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Policy Accumulation in China: A Longitudinal Analysis of Circular Economy Initiatives

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ABSTRACT

In response to the mounting environmental problems the circular economy (CE) has become a popular policy concept to achieve sustainable production and consumption goals (SDG12). In line with this China's national government has issued and implemented a series of policies over the last fifteen years, leading to a sudden increase in the volume of CE policies. In the literature this phenomenon is referred to as 'policy accumulation', a concept which occurs when governments adopt increasingly more policy than they terminate. In the case of China, the question can be raised how CE policy accumulation has manifested. The present paper analyses policy on national policy spanning 2006–2021 and uses expert interviews to gain more insights in factors driving policy accumulation. Results show that after a stable period with limited growth (2006–2015) government issued increasing numbers of policy over 2016–2021. CE policy goals experienced a shift in focus from improving production efficiency via lowering of consumption patterns, to embracing whole life cycle thinking. CE policy instruments moved from predominantly economic instruments (2006–2015) to regulatory instruments along with accompanying communicative and network instruments (2016–2021), which indicates a move from a market and innovation policy approach to a more centralized model emphasizing hierarchical instruments. Several factors explain for CE policy accumulation: (i) a response to economic growth and environmental degradation; (ii) national government institutions, their interests and agendas; and (iii) policy learning. Implications pertain to future research critically analyzing CE policy accumulation in other contexts or in sub-domains regarding topics referring to SDG12.

1. Introduction

Chinese cities have experienced rapid urbanization and industrialization since the 1980s. Meanwhile, a variety of social and environmental problems are associated with urban expansion and growing population numbers, such as growing (regional) disparity between cities (Fan et al., 2011; Wang and Fan, 2004), ecological damage, traffic congestion, air pollution, and mounting piles of waste (Chien and Wu, 2011; Yeh et al., 2015). On the other hand, an increasing number of Chinese cities report about efforts to formulate new (re)development strategies to realize in-depth urban transformation and develop a more sustainable future (Mccormick et al., 2013). In a similar vein, the Chinese central government has proposed sustainable development visions to respond to the aforementioned environmental problems while holding on to high economic growth. These visions are referred to as the "Scientific Outlook on Development", the "Ecological Civilization" and "Beautiful China" (Ma, 2021). In addition, the Chinese government introduced pilot projects in line with the national policies and with the aim to establish sustainable frames for Chinese cities. More specifically, the National Development and Reform Commission (NDRC) proposed a "Circular Economy Pilots" program in 2005. Subsequently, in 2013 and 2015, the NDRC gradually selected 101 cities and counties as "National Circular Economy Demonstration Cities" (NDRC, 2015). In 2019, the State Council issued the concept of the "zero-waste city" in order to introduce a comprehensive management reform of solid waste at the city level (Tong et al., 2018).

One of these sustainability themes pertained to the Circular Economy (CE), which is widely understood as an alternative model of production and consumption, a strategy which theoretically will contribute both to economic growth and sustainable development (Reike et al., 2018). CE focuses on resource flows. Sustainable development

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refers to development in a sense that the needs of the present are met without jeopardizing the ability of future generations to meet their own needs (Corvellec et al., 2022). CE has become an urban transformation pattern toward sustainability, actively advocated by both China's national and local government levels (Dong et al., 2021; Liu et al., 2019). CE could play a key role in achieving sustainability goals (Nikolaou and Tsagarakis, 2021). CE undoubtedly has significant sustainability potential (Velenturf and Purnell, 2021). However, this would require that prices of circular products reach a certain circular premium, which means that the difference between a circular and a conventional product is perceived as justified and is considered affordable by end-consumers (D'Adamo and Lupi, 2021). If consumers are willing to pay more for circular products this may resemble bio-products, for which consumers are willing to pay more than for conventional products (D'Adamo and Lupi, 2021).

CE strategies such as reduce, reuse, recycling, and recover are directly aligned with achieving SDG 12 (i.e., Sustainable Production and Consumption) by employing new technologies and business models, reducing the amount of unsustainable products that are produced and consumed, encouraging sharing and repairing, designing out waste and safely managing toxic substances (Schröder, 2020). Many of the goals (and related indicators) in SDG12 would theoretically be achieved by a transition to handling resources in a more sustainable way – e.g. with regard to improved management of wastes streams, consumption and production - using a "circular economy" (CE) approach (Bernstein and Vos, 2021). On the other hand, the intended outcomes are not always achieved due to negative externalities like the rebound effect, which like energy efficiency rebound effects occur when CE activities (Castro et al., 2022; Colasante and D'Adamo, 2021), which have lower per-unit-production impacts, also cause increased – i.e., unnecessary - levels of production, reducing their benefit, while causing environmental harm (Zink and Geyer, 2017). To avoid these externalities from happening public policy is required to adapt and implement CE strategies in careful yet effective ways.

China's government has issued a sequence of policies to promote and implement CE since the 2000s (Bleischwitz et al., 2022). For example, in 2008, China took the lead internationally in promulgating a CE law and passing it on January 1st, 2009. In contrast, in 2015, the European Commission only adopted its first Circular Economy Action Plan (EC, 2015). To enforce the *Circular Economy Promotion Law*, the *Circular Economy Development Strategy and Near-Term Action Plan* were officially published by the Chinese government in 2013. Relatedly, the Chinese national government introduced a series of CE policies since 2005. During the 13th Five-Year Plan, China's CE had significant impact. For instance, the energy intensity fell markedly, 0.63 tons per unit of GDP in 2015 to 0.55 tons per unit of GDP in 2019 (NBoS, 2021). According to the preliminary calculation of the China Circular Economy Association, the comprehensive contribution rate CE to China's reduction of carbon dioxide emissions was over 25 % (Liu, 2021).

By focusing on policy this paper focuses on both the institutional and social dimension of CE. Recently CE has been criticized for mainly focusing on the economic, physical and industrial dimensions while neglecting the social dimension (Mies and Gold, 2021). For example, as compared with CE, sustainability includes a clear social dimension, focusing on strengthening social justice, social inclusion, the wellbeing of communities, social acceptance and social innovation (Nikolaou and Tsagarakis, 2021). Only recently scholarly attention for social issues has emerged in the CE research domain (Mies and Gold, 2021). The present study contributes to this by focusing on the policy dimension, which inherently addresses the social aspects of acceptance and legitimacy of CE.

Policy strategies and policy instruments play a very important role in constructing CE development patterns (Friant et al., 2021). Policy instruments are not only individually implemented but combined with other policy instruments; i.e., in policy mixes (Givoni et al., 2013). As such, these instruments interact with each other and their dynamics change over time (Rogge and Reichardt, 2016). From 2015 onward, China witnessed a sudden increase of adopted CE policy instruments (Zhu et al., 2019), indicating a "policy accumulation". Policy accumulation refers to a process that governments issue and adopt more new policy than they abolish, leading to a rising volume of policy initiatives (Knill et al., 2020). This happens whenever the rate of policy production (far) exceeds the rate of policy termination (Adam et al., 2019). Thus far policy accumulation has been studied in several policy domains (Chappin et al., 2009), but not yet in the domain of CE. There is a serious shortage of systematic insight in the process of policy accumulation in CE field and its causal drivers, especially in developing countries like China (Bleischwitz et al., 2022). To address this knowledge gap, the following research question is formulated:

Did CE policies indeed accumulate during the 11th, 12th, 13th Five-Year Plan periods, and in 2021 in China (2006–2021), and if yes, how can this process be characterized in terms of the accumulation of policy goals and policy instruments?

To answer these questions, the present study examines the accumulation of relevant environmental policies that contributed to the development of CE in China between 2006 and 2021. We focus on two particular aspects: 1) CE policy goals and 2) CE policy instruments (both as issued by China's national government). While doing this we identify key patterns that spurred the policy accumulation and explore potential explanatory factors. Next to furthering insights on how policy applies to the CE domain the present study provides novel insights into understanding how policy accumulation processes evolve, and which patterns occur in relation to policy goals, instruments and the factors that explain them. In addition, the present study introduces a novel methodological approach to policy accumulation in conducting a longitudinal analysis which has not been performed before.

This paper is structured as follows. Section 2 reviews key literature on policy accumulation, policy mixes, policy goals, and policy instruments. In addition, attention is paid to factors influencing the selection of policy goals and policy instruments. Section 3 explains research design, methodology, data collection, data processing and analytical strategies. Next, Section 4 shows the results of statistical longitudinal data analysis on CE policy accumulation. Section 5, then presents the academic discussion. Finally, Section 6 presents the conclusions, as well as suggestions for future research.

2. Literature Review

To enhance ones understanding of policy accumulation, key literature on this phenomenon is reviewed, also in relation to policy making, policy goals, policy instruments and policy mixes. We present a policy instruments classification framework in the Appendix (See Table A1). Furthermore, factors driving policy making and therefore also (indirectly) policy accumulation are presented in Section 2.2.

2.1. Policy Accumulation

Policy accumulation has been defined as, "the implementation of a number of policy instruments focusing on a specific target group or on several target groups, and aiming to achieve related policy goals in relatively short time periods" (Chappin et al., 2009). Policy accumulation occurs whenever policy makers adopt new rules without abolishing old ones (Knill and Steinebach, 2021). New policies overlap but do not replace or completely wash away the previous ones (Pollitt and Bouckaert, 2011). Policy accumulation can be seen as result of a continuous addition of new policy elements to the existing policy stock without the compensatory reduction of already existing policy elements (Knill and Steinebach, 2021). The process of "policy accumulation" can also be seen as "policy layering" (Thelen, 2004). The process accumulates an increasing number of policy instruments to address an increasing amount of policy goals (Adam et al., 2018).

Policy accumulation is generally conceived as a (ad hoc) political response to rising pressure emerging from societal, cultural, economic, and technological changes (Adam et al., 2019). It can be considered as a process of continuous expansion in the volume of policies. This pertains to increase in policy density, policy layering, and the emergence of complex policy mixes (Knill et al., 2012; Thelen, 2004). In addition, a number of relevant dimensions in policy accumulation have been distinguished, such as growing variation in types of policy instruments, (in)consistencies within or between certain policy mechanisms, temporal aspects, and the clustering of instruments as policy regimes (Chappin et al., 2009). The most dominant development in policy outputs across policy sectors in developed countries is the constant, mostly irreversible accumulation of public policies (Knill et al., 2020).

Policy accumulation relates to the development and growth of policy size and quantity over time (Adam et al., 2019). Policy accumulation then focuses on the aggregate consequences of individual policy developments (van Engen et al., 2016). It can be argued that public policy accumulation has in fact led to substantial improvements in societal domains like public health, social protection and the environment (Adam et al., 2019). However, continuous policy accumulation also increases complexity in policy mixes; newly introduced policies tend to interact with pre-existing policies and although they are officially aimed at specifying, complementing or elaborating previous policies, they often make their effects blurrier and blunter, and may even give rise to unanticipated consequences (Wildavsky, 1989). Unsustainable policy accumulation will undermine feasible implementation of public policy, and undermine sophisticated policy debates within the public arena (Knill et al., 2020).

Adam et al. (2019) discern two core elements that serve as universal units to policy accumulation: (1) policy targets; and (2) policy instruments. Since "policy targets" are seen as more normative in nature than "policy goals" the two are not exactly the same. A policy typically has one or more goals. These goals describe the range of desired outcomes or what is to be achieved by implementing the policy (Howlett and Cashore, 2009). Policy goals can be seen as the intended effects of policy actions taken by relevant policy implementing entities in order to solve or mitigate relevant social and public issues (Howlett et al., 2009). Policy goals define what or who is being addressed by a new policy (Eliadis et al., 2005). In order to work a policy goal should be clear, achievable, future-oriented, and coordinated in the implementation process. For example, policy goals of the European Union's CE Policy Strategy include: reduction in material inputs, and increase in gross domestic product (GDP) due to material cost-saving opportunities (European Commission, 2020).

Policy instruments are used by public authorities to achieve certain policy goals (Howlett et al., 2009). Policy instruments define how the policy goal is being addressed (Eliadis et al., 2005). CE policy instruments, for example, are implemented to promote and achieve the goals of resource-efficient and sustainable use of natural resources while promoting CE. These instruments are classified into different types, i.e., regulatory instruments, economic instruments, network-based instruments and communicative instruments (Ma et al., 2021). In the present study, four types of CE policy instruments are discerned that capture potential differences in the availability and use of government resources and incentive mechanisms (see Appendix Table A1).

The implementation of CE policy and circular practices across European Union (EU) Member States is based on a framework of circular strategies. Formulating policies based on the "R" principles is a prerequisite for obtaining a CE. These principles initially involved the reduction, reuse, and recycling of resources in an economy, a combination which is known as the "3R principles" (Kirchherr et al., 2017; Ranta et al., 2018). These principles have been extended over time by adding the principles of "Recover" (Yang et al., 2017), "Redesign", "Remanufacturing" (Jawahir and Bradley, 2016; Yan and Feng, 2014), "Repurpose", "Refurbish", "Repair", and "Rethink" (Potting et al., 2017). Recycling has been the most widely used circular strategies (Mhatre et al., 2021).

Another concept that is theoretically relevant to understand policy accumulation is "policy mix". Policy mixes refer to more than just a combination of policy instruments, and also include core elements (like goals and strategies), processes, overarching characteristics, and key dimensions that define the context (Rogge and Reichardt, 2016) and change over time (Ring and Schröter-Schlaack, 2011). In a policy mix, each policy instrument individually offers certain benefits and limitations, yet collectively a policy mix can provide synergies and enhance effectiveness for achieving integrated goals and outcomes, that exceed the impact of single policy instruments. Policy mixes typically contain a combination of policy instrument types, assuming that different types reinforce each other (Kern and Howlett, 2009). On the other hand, policy instruments within a given policy mix may also reduce each other's effectiveness or even have detrimental outcomes when there is a lack of (legal) complementarity.

Policy mixes may have transformative potential but only if certain conditions are met. To encourage transformative change both goals and means (i.e., policy instruments) should be new and address sustainable transition, and should be well-aligned with each other, particularly during implementation (Kern and Howlett, 2009). Generally speaking, policy mixes fail to have transformative impact when policy goals and policy instruments are incongruent. For example, when policy drifting or layering takes place, e.g. either the goals or the policy instruments implemented are combined with incumbent or outdated elements, this renders policy mixes as a whole ineffective (e.g., they fail to bring about any impactful transformative change toward CE)(Rogge and Reichardt, 2016).

2.2. Factors Influencing Selection of Policy Goals and Instruments

Factors that influence policy processes (including the selection of policy goals and instruments) to resolve societal problems have attracted growing scholarly attention. They include institutional arrangements, decision makers' preferences, and partisan politics (Capano and Lippi, 2017). Peters (2002) identifies five categories of factors that influence the selection of policy instruments: ideas, individuals, institutions, interests and the international environment. Lesson-drawing from other experiences, learning from the past, emulation, inspiration, competition all can clearly influence decision makers' choices (Gilardi, 2010). Some scholars also claim that the choice of instruments results from the interaction of these different factors (Bressers, 2009). Next to selection of policy goals and instruments decision making itself (including policy making) is influenced by a combination of factors, including their political, economic and environmental contexts (Capano and Lippi, 2017). In the process of selecting policy instruments, policy makers need to deal with uncertainty, technical complexity, political salience, conflicting values, interests, preferences, coalitions and legacies by designing a solution within a specific institutional context. To ensure a policy can effectively be implemented and goals be attained, it is important that the choice of policy instruments be accepted by key stakeholders, in particular the public, and specific target group(s) (March and Olsen, 2004). Knill and Steinebach (2021) argue that crises can typically be considered as a driver for policy accumulation.

3. Methodology

A longitudinal case study research approach was chosen using a systematic review and analysis of (online) policy documents to analyze policy accumulation of CE in China during the year 2006–2021. In the next sections, operationalization, data collection, data treatment and analysis are presented.

3.1. Operationalization and Data Collection

As indicated in Section 2, policy goals and instruments are considered as the central elements of policy accumulation (Adam et al., 2019). Therefore, the analysis in the present study focuses on policy goals and policy instruments. Table 1 shows the operationalization of key theoretical concepts. This concerns a novel approach to operationalization and measurement of policy accumulation that was developed for the present study, and it has not been used in other academic-empirical work.

The accumulation of the CE policy between 2006 and 2021 was traced by five-year increments. Policy documents were collected from the *China Association of Circular Economy* database (CAoCE, 2022) and the *pkulaw* database (PKULAW, 2022), which summarizes China's CE policies at the national-level, including the CE policies which were published by China's State Council, the National Development and Reform Commission (NDRC), the Ministry of Ecology and Environment (MEE) and other relevant ministries. In China, the national government is the main policy-making body in CE governance. Therefore, the search was limited to national policy documents. Chinese national circular economy policy documents from 2006 to 2021 were examined to identify relevant policies. The terminated and modified policies are presented in the Appendix (Table A5). This period captures a sufficient period of time in which CE policies were released. In total, a database of 285 CE policies was composed.

To identify what policy goals and policy instruments are used in CE policies, policy documents were reviewed. First, all titles and keywords of policies and documents were reviewed and scanned to find CE policy goals. Table A4 (See the Appendix) shows the identified policy goals in the data collection. As a second step in the data collection, the CE policy instruments framework as described in Section 2.1 and Appendix Table A1 was used to identify the frequency of different types of CE policy instruments in each policy. Specifically, the full texts of policies were screened and the descriptions of the application of CE policy instruments in each policy were recorded. For example, in 2020, the Ministry of Finance issued the *Notice on Improving Fiscal Subsidy Policies for the Promotion and Application of New Energy Vehicles*. The goal of this policy is to 'promote new energy vehicles', and the policy instrument is 'Subsidies'. Some policies involve the use of multiple policy instruments. All of them were recorded in the present study.

Besides, relevant text documents were collected and reviewed, including national economic and social development plans, media articles, and academic publications, to understand the mechanism of CE policy making and the drivers of CE policy accumulation.

From March 2022 to May 2022, additional semi-structured interviews (See Appendix Table A3) were conducted with experts in the fields of public policy, CE, industrial ecology, and waste management in China. They were consulted at local universities and research institutes as well as environmental departments with regard to their knowledge about the mechanisms behind CE policy making and the principles of CE policy accumulation, and to verify the accuracy of the findings. In total, eight expert interviews were conducted.

The classification of policy instruments (See Appendix Table A1) is also used in other domains of environmental policy, such as low carbon city development (Goulder and Parry, 2008; Halpern, 2010; Ma et al., 2021). This classification consisting of policy goals and policy instruments has not been used in the study of CE policy accumulation and related topics. The data collection and operationalization applied in the present study can also be used to gain more knowledge on policy accumulation, such as low carbon policy evolution and accumulation.

3.2. Data Treatment and Analysis

In line with China's FYP cycle for national economic and social development, policy documents were clustered into four different periods between 2006 and 2021 (i.e., the 11th FYP: 2006–2010; the 12th FYP: 2011–2015; the 13th FYP: 2016–2020, and 2021). For each period, policy documents were coded based on two elements, i.e., policy goals and policy instruments.

First, the goals of each policy text were analyzed. In this way, understanding was gained of specific environmental problems or focus being addressed by each CE policy. The changes of policy goals are presented in Fig. 2 and analyzed in Section 4.2. Next, the CE policy instruments used in each policy were coded manually, such as subsidies, tax incentives, prices, green loans, regulations, supervision, accountability, community participation, public-private participation, environmental information disclosure, or education and persuasion in the policy documents. The classification framework for CE policy instruments was used (See Appendix Table A1) to map the use of policy instruments over the four different periods. An Excel spreadsheet was used to record the information. After collecting and coding the relevant policy documents data were analyzed, mainly using descriptive statistics and by interpreting longitudinal trends. Results of the data analysis are presented in Section 4.3.

While dealing with the interview data, the interviewees' answers to the questions regarding reasons for policy accumulation interpretive qualitative data analysis was applied. The interviews were conducted for two reasons, Firstly, to validate the longitudinal (statistical) trend analysis. Secondly, to address issues of policy accumulation for which no statistical data was available, notably policy congruence (on the relation between goals and instruments), drivers for policy accumulation, and impact. This led to establishing a more comprehensive and

Table 1
Operationalization, measurement and related data collection.

	Indicators	Data collection	Focus
Policy accumulation	Number of circular economy policies.	Calculate the number of circular economy policies.	The changes of the number of circular economy policies (2006–2021; subdivided into the 11th, 12th, 13th FYPs, and 2021).
	Accumulation of policy goals (i.e. number of policy goals; policy focus of policy goals).	Check titles and keywords of circular economy policies.	The number of circular economy policy goals over 2006–2021 (and subdivided into the 11th, 12th and 13th FYPs, and 2021). The changes of CE topics.
	Accumulation of policy instruments (i.e. number of policy instruments).	Use the circular economy policy instruments framework (Appendix Table A1) to collect data.	The number of circular economy policy instruments over 2006–2021, subdivided into the 11th, 12th and 13th FYPs, and 2021).
		Scan and record the use of circular economy instruments in each policy.	The number of policy instruments in each policy (policy density) over 2006–2021, subdivided into the 11th, 12th and 13th FYPs, and 2021). The diversity of circular economy instruments used in each policy (the shift in types of policy instruments over 2006–2021).
	Policy accumulation in a broader sense, i.e., congruence, driving factors, impact.	Interviews with experts and policy-makers.	Mutual relations between policy goals and instruments (i.e., policy congruence). Factors driving circular economy policy accumulation. The impact of circular economy policy accumulation on China's transformation.

grounded understanding of the policy accumulation of CE. CE policies proposed by various government departments were coded and sorted out to understand what kinds of policy instruments are used and what kinds of circular economy goals commitment was awarded to.

4. Results

Fig. 1 shows the main events in the CE policy domain in China from 2005 to 2022. It presents the CE policy progress within the scope of each of the four different periods analyzed. In this section CE policy accumulation is presented in terms of policy goals, policy instruments and policy mixes, and the pattern of China's CE policy accumulation and its driving factors will be addressed.

4.1. Accumulation of Circular Economy Policies

Fig. 2 shows the number of CE policies adopted by China's national government in the timeframe 2006–2021. The number of CE policies adopted in the 11th, 12th, 13th FYPs and 2021 was 15, 22, 165, 83, respectively, indicating a substantial growth over time. Arguably, there was a period of relative stasis from 2006 to 2015. However, from 2016 on, a sudden increase in policies adopted occurred. More specifically, there were 58 CE policies adopted in 2020 alone. This trend continued into 2021. An obvious explanation for this vast increase would be that China's national government started to pay significantly more attention to CE development and environmental protection as per 2015. In summary, results of the longitudinal analysis show that China's CE policies experienced a rapid policy accumulation process in the third of the last three FYP periods and continue to increase into the early 14th FYP (i.e., 2021). Here, it also makes sense to compare the increase of policies following adoption by the central government as compared to policies that were terminated (See Appendix Table A5 for an overview of the latter). The initiation of new CE polices is higher than the termination of CE policies.

4.2. Accumulation of Circular Economy Policy Goals

Fig. 3 shows the accumulation of policy goals for CE from 2006 to 2021. The number indicates the number of CE policy goals on this subject. In Fig. 3, from 2006 to 2010, the national government mainly

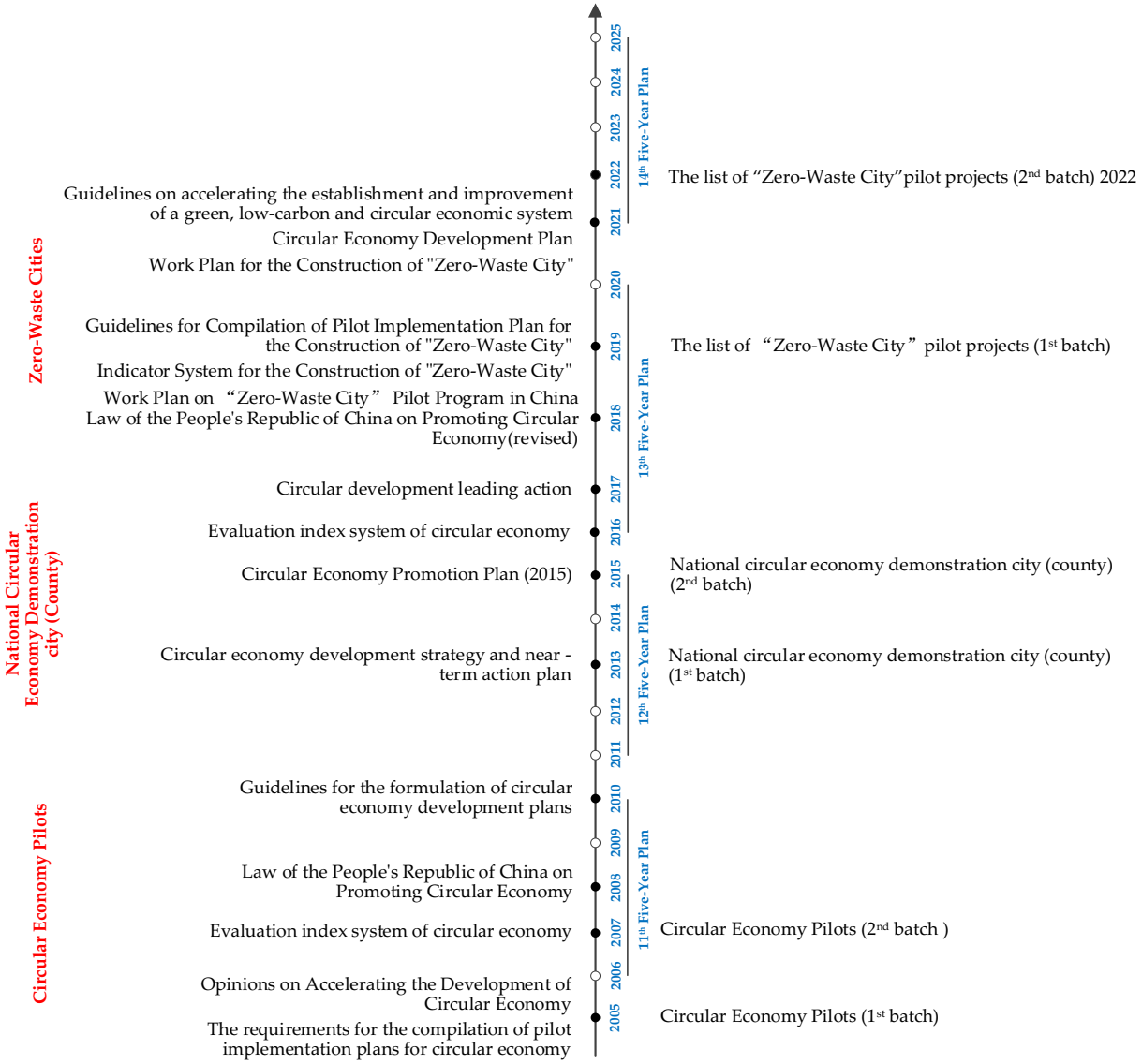

Fig. 1. Key events and programs for circular economy in China (2005–2022).
Note: Key Laws, Plans and Policies are presented on the left of the Y-axis. Circular economy pilots at different stages are presented on the right of the Y-axis.

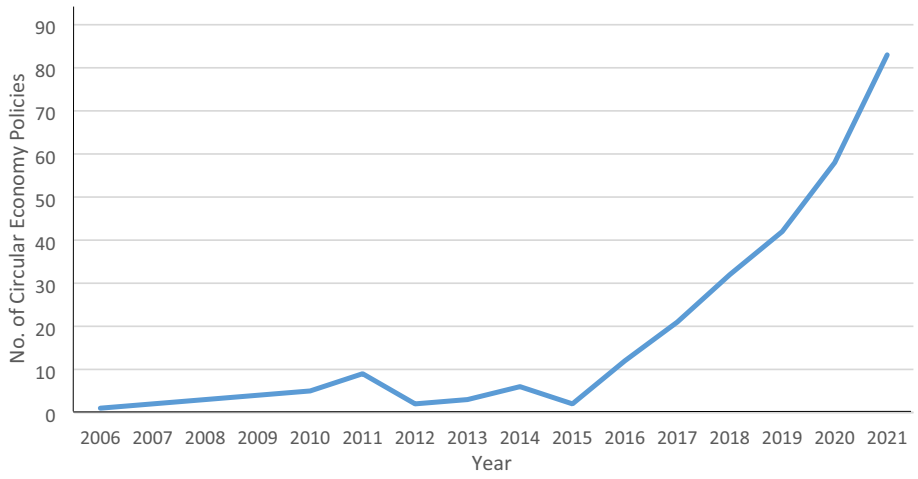

Fig. 2. Longitudinal overview of Circular Economy policies adopted by central government (2006–2021).

addressed CE in terms of stimulation through efficient lighting, energy conservation and reduction of carbon dioxide emissions, trade-in of automobile and home appliances, energy management of industrial enterprises, clean production, utilization of agricultural residues, remanufacturing industry development and elimination of backward production capacity. Within this period the main strategies used are "reduce" and "remanufacturing". These end-of-use strategies, such as reduce, reuse, recycling, remanufacturing, repair, indicate the implementation of circular strategies (Geissdoerfer et al., 2020). CE laws and standards were introduced at this stage, for example, the *Law of the People's Republic of China on the Promotion of Circular Economy* was adopted by the Standing Committee of the 11th National People's Congress of the People's Republic of China in 2008 and implemented since 2009. In 2007, the NDRC issued the "*Evaluation Index System for the Circular Economy*".

Although the number of policies did not increase significantly from the 11th FYP to the 12th FYP, the goals involved in CE policies were elaborated a bit during the 12th FYP period. The analysis shows that from 2011 to 2015, the national government still focused on energy conservation and clean production, while proposing the concept of comprehensive utilization of industrial and agricultural waste. Savings from energy and consumption, developing environmental protection industry and resource utilization became the important policy goals in this period. The national government also proposed constructing ecological demonstration zones and sponge cities during this period. The latter refers to framing cities and their infrastructures as sponges absorbing rainfall, a metaphor emphasizing their adaptative capacity to cope with extreme weather conditions (e.g., heavy precipitation) (Spacey, 2016). The "reduce" and "recycle" strategies were mainly used in the 12th FYP.

In total, 165 CE policies were adopted in the 13th FYP with energy conservation and management, clean production and consumption remaining the central goals. However, other policy goals like ecological protection, pollution control, resources recycling and ecological restoration began to attract attention. New concepts, such as "ecological civilization", "zero-waste city", and "beautiful China" were used at this stage. The vision of green development was applied in different fields production and consumption, including green manufacturing, green production, green consumption, green building, and green packaging. In the 13th FYP, the national government published more control measures, which involved more domains of pollution control. The national government also introduced more policies to deal with different kinds of waste and garbage sorting, such as toxic waste, sewage, industrial solid waste, medical waste, construction waste, agricultural waste, and livestock waste. This indicated policy making toward a more comprehensive design (Zhu et al., 2019). Within the 13th FYP, the types of CE strategies showed more variation, including ecological restoration and carbon dioxide emission reduction at the source. The most widely applied CE strategy in this period was resource utilization and recycling.

Many of the policy goals of the 13th Five-Year Plan period were carried over to the next period, starting in 2021, causing even more policies to be proposed. At the same time the concept of green development received more structural attention and was applied to various subdomains and industries, including green agriculture, green manufacturing, green shopping malls, and green low-carbon transformation. This was also true for high-quality development and water conservation. Dominant concepts in CE policy pertained to carbon peaking and carbon neutrality. CE strategies often used in 2021 were "Reduce", "Recycling" and "Ecological Restoration", a very common in the 13th FYP the term of which began in 2021.

4.3. Accumulation of Circular Economy Policy Instruments

4.3.1. Changes in the Number and Density of Circular Economy Policy Instruments

The number and density of CE policy instruments are as shown in Appendix Table A2. The number of CE policies increased slightly from the 11th FYP to the 12th FYP, but the density of policies (i.e., policy instruments per policy) changed more drastically. Only a small number of policy instruments was used since the 11th FYP period. A rising number of policy instruments was used during the 12th FYP. This was observed among legal, network and communication instruments, which strongly increased while the density of economic policy instruments decreased slightly. From the 12th FYP to the 13th FYP, the number of all types of policy instruments increased significantly, but the density of legal, economic and network policies decreased, while the density of communicative instruments did not change much. This can be explained by the large number of policies in the 13th FYP, causing a decrease in the density of policy instruments. In 2021, the density of legal, economic and communicative policy instruments increased dramatically. It shows that all types of policy instruments analyzed were widely used over this period, especially communicative policy instruments, but legal policy instruments were more commonly used than economic policy instruments.

4.3.2. Changes in the Diversity of Circular Economy Policy Instruments

Fig. 4 presents the longitudinal shift and accumulation of CE policy instruments in the period 2006–2021. Results show that CE policy instruments increased suddenly as per 2016. In 11th FYP and 12th FYP,

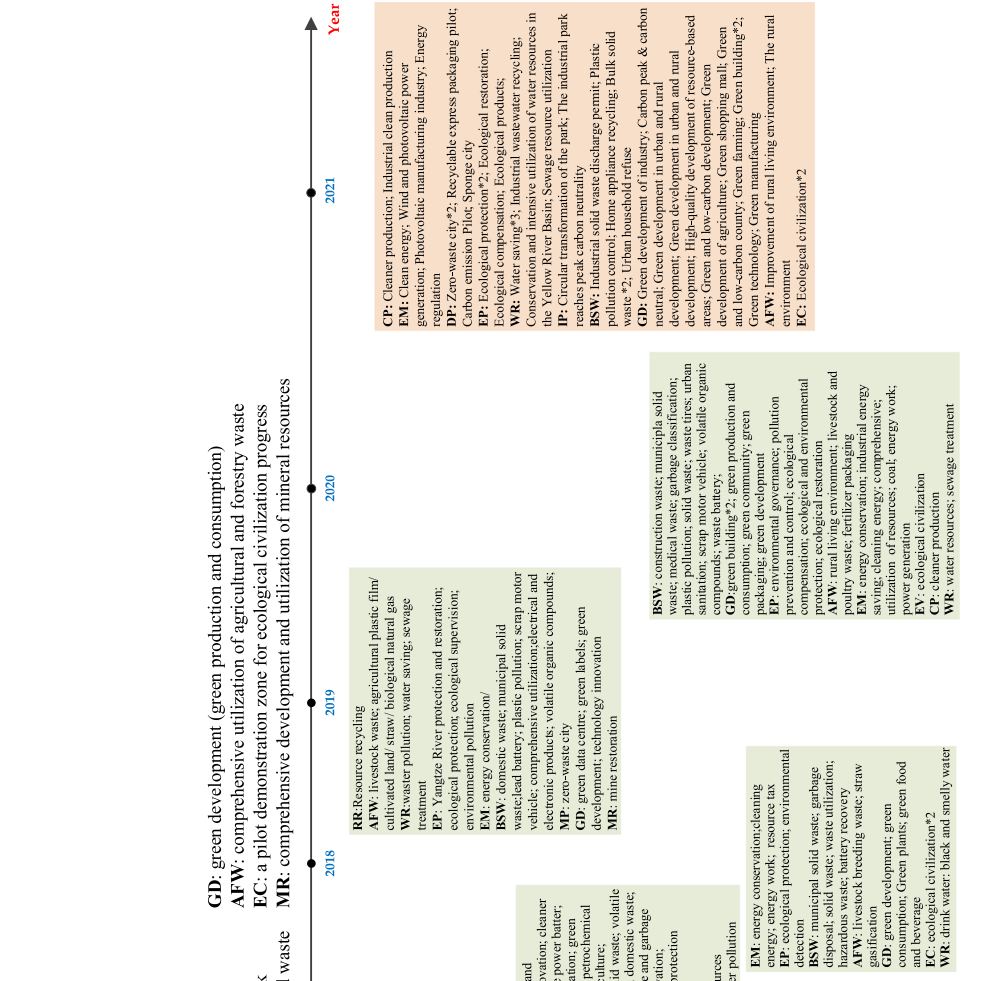

Fig. 3. The accumulation of policy goals for Circular Economy in China.

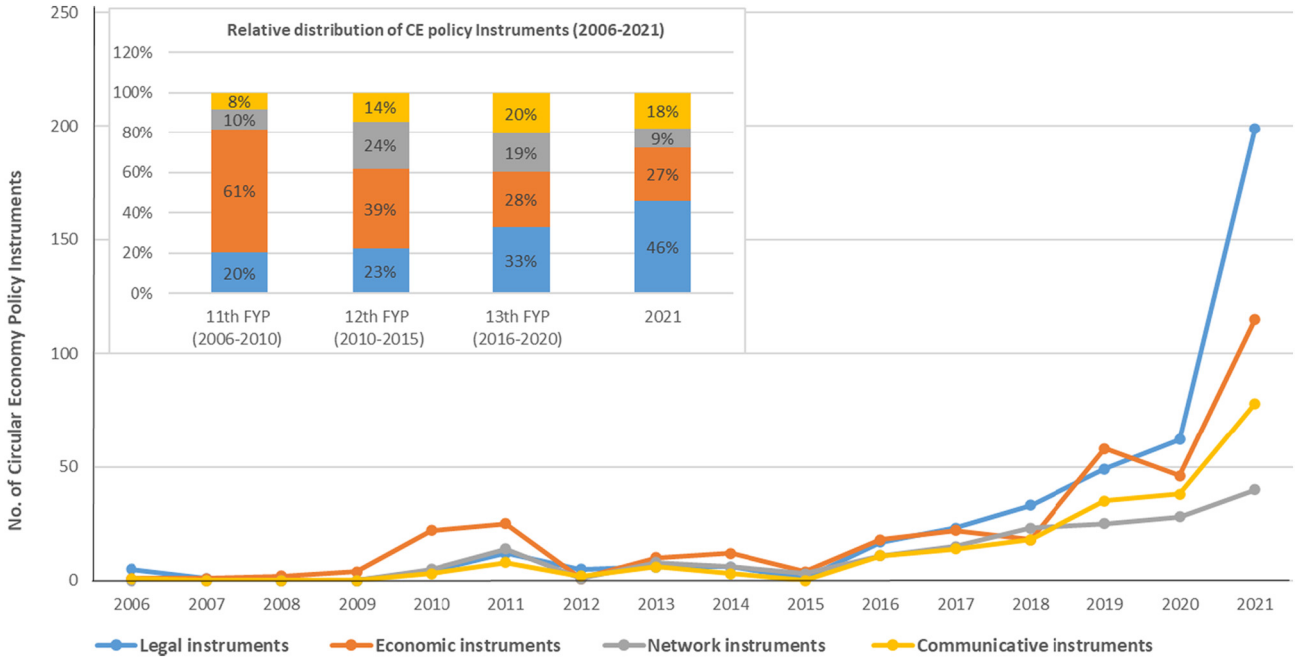

Fig. 4. Adoption of Circular Economy (CE) policies over 2006–2020, classified per type of policy instrument.

economic policy instruments were issued fairly frequently. During the 13th FYP, the number of legal, network and communicative policy instruments increased a lot. Table 2 presents the enactment of policy instruments and changes at the national government level from 2006 to 2020. In Table 2, the numbers behind the policy instruments refer to the number of CE policy instruments applied in each stage. A diverse set of policy instruments was proposed during the 13th FYP period and in 2021.

Table 2
Overview of number of policy instruments adopted in the three FYPs and 2021, classified per type of policy instrument.

	Legal policy instruments	Economic policy instruments	Network policy instruments	Communicative policy instruments
11th FYP	Target responsibility system (energy consumption index): 2 Amend the Energy Conservation Law: 2 Supervision 2 Elimination of backward production methods: 1 Circular economy evaluation index system: 1 Penal law; several types of sanctions: 1	Guide private investment (i.e., eto, encourage investment projects): 7 Pricing: 6 Subsides: 5 Green loans: 4 Tax incentives: 3 Government grants: 3 Government Procurement: 2	Coordinate and cooperate with relevant departments: 3 Encourage the participation from industrial associations, intermediary organizations and research organizations: 1 Promote the cooperation between enterprises and financial organizations: 1	Exhortation and education: 2 Open government data: 1 Public information campaigns: 1
12th FYP	Supervision: 8 Industrial standards: 8 Target responsibility system: 7 Laws and regulations: 5 Environmental regulation: 2 Assessment: 1 Punishment: 1	Taxation: 14 Grants: 10 Pricing: 6 Investment: 4 Government procurement: 6 Loans: 5 Subsidies: 4 Garbage disposal fee: 1 Financing: 2	Coordination among departments: 13 International communication and cooperation: 5 Public-private participation: 5 Introduce the participation of industry associations: 4 Forming a joint working force or joint meetings: 2 Strengthen organizational leadership: 2 Public-Public participation: 1	Public information campaigns: 7 Exhortation and education: 8 Demonstration projects and base: 3 Establish information platforms: 1
13th FYP	Supervision: 65 Regulations: 52 Responsibility: 31 Standards: 19 Performance measurement: 7 Assessment: 7 Punishment: 1 Pollutants discharge licence: 1	Funds: 41 Subsidies: 27 Tax incentives: 21 Diversified investment and financing: 12 Government procurement: 1 Disposal fees: 7 Emission trading market: 5	Public-public participation (strengthen the participation or cooperation of relevant research institutions, industry associations): 14 Public-private participation: 14 Encourage general public participation: 12 Establish a coordination mechanism: 62	Public information campaigns: 47 Exhortation and education: 34 Information sharing: 30 Organizing consultation and guidance sessions: 3 Demonstrate base: 2
2021	Supervision: 69 Responsibility: 39 Laws and regulations: 35 Standards: 29 Assessment: 15 Performance measurements: 12	Diversified investment and financing: 25 Tax incentives: 20 Grants: 20 Subsidies: 15 Price: 13 Emission trading market: 10 Disposal fees: 1 Government procurement: 1	Departmental coordination 25 Public-public participation (strengthen the participation or cooperation of relevant research institutions, industry associations): 9 Establish a coordination mechanism: 4 Encourage general public participation: 1 Private participation: 1	Exhortation and education: 23 Public information campaigns: 21 Demonstrate base: 16 Information sharing: 13 Organizing consultation and guidance sessions: 5

The number of policy instruments adopted in the 11th FYP was lower than in the 12th and 13th FYP. In the 11th FYP, the national government implemented some traditional environmental policy instruments. For example, regulatory instruments were implemented to eliminate backward production capacity. At the same time, the national government used subsidies to support the energy savings, provide dedicated or earmarked funds to support cleaner production, and apply financial measures to support energy conservation and emission reduction. National government also encouraged commercial enterprises and households to achieve energy savings in electricity use. In this period, more economic policy instruments were used than regulatory ones. A plausible reason for this is that in the early stages of CE policy making, the national government tended to focus a lot on economic incentives, such as helping companies reduce costs and improve production efficiency (Interviewee 8). Moreover, economic policy instruments were easily accepted by companies at that time, and therefore warranted a smoother implementation process (interviewee 1; 5). Enterprises can benefit from the circular economy, through improving production efficiency and reducing production costs.

Compared with the 11th FYP, China's national government formulated more industry standards and adopted more regulatory policies in the 12th FYP. More tax incentives and earmarked government funds were used to stimulate CE. However, at this stage, economic policy instruments were still the most frequently used type of policy instrument by the national government. At the same time, the number of regulatory, network and information policy instruments underwent a stable increase. More specifically, the national government invested a large amount of earmarked funds in CE development, environmental science and technology, and encouraged comprehensive utilization of resources with preferential tax policies. Moreover, a subsidy mechanism for recycling waste was established. At the same time, the central government also sought to continuously improve the legal system pertaining to CE. For example, in 2011, it promoted the legislative process of the *Regulation on the Comprehensive Utilization of Industrial Solid Waste and Resources*. Some technical and industrial standards and specifications for clean and efficient utilization of coal in coking, industrial furnaces, coal chemicals and industrial boilers were formulated, such as energy consumption quotas and pollutant discharge standards. Industry associations and other intermediaries as well as experts also started to play more important roles in encouraging CE. Overall planning and coordination in 'ecological civilization construction' were encouraged and strengthened. Various publicity channels were adopted to publicize and implement CE policies. Business enterprises (e.g., catering enterprises and relevant business firms in the waste sector) and residents were encouraged to adopt and enjoy the benefits of sustainable production methods and green living patterns. Some communicative measures were promoted, including using the products with comprehensive utilization of resources, reducing the production and consumption of disposable products, limiting excessive packaging of goods, and creating a good atmosphere for participation of broad segments of society at large.

In the 13th FYP, plenty of CE policies and policy instruments were issued and implemented. In this period, considerably more regulatory than economic policy instruments emerged. Central government adopted a lot of regulatory instruments to enforce environmental supervision and control and incorporated environmental assessment as part of the local performance assessment system. This period was also marked by the further introduction and implementation of industrial standards and rules for allocating responsibility and liability to promote cleaner production. The government strengthened supervision over polluters and vigorously regulated their emissions. In addition, environmental governance was connected with local performance measurement, which was implemented locally, with local officials being held accountable whenever things went wrong. The CE Promotion Law was revised in 2018. More laws were introduced during this period, including "Pollutant Discharge Permits", "Regulations on the Administration of Comprehensive Utilization of Industrial Solid Waste Resources". To build CE, the national government dedicated earmarked funds as mechanisms for ecological compensation, including a marine ecological restoration fund, a clean energy development fund and a pollution prevention and control fund. By doing this the national government advocated green procurement, introduced diversified investment and financing channels and implemented relevant preferential tax policies. The 13th FYP also marked increased implementation of network-based measures and actions. The government proposed to strengthen departmental coordination in green energy and promoted coordinated development of the whole industrial chain. Besides, participation and cooperation of research institutions, industry associations and enterprises were encouraged. The 13th FYP saw private sector actors becoming more involved in CE, including farmers. The national government emphasized disclosure of environmental protection information. It comprehensively used media channels, such as TV, newspapers, the internet, and radio for media campaigns to persuade citizens to adopt green products and adopt green life-styles. It also stressed

Table 3
Circular Economy (CE) policy accumulation patterns (2006–2021).

	Changes in policy goals	Changes in the types of policy instruments used			Characteristics of the policy mix used
	Policy focus; policy goals	Number of policy instruments	The types of policy instruments	Changes during the five-year plan period	
11th FYP	Cleaner production; eliminate outdated production methods and practices.	Less policies and less instruments.	Pre-dominant economic policy instruments.		A policy contains typically only one goal and one instrument.
12th FYP	Consumption conservation; environmental protection; energy protection; energy savings.	Less policies and more instruments; high density of policy instruments.		*From 11th FYP to 12th FYP:* The number of policies and policy instruments increased slowly.	Some comprehensive policies are proposed (and introduce action plans and guidelines). A policy mix contains multiple types of policy instruments.
13th FYP	Green development (green manufacturing, green production, green consumption, green building, green packaging); resources recycling; ecological restoration; garbage sorting; waste disposal (agricultural waste; medical waste, domestic waste; construction waste, industrial solid waste; hazardous waste).	More policies and more policy instruments.	The number of legal policy instruments exceeds that of economic policy instruments. The number of network and communicative policy instruments issued increases.	*From 12th FYP* via *13th FYP to 2021:* The number of policies and policy instruments increased rapidly.	Policies or policy goals relate to resolving a vast amount of environmental governance issues. Policies contain multiple goals and topics, which are fairly detailed. Multiple policy instruments are used in one policy package.
2021	Green development (high quality development; green-low carbon; green farming); Carbon peak and carbon neutrality; Ecological protection; Water saving.				

the importance of energy conservation and environmental protection, such as water conservation education.

In general, 2021 shows continuation of the trend started in the 13th FYP, with increase in the number of all types of policy instruments, but in particular regulatory instruments, with the latter and economic policy instruments being pre-dominantly used. However, in comparison to the 13th FYP there is one noticeable exception: a sudden increase in the number of economic policy instruments adopted, albeit in absolute number, not in relative ones.

4.4. China's Pattern of Circular Economy Policy Accumulation

Table 3 shows the pattern of China's CE policy accumulation and the main findings in this paper. Some policy goals were proposed in the 11th FYP and continued to undergo implementation into the next FYP. For example, utilization of straw resource, energy conservation and emissions reduction and comprehensive utilization of different types of waste were proposed in 11th and 12th FYP, with more policies embracing these goals being implemented in the 13th FYP. CE as a policy goal shifted from a focus on improving production efficiency via lowering consumption levels, to adopting a whole-life cycle perspective (Interviewee 1). However, increasingly diverse and detailed policy goals and targets were proposed during the 13th FYP and in 2021.

The number of CE policies increased steadily from the 11th FYP to the 12th FYP, and further accumulated from the 12th FYP to the 13th FYP. However, the density of policy instruments during the 12th FYP period was greater than that during the 11th FYP period. With regard to the numbers of policy instruments, a dramatic increase was witnessed during the 13th FYP. When looking into type of policy instrument used it can be observed that during the 11th FYP and 12th FYP, economic policy instruments predominated. This differs from other environmental policies which traditionally rely on regulatory instruments. CE policies have widely applied economic instruments from the very beginning (Zhu et al., 2019). To ensure that both reducing environmental degradation and maintaining economic growth remain within reach. However, during the 13th FYP, the number of legal policy instruments exceeded that of economic policy instruments. That same FYP also witnessed increased use of network and communicative policy instruments. More in general, policy instruments were applied more widely. In terms of CE policy overall, policies mostly contained only one goal and one instrument during 11th FYP, whereas CE policies became more comprehensive during the 12th FYP, with policy mixes containing multiple types of policy instruments. In the 13th FYP, policies typically consisted of multiple topics and targets with multiple policy instruments. The trend of CE policy accumulation in the 13th FYP period largely continues into 2021. When regarding the overall pattern of policy accumulation in China's CE, policies were applied to new sectoral sub-domains. As a consequence, there were more subdivisions, in particular with regard to the composition of policy instruments.

4.5. Factors Influencing Policy Accumulation

Expert interviews revealed several factors accounting for CE policy accumulation: (i) response to economic growth and environmental degradation, (ii) institutions and interests, and (iii) policy learning. The first type of factors pertains to China's impressive economic growth, its environmental impact, and the government's response to this. China's economic development had reached a stage where its government began to pay attention to environmental protection and efficient use of resources (Interviewees 1, 5, 6). At the same time China had increased its governing capacity to implement environmental policies. During the 11th FYP, the Chinese government encouraged rapid economic development, whereas steady economic growth was emphasized in the 12th and 13th FYP. During the 13th FYP (Interviewee 6), policy goals did not only address decreasing environmental degradation (by lowering emissions of pollutants), but also concerned establishing a more livable and sustainable country, in which CE was considered a necessary requirement, and (even) perceived as the basic pathway toward development of an ecological civilization (Interviewees 2, 7). Moreover, CE was accepted as a fundamental pillar of national economic policy (Bleischwitz et al., 2022).

Secondly, the issuance, adoption and implementation of China's policies toward achieving CE goals were driven by multiple state actors (Zhu et al., 2019). It can be stated that both the policy agendas of these organizations themselves and institutional alignment with strategic national agendas drove them to issue growing volumes of CE policy. For example, CE policies were issued in line with the national policy paradigms adopted in the 12th and particularly in the 13th FYP (Interviewee 5, 7). During the latter period this went hand in hand with several national government ministries and committees issuing growing numbers of CE policies, in accordance with their respective tasks and responsibilities, but arguably also in competition with each other since all of them vied for attention and aspired to take the lead in promoting "ecological civilization" (Interviewee 5).

Third, dedicated policy learning occurred and fueled CE policy accumulation with the Chinese government actively encouraging students and academic researchers to travel to developed countries and obtain a great deal of insights into CE practices, policies, environmental governance, experiences and skills (Interviewee 1, 7). To improve formulating environmental policies, China adopted insights from other countries like Germany (e.g., policy to cope with lead, black and odorous water, and industrial pollution control; Interviewee 1), and Japan (e.g., its 3R policy - reduction, reuse, recycle -), as well as insights on encouraging industrial ecology (Bleischwitz et al., 2022). In addition, international cooperation projects were set up, such as Eco-Industrial Parks and the International Shenzhen Low Carbon City, etc. Here, the focus was mainly on the use of the energy-saving technologies and lean production strategies adopted from international business partners (Huang et al., 2019).

5. Discussion

Initially, attention for CE in China emerged in response to environmental degradation and scarcity of resources. This was a way for the Chinese government to explore new development and transformation pathways. A similar approach was taken by the European Union (EU) which started adopting CE as a particular approach to circularity, with high expectations to increase economic competitiveness, promote economic growth and create jobs while reducing environmental impacts and resource dependency (Friant et al., 2021). Adoption of the "ecological civilization" catchphrase, by the CPC charter at the 18th National Congress in 2012, positioned a new strategy toward national development and set the "initial establishment of resource recycling systems" as one of the goals of building a well-off society. In the shadow of this paradigm, CE was adopted as a key theme in national economic development programs. Later, CE was positioned with the aim of having ecological civilization contribute to societal transformation. This is in line with findings from previous studies (Cui and Zhang, 2018).

Second, it also shows that this increase is related to the leading policy frame adopted by national government, and that once a policy theme (i.e., CE) becomes 'mainstream' it is likely that a policy accumulation effect occurs. At the start of the 13th FYP in 2016, multiple national government ministries and commissions vied for attention and managed to get involved in the ecological civilization program: they issued a great number of CE policies. This went along with an interdepartmental competition of national government ministries and committees, each wanting to show their commitment to the cause, resulting in the issuing of many new policy instruments to go with an increased specification and classification of the latter. In addition, CE helped to handle economic and environmental issues that China is facing. And political support helped to involve different agencies in CE implementation (Zhu et al., 2019). This shows that CE is

strongly linked to institutions, particularly in developing new policies, laws and regulations (Rweyendela and Kombe, 2021). From a critical perspective, it can be argued that policy accumulation might potentially only refer to an optical trick using intensified classification and specification of policy instruments as a disguise to portray a vast increase in the volume of policy instruments. At the same time – after 2015 - a notable growth in the academic literature on CE was observed in other countries, probably driven by the evolution of European and global programs and policies in this policy domain, such as the 2015 United Nations Climate Change Conference (COP 21) (Betancourt Morales and Zartha Sossa, 2020).

Third, the present study also observed that policy accumulation was influenced by policy learning, with the national government learning from foreign policy practices before adopting and issuing them nationally - via international projects and students learning from practices and institutions abroad. This is in line with previous studies addressing the influence of policy learning on policy accumulation (e.g., Gilardi, 2010) and transferring successful CE practices from around the world (Zhu et al., 2019).

Fourth, when reflecting on previous literature on policy accumulation, the present study verifies claims related to certain explanatory factors (e.g., Capano and Lippi, 2017; Peters, 2002). These include factors like 'grand' ideas, economic and environmental factors (i.e. as a response to declining environmental quality as a problem pressure) (Adam et al., 2019) or even as a 'crisis' (Knill and Steinebach, 2021), (departmental) interests, and the international environment. In the literature these factors influence the selection of policy instruments, which in the present study also pertains to the numerical size and specification of instruments and their targets.

Fifth, results of the present study also verify claims that processes of increasing numbers of policy instruments go hand in hand with increasing numbers of policy goals or targets (in line with Adam et al., 2018), and that policy accumulation includes the issuing or implementation of new policy instruments, but does not do this "from a clean slate" in the absence of pre-existing instruments and mixes (in line with Knill and Steinebach, 2021; Pollitt and Bouckaert, 2011). Each of the periods came with their own policy focus and instruments that varied somewhat in terms goals, targets and instruments, and came with increasing variation in policy instruments and complex policy mixes (Chappin et al., 2009; Thelen, 2004), but also maintained key instruments and topics from previous periods. Energy efficiency, for example, remained an important policy goal in four different periods.

When perceiving CE policy accumulation in China from an evolutionary or sustainable innovation perspective it makes sense to adopt a mission-oriented innovation system (MIS) approach (Hekkert et al., 2020). Here, CE policy accumulation started in a limited number of application (sub-)domains, with experimentation and pilot demonstrations, while at the same time using economic policy instruments to foster innovation and niche market development via funding of (innovative, experimental) CE projects, and later (after 2016) trying to scale up and roll out CE to the 'mainstream market' of a larger number of domains with regulatory and network policy instruments to accompany this process.

Limitations of the present study pertain to the use of data based on second-hand online information. No offline documents were checked and neither were internal data published by the government. This was due to the limited availability of these data and serious travel restrictions over 2019–2022. Future research should expand the range of interviewees and obtain internal data from government officials to improve the reliability of research conclusions. This research also lacks in detailed information with regard to the decision-making process surrounding CE policy formulation and its implementation at the local level. We suggest that future research be conducted using a more complete approach to the process of decision making to acquire a firm grasp on policy processes, development and implementation, covering all three of the analyzed FYPs and potentially extended into the 14th FYP, beyond 2021.

This study has covered potential causal drivers of CE policy accumulation from the perspective of China's stage of economic development and environmental conditions. Future research should also pay attention to the social side of CE policy, and in specific subdomains of SDG12 addressing sustainable production and consumption. For example, what are the positive and negative effects on the different actors in society, how do these actors engage in CE (e.g. in terms of labor in production process, or in terms of social acceptance, (financial) participation, or decision-making)? In the present study, we assumed that CE would have a positive impact on both economic growth while declining environmental degradation. However, some negative effects of CE also need to be considered, for example, CE reducing the (e.g., energy) consumption per unit of output, which might have a behavioral impact on end-consumers who get the impressions that since they consume less products (e.g., energy) due to more efficient production they might as well consume more (perceived efficiently produced energy), which leads to increasing volumes in total production. This rebound effect triggers non-essential consumption with detrimental effects to environmental benefits associated to CE (Salvador et al., 2022). Future research might pay attention to how accumulating CE policy might result or even encourage CE rebound effects. In addition, we suggest research of (accumulating) economic policy encouraging the use of circular products from the perspective of CE premium, focusing on the effectiveness of certain economic policy instruments on reaching affordable and acceptable CE premium pricing (in line with Appolloni et al., 2022). In addition, we advocate more scholarly attention to circular premium, and which policy mix and strategy can contribute to it. Finally, we suggest more research on the social dimension of CE (Mies and Gold, 2021), in particular to social aspects that are closely related to agenda setting, policy making and policy implementation, like social acceptance of CE policy, legitimacy, and negative externalities of CE which might harm social communities.

6. Conclusion

This paper analyzed how CE policies have accumulated in China over four different periods (2006–2021) and did so in terms of policy, policy goals and instruments. Results show the number of CE policies as well as their diversity increase in all of the three FYPs, but particularly in the 13th FYP (after 2016) and in 2021.

In terms of CE policy goals, a strategic shift occurred from – in chronological order - focusing on production efficiency to lowering consumption, to adopting a whole life cycle perspective and carbon peak and carbon neutrality. In the 11th and 12th FYP, policy instruments used were pre-dominantly economic ones. During the 13th FYP, the attention shifted toward adopting regulatory instruments along with network-based and communicative instruments. Economic policy instruments remained in place but became less prominent. The CE policy domain transitioned from a rather market-oriented to more regulated sector. The present study revealed how policy accumulation takes place over time, with periods of relative stasis (the 11th and 12th FYP) and then a sudden increase in policies, goals and instruments issued (the 13th FYP and 2021).

With regard to academic debates about policy accumulation the present study provides several insights. Several factors were identified to account for China's CE policy accumulation. China's economic development stage urged the government to pay more attention to environmental protection. At this stage, China's government also had a greater environmental governance capacity. To seize the opportunity to contribute to ecological civilization, various national level ministries and commissions grew eager to participate, which led to a sudden increase in CE policies being issued and implemented. Finally, the Chinese government actively encouraged policy learning and diffusion from CE policies and practices in developed countries. This led to students of CE

policy gaining knowledge abroad and setting up international cooperation projects. The knowledge gained was eventually used to develop domestic policy based on foreign examples, while tailored to the national context. This contributed to increasing the volumes of CE policy, also with the ambition to reach objectives related to SDG12.

This paper is the first comprehensive, longitudinal, empirical study to explore policy accumulation of circularity. The CE policy accumulation pattern observed in China provides implications for the body of knowledge of policy accumulation. It would therefore be worthwhile for future research to replicate this study, also in other contexts, as the research approach used in the present study is not limited to China. The identified factors driving CE policy accumulation provide clues for further analysis, for example for further exploration or for verification. The research approach presented in this article, i.e. policy classification, methodology, but also operationalization and measurement of policy accumulation can be considered useful to be applied to other environmental issues from CE, like climate mitigation.

Future research may assess whether CE policy instruments align with CE policy goals or compare the CE policy implementation in different sectors because there are still considerable differences between Chinese provinces in terms of CE development. Knowledge on CE policy accumulation can be expanded with future research in other regions and countries of the world, which use more democratic models and polycentric governance models. Future studies can equally explore how different CE pilot programs (CE pilots, National CE demonstration cities, Eco-Industrial parks, or zero-waste city pilots) evolve over time, how they work, which policy instruments or mixes are used, and whether they are effective in achieving their CE goals. Finally, future researchers are advised to study in more detail how policy accumulation resembles or differs from policy layering practices, and address how policy accumulation leads to unanticipated implementation circumstances and evolving political needs.

CRediT authorship contribution statement

Wenting Ma: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Thomas Hoppe:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Martin de Jong:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

In the Appendices complementary information for this article is presented, including a classification of circular economy policy instruments, the number of policies and density of Circular Economy policy instruments from 2006 to 2021, interviewee information, an overview of identified CE policy goals, and termination and modification of CE policy.

Table A1
The classification of circular economy policy instruments.

Policy instruments	Description	Policy Instruments	Examples	References
Legal policy instruments	Use administrative means and government power to require or specify certain behavior. Control and command.	Regulations Target responsibility system Supervision and oversight	Environmental regulations and laws Industrial standards Supervision Emission permits Strengthen accountability Punishment	(Jenkins, 2014; Liu et al., 2017; Su et al., 2013; Zhu et al., 2019)
Economic policy instruments	Use economic incentives and market forces to attain a certain policy goal.	Tax incentives Pricing incentives Financing preferential policies Competition-based government sponsorship Carbon trade policy	Subsidies Price mechanism Tax incentives Green loans Government grants Levies Government procurement Establishing a (regulated) market mechanism	(Kautto and Lazarevic, 2020; Morseletto, 2020; Wang and Chang, 2014)
Network policy instruments	Mutually interdependent actors like enterprises, private organizations, communities and government organizations are encouraged to collaborate, exchange resources and coordinate their actions.	Ad hoc taskforce Public-public partnerships Public-private partnerships Voluntary participation	Establish a special leading group and work for promotion group Establish a special joint meeting system for promoting work Participation from environmental organizations, research institutions Public-public partnership Public-private partnership Voluntary organizations	(Britton and Woodman, 2014; Khanna et al., 2014; Shen et al., 2020; Stelling, 2014)

(continued on next page)

Table A1 (*continued*)

Policy instruments	Description	Policy Instruments	Examples	References
Communicative policy instruments	Use information, publicity, education to persuade and influence people's preferences, intention, and behaviours.	Public information campaigns Exhortation and education Public consultation Open government data	Family and community Environmental information disclosure Advertising measures, labels Public education Media campaigns encouraging CE lifestyles Government exhortation or suasion Multimedia Media campaigns	(Kautto and Lazarevic, 2020; Wang and Chang, 2014; Winans et al., 2017)

Table A2
Number of policies and density of Circular Economy policy instruments across three FYPs (2006–2021).

FYP	Number of policies	No. of policy instruments					Density of policy instruments				
		Legal	Economic	Network	Communicative	Total	Legal	Economic	Network	Communicative	Total
11th	15	11	30	5	4	50	0.733	2.00	0.333	0.267	3.333
12th	22	31	47	31	17	126	1.409	2.136	1.409	0.773	5.727
13th	165	184	162	102	116	564	1.115	0.998	0.662	0.793	3.418
2021	83	199	115	40	78	432	2.398	1.386	0.482	0.940	5.205

Table A3
Interviewees information.

No.	Date	Age	Gender	Education level	Position	Research interests
1	20220321	47	Female	PhD	Professor	Economic geography; Industrial geography; the relation between the global environmental governance and the technological change in developing countries
2	20220327	51	Male	PhD	Professor	Strategic environmental assessment; Environmental planning and management; Environmental governance system and policy analysis
3	20220330	70	Female	PhD	Professor	Capital theory; Network economy; Circular economy; Low carbon economy and carbon trading
4	20220331	60	Male	PhD	Professor	Ecological civilization; Green development; Circular economy; Resource recycling; Garbage classification
5	20220402	37	Male	PhD	Assistant Professor (Highly cited researcher in industrial ecology)	Industrial ecology; Environmental systems analysis; Environmental management; Circular economy; Enterprise environmental management; Eco-industrial parks; Sustainable industrial planning and urban planning
6	20220505	50	Male	PhD	Professor	Complexity of industrial ecosystem; Resource metabolism; Ecological innovation
7	20220527	38	Female	PhD	Professor	Environmental assessment; Environmental planning and management; Industrial ecology; Low-carbon and sustainable development
8	20220529	29	Female	Master	Engineer in environmental sciences	Environmental innovation; Circular economy policy

Table A4
Policy goals – Circular Economy Policy.

Identified CE Policy Goals		
1 High-quality and efficient agriculture with special features	23 Solid waste shipment	45 Scrap motor vehicle recovery
2 Development of remanufacturing industry	24 Solid waste pollution control	46 Reduction of volatile organic compounds
3 Recycling industry cleanup	25 Prevention and control of soil pollution	47 Volatile organic pollution control/integrated control
4 Renewable energy, renewable resources	26 Prevention and control of groundwater pollution	48 Tradable permits
5 Science, education and energy in agriculture and rural areas	27 Disposal of garbage	49 Comprehensive utilization of waste battery of new energy vehicles
6 Green development of agriculture	28 Waste incineration power generation	50 Promotion of new energy vehicles
7 Comprehensive utilization of crop straw	29 Urban sanitation	51 zero-waste city
8 Improvement of rural living environment	30 Municipal solid waste treatment (clean transport, incineration)	52 Forestry ecological protection and restoration
9 Rural domestic sewage treatment	31 Urban sewage treatment	53 Green development of private enterprises
10 Comprehensive utilization of agricultural and forestry residues	32 Plastic pollution control (use and recycling of disposable plastic products)	54 Water pollution prevention and control
11 Agricultural and forestry biomass power generation	33 Wall material innovation	55 Water tax reform
12 Soil environmental management of agricultural land	34 Energy saving and comprehensive utilization in industry and communication	56 Water resources management
13 Agricultural plastic film pollution prevention	35 Energy management for industrial enterprises	57 Pollution prevention and control
14 Strengthen the management of environmental assessment	36 Comprehensive utilization of industrial solid waste	58 Sewage and garbage disposal
15 Special treatment of medical waste	37 Industrial energy saving	59 Sewage treatment plant discharge permit
16 Hazardous waste control	38 Recycling and processing of waste household appliances	60 Development of automobile power battery

Table A4 (*continued*)

Identified CE Policy Goals					
17	Development of circular economy	39	Comprehensive utilization of waste tires	61	industry Car appliances for new
18	Developing green transportation	40	Pollution prevention and control of waste lead battery	62	Marine ecological protection and restoration
19	Develop energy conservation and environmental protection industries	41	The reduction of construction waste	63	Sponge city
20	Safe utilization of polluted cultivated land	42	Resource utilizaiton of construction waste	64	Clean the heating
21	Third party treatment of environmental pollution in the park	43	Recycling transformation	65	Cleaner production
22	Comprehensive utilization of solid waste	44	Circular economy evaluation index system	66	Clean energy (clean and efficient use of coal)
67	Coal energy development	92	Green product identification	117	Battery recovery
68	Environmental protection equipment and product industrialization	93	Green manufacturing	118	Resource tax collection
69	Development of environmental protection equipment manufacturing industry	94	Green packaging	119	Comprehensive utilization of resources
70	Environmental protection standard	95	Green development	120	Technological innovation in the field of resources
71	Development of environmental protection science and technology	96	Green plants	121	Pollution prevention and control in papermaking industry
72	Environmental governance	97	Green building materials	122	The boiler energy conservation
73	Ecological environment protection	98	The green building	123	Yangtze River Protection and restoration
74	Ecological restoration (coal mines)	99	Green circular consumption	124	Green development of the Yangtze River Economic Belt
75	Eco-circular agriculture	100	Green technology innovation	125	Limited use of hazardous substances in electrical and electronic products
76	Ecological progress	101	The construction of green data center	126	Environmental protection of drinking water sources
77	Ecological and environmental supervision	102	Green production and consumption	127	Efficient lighting product promotion
78	Reform of the environmental science and technology system	103	Green community	128	Treatment of black and smelly water bodies
79	Code of conduct for ecological environment	104	Green food and beverage		
80	Ecological compensation	105	Green and efficient refrigeration		
81	Household garbage classification	106	Fertilizer packaging waste recovery		
82	Domestic waste incineration to generate electricity	107	Energy development		
83	Biological natural gas industrialization development	108	Energy work		
84	Harmless treatment of livestock and poultry	109	The energy management		
85	Livestock and poultry waste resources utilization	110	Water saving		
86	Green development of the petrochemical industry	111	Conservation-type organ creation		
87	Conservation and comprehensive utilization of mineral resources	112	Energy saving		
88	Import of solid waste is prohibited	113	Energy saving products		
89	Livestock breeding waste resource utilization	114	Energy saving and emission reduction; Phasing out outdated production capacity		
90	Comprehensive utilization of straw	115	Energy conservation publicity week		
91	Waste resources utilization	116	Energy saving technology transformation		

Table A5
Termination and modification of Circular Economy Policy.

No.	Departments	Polices	Year	Status
1	Ministry of Finance\State Council	Interim measures for the administration of special funds for Circular Economy development	2012	Policy termination
2	National Development and Reform Commission Ministry of Education\ Ministry of Finance \Tourism Bureau	Provisions on the application and administration of national Circular Economy education demonstration base	2012	Policy termination
3	National Development and Reform Commission	Guide for compiling circular Economy Development Plan	2010	Policy termination
4	Standing Committee of National People's Congress	Circular Economy Promotion Law of the People's Republic of China	2009	modified

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