, and natural gas [2–5]. Coal will continue to be a major component of energy consumption in the foreseeable future [4]. This means that energy consumption in China

has a great impact on air pollution [6–9]. Coal combustion is also the leading cause of China's massive CO₂ emissions, estimated to be at 10.3 billion tons in 2018 (27.8% of the world's total). The increasing role environmental and climate change concerns play in energy governance is reflected in China's changing climate diplomacy, from resisting international obligations to proposing an absolute cap on emissions subject to international measurement, reporting, and verification under the Paris Agreement [10, 11]. Energy security is another key issue—as China's energy demand cannot be covered by domestic sources, the dependency on energy imports from politically unstable regions will grow [12]. In short, driven by domestic interests and international obligations, managing energy consumption has become a policy priority for China [13, 14].

China has adopted a number of energy conservation policies since the 1980s and introduced the Energy Conservation Law in 1997 [15]. However, as China's energy consumption growth rate reached an unprecedented level between 2003 and 2005, during which the country recorded double-digit growth for three straight years, it became clear that a new policy approach was urgently needed [16]. In November 2005, the Politburo announced a mandatory goal of reducing energy intensity by 20% during the 11th 5-Year Plan (2006–2010) [17, 18]. While energy conservation targets were presented in the 9th and 10th 5-Year Plans, those targets were not mandatory [19]. Making energy conservation

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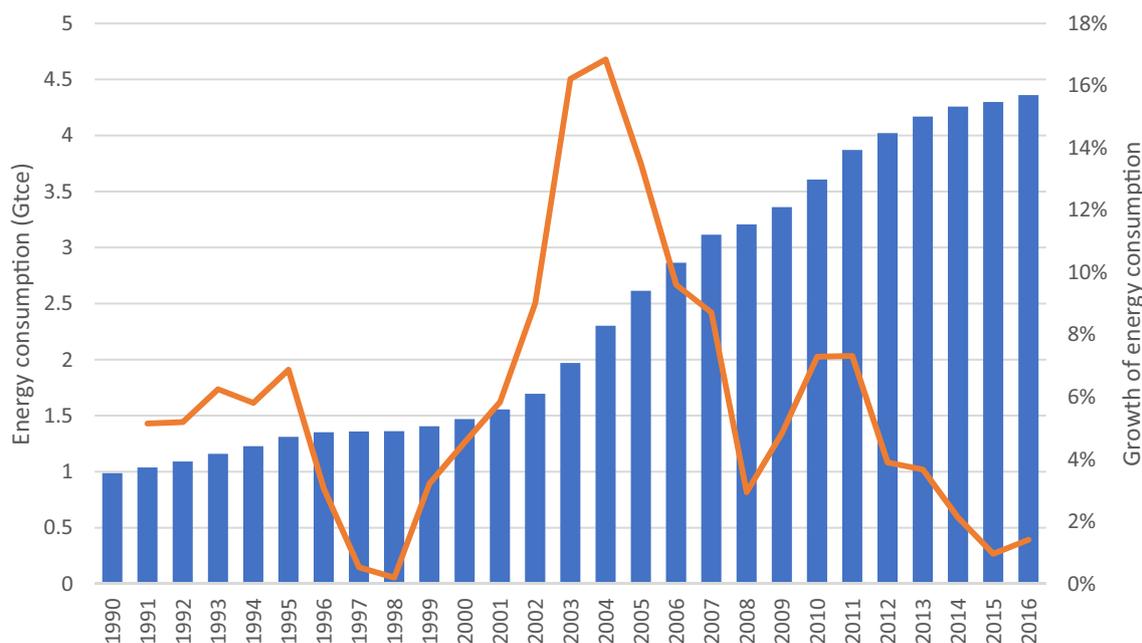


Fig. 1 China's energy consumption and energy consumption growth (1990–2016). Source: National Bureau of Statistics [21]

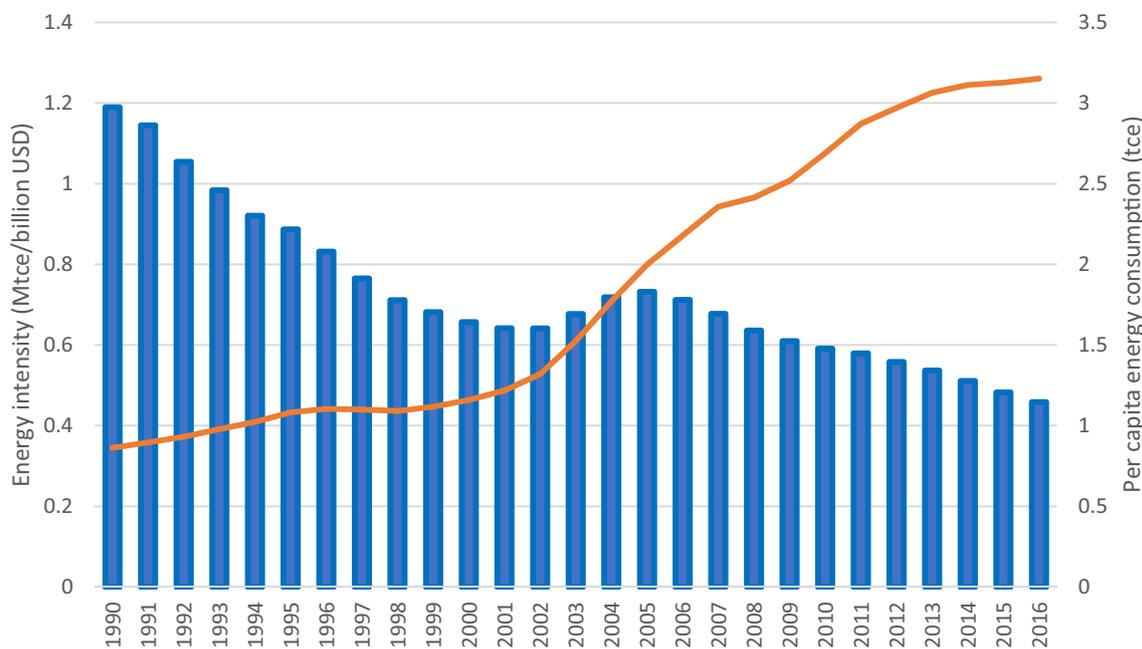


Fig. 2 China's energy intensity and per capita energy consumption (1990–2016). Source: National Bureau of Statistics [21]

a mandatory goal was considered to be of high significance because it signaled the central government's political commitment to take energy conservation seriously [20].

To give teeth to the commitment, the energy targets are incorporated into the energy conservation target responsibility system (ECTRS), wherein the central government assigns specific energy targets for local governments. Given the

heavy reliance on mandatory targets for implementation, a better understanding of how they function is key to an evaluation of China's recent efforts to control energy consumption growth. The aim of this article is to examine the ECTRS in terms of three key aspects: First, it explains the governance problem the ECTRS aims to address through an analysis of the challenges energy conservation efforts present to the

fragmented authoritarian governance structure. Second, it traces the development of the ECTRS from the last decade, with a specific focus on the introduction of energy caps in the 13th 5-Year Plan. Third, it analyzes the difficulties and limitations faced by the ECTRS. This paper concludes with a policy outlook and a discussion of the policy lessons that can be drawn from the Chinese experience.

What are target responsibility systems?

China is an authoritarian and unitary state, and it has often been suggested that the central government plays a dominant role in energy policymaking by formulating many initiatives in renewable energy and energy conservation [17, 22, 23]. However, China's political system is also decentralized in the sense that local governments are responsible for implementing national policies [24, 25]. Consequently, successful implementation depends on the willingness of local governments to carry out central directives. In the area of environmental protection, energy conservation, and climate change, where the interests of the local governments are often limited, the achievement of national objectives cannot be taken for granted [14, 26, 27].

The central government has several ways to ensure its directives are implemented at the local level. First, the government enhances local government support by conducting consultations, which typically results in providing some concessions to local interests. However, this method has its limitations and often results in deadlock, especially in the area of climate and environmental protection when the interests between different layers of government greatly diverge. Second, the government can centralize implementation by taking away local control over the functional ministries, especially regarding their budget and personnel [28]. This, however, has the problem of marginalizing local governments in key areas of energy, which are closely linked to economic development, and may further create conflict between the central ministries and local governments.

The third option is to better align the interests of local officials to the central government by rewarding (or punishing) local officials for achieving (or failing to achieve) top-down objectives. The central government introduced the target responsibility system (TRS) in the 1990s to provide political incentives to induce appropriate behavior [29, 30]. The TRS is an annual performance evaluation exercise of local cadres and has been used by the central government in policy areas of national importance, such as family planning, public security, and, more recently, environmental and climate issues [26, 31]. The TRS has three key features [29]: first, it contains specific and measurable targets that signify to local officials the desires of the central government. Second, it places the responsibility to achieve the targets on

the local leadership (e.g., provincial governors and party-secretaries). Third, it has a so-called “one-item veto” system, meaning that failure to achieve any one of the key targets in the TRS will result in the leading local cadres being penalized, regardless of their achievements in other policy areas.

The ECTRS

The State Council introduced the ECTRS in 2006, incorporating energy targets into its annual performance evaluations [32, 33]. Energy conservation targets that are used to evaluate local officials are at the heart of the ECTRS, but the system has additional requirements than simply meeting the quantified targets. As shown in Table 1, the central government has designed a 100-point system, ranging from meeting energy conservation targets (40 points), to investing in energy conservation (10 points), to promoting energy conservation technologies (9 points). There are four possible outcomes: outstandingly completed (95 points or above), completed (80–94 points), basically completed (60–80 points), or incomplete (below 60 points). Therefore, achieving more than 60 points counts as passing the evaluation. Local governments who fail to pass the evaluation are given 1 month to submit a rectification plan to the State Council and will be followed up on by the National Development and Reform Commission (NDRC). Furthermore, failure to comply with the energy conservation target may incur investment restrictions and disqualification from consideration for annual honors. The government has also established an early warning system. Several times a year, the NDRC announces the progress each province has made in achieving their 5-year targets. Provinces are given red, yellow, or green ratings, with red signaling that a province is seriously behind target, whereas green means they are on track to meet the target. The results are released to the public to increase pressure on local governments.

In the 11th and 12th FYP, the all-important energy conservation target was defined in terms of energy intensity (energy consumption per unit of GDP) [34]. In the 11th FYP, the national target was set as a 20% reduction of energy intensity [35]. This target was subsequently disaggregated into provincial targets, but the process did not go smoothly. The main problem was that provincial targets were highly uniform, with most provinces given a 20% reduction target despite their vastly different local circumstances (Table 2). This leads to concerns over fairness, as well as many mid-plan renegotiations as some local governments found it very difficult to meet the targets [31, 33]. The target allocation process was refined in the 12th FYP. The NDRC established an expert group, headed by the Energy Research Institute (a research institute under the NDRC), to conduct clustering analysis to classify the provinces into five tiers [31].

Table 1 ECTRS evaluation system

Category	Item	Details
Targets (40 marks)	Lowering energy intensity (40 marks)	Up to 40 marks are awarded if the target is met or partially met; no mark is awarded if below 50% of the target is met
Actions (60 marks)	Leadership organization (2 marks)	One mark is awarded for monitoring local energy intensity. One mark is awarded for coordinating energy conservation work, including a clear definition of responsibility and periodical convening of high-level meetings
	Disaggregating targets (3 marks)	One mark is awarded for disaggregating energy conservation targets to lower levels of government, 1 mark for enforcing the targets, and 1 mark for publicizing energy consumption statistics
	Economic restructuring (20 marks)	Four marks are awarded for expanding the tertiary sector, 4 marks for expanding high-tech industry, 4 marks for accessing impacts of investment projects on energy consumption, and 8 marks for successfully implementing the Obsolete Capacity Retirement Program
	Investing in energy conservation (10 mark)	Three marks are awarded for establishing an energy conservation fund, 4 marks for increasing the proportion of expenditure on energy conservation, and 3 marks for implementing major energy conservation projects
	Deploying energy conservation technologies (9 mark)	Two marks are awarded for including energy conservation technologies in the annual technology plan, 4 marks for increasing the proportion of expenditure on energy conservation technologies, 2 marks for organizing demonstration projects of energy conservation technologies, and 1 mark for promoting energy-saving technologies and services
	Managing energy-intensive enterprises (8 mark)	Three marks are awarded for successfully meeting the key energy-intensive enterprises' energy conservation targets, 1 mark for monitoring key enterprises' energy conservation, and up to 4 marks for achieving a 100% compliance rate in energy efficiency standards for new buildings
	Enforcing energy law and regulations (3 marks)	One mark is awarded for implementing the Energy Conservation Law, 1 mark for monitoring the implementation of the law, and 1 mark for implementing energy efficiency standards for energy-intensive products
	Building groundwork of energy conservation (5 marks)	One mark is awarded for capacity building; 1 mark for collecting energy statistics, 1 mark for procuring energy consumption measurement equipment, 1 mark for promoting energy conservation, and 1 mark for rewarding energy conservation actions

Source: [42]

As a result, target allocation under the 12th FYP was more sophisticated, resulting in more diverse targets (Table 2). The overriding principle seemed to follow the international climate law doctrine of “common but differentiated responsibility principle”, where provinces with more capacity bore more responsibility for energy saving [33]. For example, Guangdong and Shanghai, two of China's most prosperous provinces, were assigned a target of 18%, whereas poor inland provinces such as Xinjiang and Qinghai were only given a target of 10%.

Using energy intensity as targets, however, attracted criticism over limiting the effectiveness of the ECTRS as a governing tool. The most significant problem is that improvement in energy intensity does not necessarily lead to a reduction in energy consumption, or even a slowdown of growth [36, 37]. Local governments can freely increase

energy consumption without worrying about the energy intensity target as long as the economy grows at a faster rate, particularly in less energy-intensive areas such as property development and the tertiary sector [38]. Developed provinces were, therefore, able to meet their targets through economic restructuring—deindustrialization and relocation of their energy-intensive enterprises to China's hinterlands [39]. Despite a massive growth in the number of energy-intensive enterprises [40], the inland and less-developed provinces were also able to meet their energy-saving targets because these relocating enterprises not only upgraded their technologies, they also vigorously expanded their production, which contributed to a decrease in energy use per unit [39, 41]. In short, the energy-intensity-based ECTRS contributed to the problem of carbon leakage in China, and despite the energy intensity targets being achieved, they

Table 2 ECTRS targets for 11th–13th FYP

	11th FYP targets (reduction in energy intensity, %)	12th FYP targets (reduction in energy intensity, %)	13th FYP targets (reduction in energy intensity, %)
China	20	16	15
Beijing	20	17	17
Tianjin	20	18	17
Hebei	20	17	17
Shanxi	22	16	15
Inner Mongolia	22	15	14
Liaoning	20	17	15
Jilin	22	16	15
Heilongjiang	20	16	15
Shanghai	20	18	17
Jiangsu	20	18	17
Zhejiang	20	18	17
Anhui	20	16	16
Fujian	16	16	16
Jiangxi	20	16	16
Shandong	22	17	17
Henan	20	16	16
Hubei	20	16	16
Hunan	20	16	16
Guangdong	16	18	17
Guangxi	15	15	14
Hainan	12	10	10
Chongqing	20	16	16
Sichuan	20	16	16
Guizhou	20	15	14
Yunnan	17	15	14
Shaanxi	20	16	15
Gansu	20	15	14
Qinghai	17	10	10
Ningxia	20	15	14
Xinjiang	20	10	10
Tibet	12	10	–

utterly failed to serve the purpose of the ECTRS, which is to control energy consumption.

The 13th FYP and the reform of ECTRS

The year 2016 marked the beginning of China's 13th FYP, which started a new 5-year policy cycle. The 13th FYP is especially important for China's low-carbon transition because it is the first policy cycle to follow the 2015 Paris Climate Change Agreement, where China committed to capping carbon emissions by 2030 [10, 43, 44]. In particular, the introduction of energy caps represents a key reform to the ECTRS, designed to address the failure of energy intensity-based targets in controlling energy consumption growth.

While it is commonly assumed that China's authoritarian system allows for policy expediency and stringency [45], the case of energy caps shows that the policy-making process in China can be protracted due to differing opinions among the ruling elites, either within the central government or between the central and local governments. Official discussions on the need to place an absolute limit on energy consumption began as early as 2007 when the NDRC released the 11th FYP on Energy Development [46]. This plan mentioned that energy consumption should be limited to 2.7 Gtce per year by 2010. However, because of the ineffectiveness of the ECTRS, actual energy consumption in 2010 was 3.61 Gtce, exceeding the 2010 target by 33.7%. The possibility of using energy caps was first suggested in 2010 by the NDRC [47]. In January 2013, the NDRC released the 12th FYP on Energy Development; this contained an energy consumption

target of 4 Gtce by 2015, and more importantly, featured a statement claiming that the national energy cap would be disaggregated, being enforced at the provincial level [48]. However, this target was based on under-estimated energy consumption data from 2010 (3.25 Gtce; later revised to 3.61 Gtce by the National Bureau of Statistics). This under-estimation meant that achieving the 4 Gtce target would have been all but impossible.

Over the 11th and 12th FYP periods, there was limited consensus on the introduction of the energy cap, even within the central government. A forecast-based study entitled “China’s Low Carbon Development Path to 2050” (conducted by the Energy Research Institute under the NDRC) concluded that it was feasible to achieve a 4 Gtce cap by 2020 [49]. However, an article released by the Development Research Center of the State Council called for caution in introducing energy caps because (1) energy consumption is closely linked to economic growth, high uncertainty over economic growth would complicate choosing a suitable energy cap; (2) at the time, there was no consensus between central and local governments regarding the size of the cap; and (3) there was a lack of reliable energy consumption data at the local level, making it difficult to enforce caps [50]. There was a clear concern that an overly generous energy cap might not be meaningful, whereas an overly restrictive energy cap might be resisted by local governments, possibly resulting in data falsification. Furthermore, there is an issue of fairness, as the negative economic impact of energy caps is likely to be concentrated in a few economically underdeveloped provinces [51].

The 13th FYP definitely moves the energy cap system forward. In 2014, the State Council [52] suggested a 2020 goal of 4.8 Gtce in the Energy Development Strategic Plan (2014–2020). However, the finalized target was increased to 5 Gtce by 2020, which suggests that the State Council faced pressure from local governments to relax the limit [53]. Given that energy consumption in 2015 was 4.3 Gtce, the national energy cap allows for an annual expansion of energy consumption of 0.7 Gtce over 5 years. Furthermore, despite earlier speculation that the energy cap was going to be a mandatory target [54], in the end it was only listed as a guiding target. As such, it seems that the introduction of a less ambitious version of energy caps represents a compromise between the need for economic growth and the need to control energy consumption. Target-setting, both at national and regional levels, is very much a political decision, rather than one based solely on scientific evidence.

The 5 Gtce national energy cap forms the basis of provincial energy caps, and all provincial-level governments, with the exception of Tibet, were assigned one (Table 3). The ECTRS evaluation system has been slightly modified to accommodate the introduction of the new targets—provincial governments are now required to fulfill both energy

intensity and total energy consumption targets under the so-called “dual control” approach [55]. Following the practice of the 12th FYP, the poorer inland provinces received more generous caps than the eastern seaboard provinces. Shanghai, for example, was allocated an energy cap of 123.57 Mtce, meaning that its energy consumption can only grow at an annualized rate of 1.7%. Relatively developed coastal provinces received targets between 2 and 3% (Beijing 2.3%, Tianjin 2.5%, Hebei 2.3%, Shandong 2.1%, Jiangsu 2.3%, Guangdong 2.4%). In contrast, inland provinces typically are allowed increases in annual energy consumption above 3%. In particular, Qinghai and Ningxia are allowed to grow at 5.4% and 5.6%, respectively, while Hainan is allowed to grow at 6.8%. Despite being given more generous targets, the energy caps are likely to have more impact on these inland provinces; they now need to closely monitor their energy consumption growth. This shift in policy attention to a carbon- and energy-constrained world is a key attribute of the energy caps.

While energy caps address some of the issues of energy-intensity-based targets, one of the main challenges of the ECTRS remains the enforcement of the cap. Like other components of the TRS, enforcement is primarily based on central inspection and self-reporting. However, both approaches have serious limitations. Central inspection team visits are costly and time-consuming and can thus only happen very infrequently. For the inspection team to have authority, it must be comprised of both energy experts and senior government officials. For instance, the recent round of energy conservation inspection teams, organized by the NDRC, was headed by officials such as the Deputy Director of NDRC’s Resource Conservation and Environmental Protection Division, the Deputy Director of NBS’s Energy Statistics Division, and the Deputy Director of the Ministry of Transport’s Integrated Planning Division. These infrequent and brief inspections typically involve meetings with local officials and site visits to key energy-intensive enterprises. However, because the central government announces the visit at least a few months in advance, the local governments are able to prepare well for these visits.

The central government requires provincial governments to submit a self-evaluation report to the State Council before the end of March every year. However, self-evaluation is highly susceptible to data manipulation [38]. The NDRC publicly acknowledged this problem in a report, stating that there was a mismatch between local and national statistics, which was seriously undermining the attainment of the national energy conservation target [56]. The problem of data manipulation is more common among the less developed inland provinces because they find it more difficult to meet the targets and because their statistical system is less sophisticated [38]. The energy cap is easier to enforce than that of energy intensity, however, because the energy

Table 3 ECTRS provincial energy caps in the 13th FYP

Region	2015 total energy consumption (10,000 TCE)	2020 energy cap (10,000 TCE)	Difference between 2020 and 2015 (10,000 TCE)	Growth across 5 years (%)	Average growth per year (%)
Hainan	1938	2598	660	34.1	6.8
Ningxia	5405	6905	1500	27.8	5.6
Qinghai	4134	5254	1120	27.1	5.4
Xinjiang	15651	19191	3540	22.6	4.5
Fujian	12180	14500	2320	19.0	3.8
Gansu	7523	8953	1430	19.0	3.8
Guangxi	9761	11601	1840	18.9	3.8
Inner Mongolia	18927	22497	3570	18.9	3.8
Yunnan	10357	12297	1940	18.7	3.7
Chongqing	8934	10,594	1660	18.6	3.7
Guizhou	9948	11798	1850	18.6	3.7
Shaanxi	11,716	13,886	2170	18.5	3.7
Jiangsu	8440	9950	1510	17.9	3.6
Jilin	8142	9502	1360	16.7	3.3
Liaoning	21,667	25,217	3550	16.4	3.3
Shanxi	19,384	22,394	3010	15.5	3.1
Heilongjiang	12,126	14,006	1880	15.5	3.1
Hunan	15,469	17,849	2380	15.4	3.1
Henan	23,161	26,701	3540	15.3	3.1
Anhui	12,332	14,202	1870	15.2	3.0
Hubei	16,404	18,904	2500	15.2	3.0
Sichuan	19,888	22,908	3020	15.2	3.0
Tianjin	8260	9300	1040	12.6	2.5
Zhejiang	19,610	21,990	2380	12.1	2.4
Guangdong	30,145	33,795	3650	12.1	2.4
Beijing	6853	7653	800	11.7	2.3
Hebei	29,395	32,785	3390	11.5	2.3
Jiangsu	30,235	33,715	3480	11.5	2.3
Shandong	37,945	42,015	4070	10.7	2.1
Shanghai	11,387	12,357	970	8.5	1.7
Tibet	–	–	–	–	–
China	447,317	515,317	68,000	15.20	3.04

intensity target is based on Gross Domestic Product (GDP), which is notoriously difficult to measure and highly susceptible to data manipulation. Furthermore, the lack of readily observable alternatives makes it difficult to detect said manipulation [57, 58]. Li Keqiang once admitted that “GDP figures are ‘man-made’ and, therefore, unreliable” [58]. The upward adjustment of GDP data by local governments to project a positive state of the local economy for political purposes is common because economic prosperity is considered to be an important sign of competence. This means that energy intensity reporting is also highly unreliable, and more importantly, it is very difficult for the central government to establish its validity. Removing GDP from the equation makes it easier for the central government to enforce energy

conservation. However, more needs to be done to improve the quality of energy data.

An important and ongoing reform in energy data collection is the establishment of a real-time energy system. In 2017, the NDRC and the General Administration of Quality Supervision, Inspection and Quarantine (GAQSIQ) released a policy document entitled “Key energy intensive enterprises energy consumption online monitoring system development plan” [59]. This policy requires all energy-intensive enterprises to install real-time energy meters to all energy consumption devices and to connect this system to a provincial platform where energy consumption data will be automatically uploaded. The provincial platform is required to be connected to a national platform developed and maintained

by the NDRC so that data will be uploaded in real time to the central government. This move can bring benefits to both the enterprises and the government. For the enterprises, the real-time energy consumption data can be used to improve their understanding of energy consumption, improve energy-aware decision-making, and underpin energy-efficient production management practices [60]. For the government, the data provides for more targeted and responsive enforcement of the energy cap, and also enables data-driven policymaking [61]. Furthermore, the central government also intends to use the real-time data to better understand local situations in energy consumption, and to improve enforcement over local governments.

Policy outlook

As an authoritarian country where different levels of governments and state-owned enterprises are embedded in a hierarchical party-state system, top-down control has always featured prominently in China's energy conservation governance [45, 62, 63]. On the one hand, regulations designed to improve energy efficiency follow a top-down structure in that policies are designed by the State Council and implemented by each level of local government [64]. On the other hand, the degree of administrative fragmentation has been significant, and the results of the fragmentation tend to be evaluated negatively [62]. The ECTRS was introduced in 2006 as a "soft" centralization mechanism—providing political incentives for local governments to conserve energy rather than taking away local control over energy management. The 13th FYP has seen the government implement a number of measures to improve the ECTRS. In particular, the new energy caps significantly tighten control over energy consumption growth and make it easier to enforce. Local governments can no longer freely increase energy consumption in their jurisdiction, but instead need to consider the energy consumption implications of their policy decisions. However, whether the new targets are restrictive enough, especially in less developed inland provinces, is a matter of debate, and should be the subject of further empirical research.

Looking forward, 2030—the year by which China has pledged to peak carbon emissions—is fast approaching, and pressure from the international community to control carbon emissions is becoming more and more intense. Recently, the NDRC released the Energy Revolution Strategy (2016–2030), which caps primary energy consumption at 6 Gtce by 2030 [65]. It is, therefore, important to continuously improve the ECTRS to ensure China can avoid a future of carbon-intensive growth. There are a number of measures that could help to achieve this transition from a governance perspective. First, to strengthen control, total energy consumption needs to be

changed from a guiding target to a mandatory target in the 14th FYP. A mandatory target will not only communicate political resolve in controlling energy consumption, it will directly translate to more pressure on local governments, as it means that their targets will also be mandatory. Second, having the right targets is key. There is a need to recognize the political necessity to balance economic and climate objectives, especially the right to develop for the poorer inland provinces. This does not mean that the inland provinces should be given more lenience. Instead, restrictive energy caps should be upheld to place real political pressure on local officials, while at the same time providing developing provinces with more assistance in their economic restructuring and decarbonization. Third, more effort should be put into enforcement, especially in terms of data collection. While the establishment of the real-time energy system has solved some data quality problems, the amount of energy consumption data collected remains limited. Industrial energy consumption only covers energy-intensive enterprises, while that from smaller enterprises is ignored. The collection of transportation, commercial, and residential energy consumption data is even more uneven, and in some cases is based on "guesstimates" [38]. More training is needed, and more resources need to be invested in energy data collection. In the long run, the introduction of an independent energy monitoring agency, the centralization of energy data collection, and the use of big data monitoring could improve the quality of energy consumption statistics and reduce local interference [26, 66]. Last but not least, China's energy governance is undergoing a series of market-oriented reforms, such as the introduction of carbon trading [67, 68] and the adoption of demand-side management in the context of ongoing power sector reforms [69]. These reforms are important to enhance cost-effectiveness and flexibility in energy conservation, and the ECTRS needs to be reconfigured to encourage local governments to embrace market-based reforms. It is also necessary to better align the ECTRS with the national carbon trading scheme. In particular, analyses have shown that much of the efficiency gain from carbon trading will be achieved through interprovincial trading, where provinces with high abatement costs buy quota from those with low abatement costs [70–72]. However, for this to happen, the ECTRS needs to be modified such that energy intensity and energy consumption quotas are made tradable. Doing so will also make the ECTRS more equitable, as funds can be transferred from the eastern coastal regions to the central and west regions where compliance costs are much lower [73].

Policy lessons

China's experience with energy consumption governance through top-down control has broader international relevance, especially for countries in the Middle East and North

Africa (MENA) region, which are facing similar challenges in decarbonization amid rapid energy demand growth [74]. Several important policy lessons can be drawn from China's experience.

At the most fundamental level, China's ECTRS represents a different mode of governance. In contrast to the more commonly studied bottom-up approach to energy and climate governance typically found in liberal democracies [75–82], China is guided by the logic of environmental authoritarianism where the national government drives and coordinates pro-environmental actions in a hierarchical manner. In light of the growing discontent over the lack of effectiveness of neoliberal governance models, there is an increasing interest in whether authoritarian regimes are more capable in environmental stewardship [45, 83, 84]. This study of the ECTRS contributes to this debate by critically and empirically evaluating this “authoritarian advantage”.

At a more practical level, our analysis of the ECTRS illustrates the design considerations that are important for making hierarchical governance works for climate protection and energy conservation. At the heart of the “governing by numbers” approach embodied by the ECTRS are quantified targets such as energy intensity and energy consumption. Targets are important because they channel local actions towards achieving specific goals. However, setting the right targets need to take into consideration the issues of validity, consistency, feasibility and fairness. Validity means that the indicators selected as targets should measure what they are supposed to measure. In this regard, energy consumption is a better indicator of energy efficiency than energy intensity, because energy intensity can improve despite energy efficiency deterioration [85]. Consistency means that the targets should align with targets in other policy realms such as economic development. Inconsistency or even contradictions among targets would put local officials in a difficult position in having to decide which targets are more important [27]. Feasibility is important because targets that are impossible or too difficult to achieve may lead to unintended and undesired consequences. For example, in 2010, a number of local governments that had fallen behind their ECTRS targets initiated drastic and disruptive measures by switching off power stations and limiting electricity supply to enterprises, households, and public facilities (e.g., schools and hospitals) [38, 86]. Fairness and equity are important but often contested issues in target allocation. While every local government must work towards national energy and environmental goals, it is essential to recognize that they come from highly differentiated circumstances, and some have lower ability to control energy consumption due to their industrial structure and/or weak financial capability. Allocating targets that are valid, consistent, feasible, and fair, therefore, requires a thorough understanding of local situation and extent consultation with local authorities.

The evaluation of local performance is another key component of top-down control because it forms the basis of rewarding good performance or punishing non-compliance. A fundamental challenge in evaluation is that of information asymmetry. Collecting accurate and reliable information about local energy consumption is not only a technical or resource issue but also a political challenge over the control of the information collection process. In China, the decentralization of statistical work has created problems of data falsification, thus weakening the effectiveness of top-down control. Therefore, centralizing and investing more resources in statistical capacity building is important for top-down control.

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