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Economic Logic Exploration of Collaborative Legislation of Circular Economy and Low Carbon Economy under Double Carbon Goal

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Abstract: Throughout the world, the European Union, the United States, Japan, Singapore and other major developed economies have taken the development of circular economy as an important pillar and key path to drive economic growth and achieve climate goals, and have formulated a series of supporting regulations, directives and relevant action plans. In 2015, the EU adopted the EU Circular Economy Action Plan, which included the circular economy as an important strategy to tackle climate change and boost economic growth under the framework of the Europe 2020 Strategy. With the increasingly serious problem of global climate change, the realization of the dual carbon goal (carbon peak and carbon neutrality) has become the core issue of common concern of governments and global organizations. In order to achieve this goal, circular economy (CE) and low carbon economy (LCE), as two important development concepts, are gradually paid attention to by national policies and economic fields. However, it is often difficult for a single economic model and policy to effectively promote the deep integration and coordinated development of the two. Therefore, exploring the collaborative legislation of circular economy and low-carbon economy has important theoretical and practical significance.

1. Introduction

In the context of global carbon emission reduction and climate change response, circular economy and low-carbon economy have become an important path to promote sustainable development. Based on economic logic analysis, this paper discusses the theoretical basis and practical significance of collaborative legislation between circular economy and low-carbon economy.

2. Economic logic of collaborative legislation of circular economy and low-carbon economy

2.1 Synergies between circular economy and low-carbon economy

In the context of the goal of "dual carbon" (carbon peak, carbon neutrality), the circular economy

and the low-carbon economy form a deep synergy through resource efficiency improvement and carbon emission reduction[1]. The core of circular economy lies in "reduction, reuse and resource utilization", which reduces the consumption of primary resources through industrial recycling systems (such as scrap smelting and waste heat recovery) and directly reduces the carbon emissions of energy-intensive industries (such as the carbon emissions of the steel industry are reduced by 20%). The low-carbon economy focuses on the transformation of the energy structure (such as increasing the proportion of renewable energy to 50%) and energy efficiency optimization, which have a high degree of overlap in goals, as shown in Figure 1.

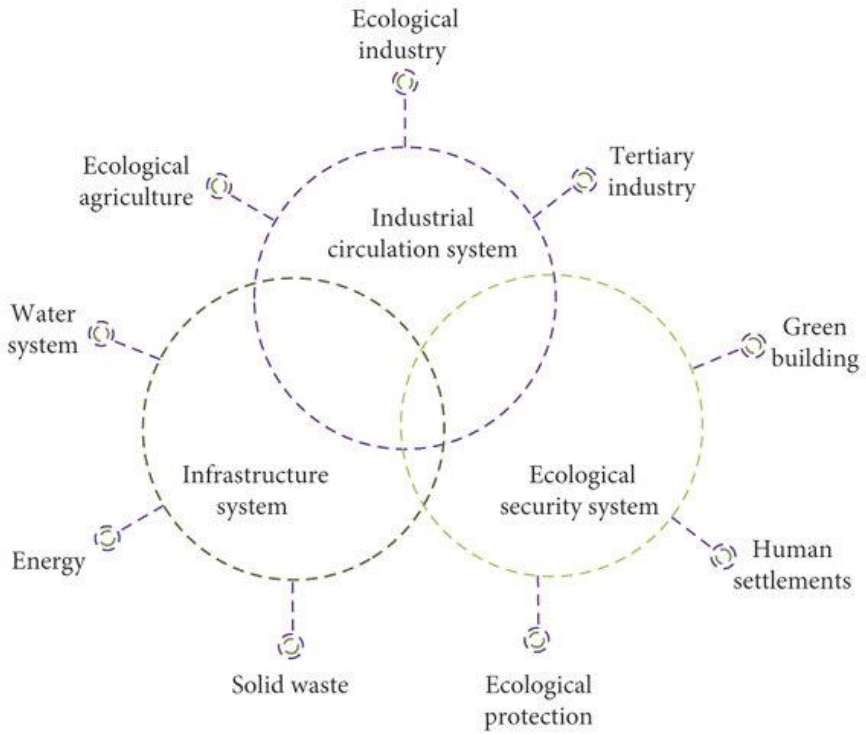

Figure 1. A visual diagram of the relationship between circular economy and low-carbon economy

In terms of policy coordination, circular economy policies (such as the extended producer responsibility system) require enterprises to recycle products, and promote the manufacturing industry to design low-carbon products (such as modular mobile phones for easy disassembly and maintenance); Low-carbon policies (such as carbon trading markets) incentivize companies to invest in circular technologies through carbon price signals (such as cement plants that use carbon capture to produce recycled building materials). The EU's "circular Economy Action Plan" and "Green New Deal" are integrated through legislation, binding the plastic recycling rate target (55%) and carbon reduction target (55% reduction by 2030), forming a two-way promotion mechanism[2].

2.2 Legislative needs of the collaborative framework

The key to the collaborative development of circular economy and low-carbon economy is to break the existing policy barriers through legal tools and build a unified resource-energy-carbon emission management framework. There are significant differences in the current legislative system. For example, China's Circular Economy Promotion Law focuses on resource reuse and waste management, while the Carbon Emission Trading Management Measures focus on emission quota allocation and trading. The two lack effective connection in terms of target coordination, data

sharing and enforcement mechanisms. To this end, the following key legislative tools need to be introduced:

Cross-field standard integration: Develop comprehensive indicators of "carbon-resource efficiency", such as requiring manufacturing enterprises to simultaneously meet the carbon emission intensity per unit product (such as tons of steel $CO_2 \leqslant 1.8$ tons) and the proportion of recycled materials (such as recycled materials in plastic packaging $\geqslant 30\%$). The EU's Circular Economy Action Plan binds plastic recycling targets with carbon reduction targets to promote member states to achieve 100% recyclable plastic packaging designs by 2025, while reducing carbon emissions from plastic production by 50%.

Synergy of economic incentives: carbon tax revenue will be directed to support recycling technology research and development, such as Germany will invest 25% of carbon tax revenue into renewable energy and industrial waste heat recovery projects; At the same time, the implementation of resource tax relief for enterprises that adopt low-carbon recycling technologies (such as a 5% reduction in the tax rate of scrap steel), forming a two-way incentive of "emission reduction - recycling"[3].

However, there are still significant gaps in the existing legal framework:

Lack of industrial coordination mechanism: lack of policy linkage between construction waste recycling and low-carbon building materials production, resulting in low efficiency of resource recycling. It is estimated that China's construction waste reuse rate is less than 10%, if legislation requires new projects to use 30% recycled aggregate, can reduce carbon emissions of building materials production by 15%.

Data island problem: Resource cycle data (such as waste type and recycling amount) and carbon emission data (such as enterprise emission inventory) are managed by environmental protection departments and development and reform departments, which is difficult to support comprehensive decision-making. It is necessary to establish a cross-departmental data platform through legislation, force enterprises to report two-dimensional data of "resource-carbon emission", and set joint KPIs (such as "cycling-carbon emission reduction comprehensive index")[4].

2.3 Economic analysis of collaborative legislation

The economic impact of collaborative legislation should be analyzed from the perspective of the balance between short-term costs and long-term benefits. Taking the steel industry as an example, the use of electric arc furnace scrap smelting (the core practice of circular economy) can reduce carbon emissions by 60% compared with the traditional blast furnace process, but the initial equipment renovation cost increases by 30%. However, through carbon trading gains (worth €50 per tonne of carbon allowances) and resource tax relief (a 5% reduction in the tax rate on scrap use), companies can recoup their investment within five years and increase long-term net returns by 15%, as shown in Table 1.

Table 1. Economic analysis of collaborative legislation

Project/Area	Short-Term Costs	Long-Term Benefits	Data Support	Associated Benefits
Steel Industry	- 30% increase in electric arc furnace equipment retrofit costs - 1-3% increase in annual revenue from R&D investments	- 60% reduction in carbon emissions - Carbon trading revenue (€50/ton) - Resource tax reductions (5% reduction in scrap steel tax rate)	- EU study: GDP growth of 2-3%, 40% carbon emission reduction - Baowu Group: Carbon trading revenue exceeded 500 million RMB in 2022	- Promotion of industrial recycling systems (e.g., waste heat recovery) - Reduction in reliance on primary resources (savings of $20 billion/year

		- 15% net profit increase within 5 years		on iron ore imports)
Green Buildings	- 10% increase in cost of energy-saving materials - Compliance costs (data system construction accounts for 1-3% of annual revenue)	- 20-30% reduction in building energy consumption - 5-10% price premium for green-branded products	- Tesla: Green supply chain premium advantage	- Reduction in community carbon emissions (e.g., distributed photovoltaics) - Improved public health (30% reduction in PM2.5)
Regional Energy Networks	- Increased municipal spending on regional waste treatment center construction	- 30% reduction in per capita carbon footprint in the community - 12% reduction in municipal energy expenses (Ruhr Area case)	- Ruhr Area (Germany): Collaborative legislation saves 12% in energy costs	- Waste incineration replaces landfill (90% methane reduction) - Integration of distributed photovoltaics with waste heat recovery
Ecological Agriculture	- 15% increase in initial investment for organic agriculture (e.g., composting facilities)	- Enhanced carbon sink capacity in water areas (+2 tons of carbon per hectare/year) - Carbon credit revenue ($50/ton)	- China “Zero Waste City” pilot: 30% reduction in fertilizer runoff	- Reduction in fertilizer use (5 million tons CO_2e methane reduction) - Protection of water ecosystems (40% reduction in nitrogen and phosphorus pollution)
Cross-Department Coordination	- Cost of building and sharing data platform (joint investment from government and businesses)	- 20% increase in resource efficiency (Circular Economy + Carbon Reduction Index) - 90% KPI achievement rate for policy implementation	- EU cross-departmental data platform: Reduces data silo issues	- Promotion of industry linkages (e.g., construction waste → low-carbon building materials) - Optimized regional resource allocation

Data source:

Eu study: The impact of circular economy and low-carbon coordinated policies on GDP and carbon emissions (Schoenfeld et al., 2023);

Baowu Group: 2022 carbon trading revenue public financial report;

Ruhr Region, Germany: Municipal Energy Expenditure Report (2022);

Tesla: A Low carbon Supply Chain Premium Analysis (Bloomberg, 2023).

3. International case study on collaborative legislation of circular economy and low-carbon economy

3.1 Cases of global circular economy and low-carbon economy legislation

Case 1: The EU Circular Economy Action Plan and its implications for low-carbon initiatives

The EU issued the Circular Economy Action Plan in 2015 and updated it into the New Circular Economy Action Plan in 2020, which clearly binds the circular economy to the European Green New Deal (a 55% reduction target). The core measures include: first, the plastics strategy: requiring

all plastic packaging to be recyclable or reusable by 2030, reducing carbon emissions from the production of primary plastics (the plastics sector accounts for 20% of industrial carbon emissions in the EU); The second is the recovery of key raw materials: set the minimum recovery rate of lithium, cobalt and other battery materials (lithium recovery target 70%) to support the low-carbon electric vehicle industry; The third is the product eco-design Directive: force the modular design of electronic products, extend the service life, and reduce electronic waste (about 12 million tons of electronic waste in the EU every year)[5].

The achievements achieved through these initiatives are: first, the plastic recycling rate has increased from 30% in 2015 to 41% in 2022, reducing carbon emissions by about 150 million tons/year; Second, the number of people employed in the circular economy sector increased to 4 million, accounting for 1.7% of total employment in the EU; The third is a 22% reduction in industrial carbon intensity in the EU (2015-2022) through circular measures.

But at the same time, it also faces the challenge of strengthening regulatory coordination by member states with different implementation efforts (for example, Eastern European countries have lower recycling rates than Western European countries)[6].

Case 2: China's circular economy and low-carbon economy policy

China in the "13th Five-Year Plan" proposed "waste free city" pilot, and in the "14th Five-Year Plan" clear carbon neutral goal (2060), through the following policies to integrate the cycle and low-carbon goals: first, the extended producer responsibility system (EPR) : forced household appliances, automobile enterprises recycling waste products, 2025 target recovery rate increased to 50%; The second is the carbon trading market: covering high-carbon industries such as electricity and steel, the carbon price in 2023 is about 60 yuan/ton, encouraging enterprises to adopt recycling technology (such as scrap steel smelting); Third, comprehensive utilization of industrial solid waste: the comprehensive utilization rate of bulk industrial solid waste in 2025 will reach 75% (60% in 2022), and carbon emissions from cement production will be reduced by about 100 million tons/year[7].

Through these measures, the utilization rate of enterprise scrap steel increased from 10% in 2015 to 22% in 2022, reducing iron ore import dependence (saving about $20 billion in foreign exchange/year), the cumulative turnover of carbon market exceeded 10 billion yuan, covering about 4.5 billion tons of emissions, and the "no waste city" pilot reduced landfill volume by 30%. Reduced methane emissions by about 5 million tons of CO_2e.

3.2 National and regional cases

Case 3: Japan's circular society and low carbon integration

Japan through the "Circular society formation Promotion Basic Law" (2000) and the "Global warming Countermeasures Promotion Law" (revised in 1998), to build a "resource-energy-emission reduction" trinity framework: First, the home appliance recycling law: manufacturers are required to recycle air conditioners, televisions and other products, the recovery rate of more than 85% in 2022 (metal materials reuse rate of 95%); The second is the hydrogen energy strategy: the use of waste to produce hydrogen (such as plastic chemical recycling), the goal is to supply 3 million tons of hydrogen energy by 2030, replacing 10% of fossil fuel carbon emissions; The third is the carbon pricing pilot: Tokyo and Saitama pilot carbon trading, covering the construction and industrial sectors, with a carbon price of about 2,000 yen/ton (about $15).

Through these measures have achieved good results, waste incineration power generation accounted for 80%, reducing landfill carbon emissions by 90%; And the circular economy industry scale reached 68 billion US dollars, accounting for 1.3% of GDP; And the hydrogen energy project reduces carbon emissions by about 5 million tons/year (2022). However, it also faces the challenge

of high cost of hydrogen infrastructure and increased public participation.

Case 4: AB 32 and the Circular Economy in California

California passed the Global Warming Solutions Act (AB 32,2006) and the Circular Economy Roadmap (2021) to promote collaborative legislation that includes a carbon market that covers transportation fuels and industrial emissions with a carbon price of about $30 / ton (2023), with the proceeds used to finance renewable energy projects; The second is the mandatory recycling of organic waste: requiring that the amount of organic waste landfill be reduced by 75% before 2025, and compost is used for agricultural carbon sequestration; The third is the green procurement policy: the mandatory use of 30% recycled materials (such as recycled asphalt) for government projects.

These initiatives have resulted in a reduction in landfill rates from 50% in 2000 to 37% in 2022; Renewable energy accounts for 60% (2023), reduces carbon emissions from the power sector by 40% and creates 350,000 jobs in the circular economy, accounting for 2.1% of the state's total employment, but also faces the challenge of high compliance costs for small and medium-sized enterprises and the need for financial subsidies[8].

3.3 Key findings and lessons learned

Table 2. Key findings and lessons learned

Country/Region	Policy Tools	Core Measures	Key Data	Challenges
European Union	Circular Economy Action Plan	Plastic recycling targets, product eco-design	Plastic recycling rate 41%, carbon emissions reduced by 150 million tons/year	Variability in implementation among member states
China	Zero-Waste City Pilot + Carbon Trading Market	EPR system, waste utilization targets	Scrap steel utilization rate 22%, carbon market transaction volume exceeds 10 billion RMB	Lack of technology in small and medium-sized enterprises
Japan	Circular Economy Law + Hydrogen Strategy	Home appliance recycling law, hydrogen production from waste	Home appliance recycling rate 85%, hydrogen carbon reduction 5 million tons/year	High infrastructure cost for hydrogen energy
California, USA	AB 32 Law + Circular Economy Roadmap	Carbon trading, organic waste recycling	Renewable energy share 60%, 350,000 circular economy jobs	Compliance costs for small and medium-sized enterprises

International cases show that the core of collaborative legislation between circular economy and low-carbon economy lies in the systematic integration and implementation of policy tools. Through economic incentives, technological innovation, and international cooperation, countries can achieve deep emissions reductions while safeguarding economic growth[9].

By comparing the above cases in Table 2, we can find the following lessons and best practices:

Cross-sectoral synergies: the EU promotes policy integration through integrated "cycling-climate" indicators (e.g., carbon-resource efficiency);

Precise economic incentives: California will direct carbon trading proceeds into the research and development of regenerative technologies to avoid capital dispersion;

Technology standardization and innovation support: Japan supports hydrogen technology through the "Green Innovation Fund" to reduce corporate risks;

Public participation and education: China's "waste-free cities" pilot project increased waste

sorting rates through community publicity (up to 50% in pilot cities);

Regional and international linkages: The EU's Carbon Border Regulation Mechanism (CBAM) prevents carbon leakage and transforms global supply chains.

4. Economic analysis of policy measures in coordination with legislation

4.1 Policy measures for circular economy

The core policy measures of circular economy include the combination of economic incentives and mandatory legislation. In terms of economic incentives, tax breaks (such as a 5% reduction in the tax rate on scrap use), subsidies (EU funding for research and development of recycled plastics), and incentives (such as enterprise ratings in China's "waste-free cities" pilot) can significantly reduce the cost of transformation for enterprises[10]. For example, Germany provides a 15% VAT discount for electronics companies that adopt modular designs to promote product maintainability. The legislative push focuses on ecodesign (the EU Ecodesign Directive requires the disassembly of electronic products), extended producer responsibility (EPR) and recycling target constraints. .

4.2 Policy measures for low-carbon economy

Low-carbon economic policies should focus on carbon pricing and be complemented by technology promotion. Carbon pricing mechanisms include carbon taxes (120 euros/ton in Sweden) and emissions trading systems (ETS), such as the Chinese carbon market, which covers 4.5 billion tons of emissions, with a carbon price of 60 yuan/ton (2023), and incentives for steel companies to switch to electric arc furnace processes (60 percent carbon reduction). Supporting policies include renewable energy subsidies (Germany subsidizing solar installations by 30 percent), energy efficiency standards (California reducing building energy standards by 20 percent), and research and development funds for low-carbon technologies (Japan's $15 billion Hydrogen strategy)..

4.3 Coordinated policy measures

Collaborative legislation needs to integrate recycling and low-carbon targets. Examples of measures:

Carbon-resource efficiency indicators: The European Union binds the plastic recycling rate target (55%) to the carbon reduction target (55% by 2030), requiring enterprises to report resource cycle and carbon emission data simultaneously;

Recycling technology into carbon trading: China's pilot scrap smelting carbon reduction into the carbon market, enterprises can sell additional allowances;

Green procurement legislation: Japan requires public projects to use 30% recycled materials while meeting low-carbon standards (such as recycled steel with a carbon footprint 30% lower than raw materials)[11].

Synergies: The circular economy reduces the mining of raw materials (e.g., the replacement of iron ore with scrap steel reduces energy consumption by 70%) and directly reduces carbon emissions; Low-carbon policies, such as carbon taxes, drive up the cost of fossil fuels and force companies to adopt circular technologies. It is estimated that the EU's coordinated policies can increase GDP by 2-3% while reducing carbon by 40%, while China's "waste free city" pilot reduces landfill methane emissions by 5 million tons of CO_2e/ year. In the future, international standards such as CBAM will be needed to prevent carbon leakage and ensure a coordinated transformation of global supply chains.

5. Conclusions

The collaborative development of circular economy and low-carbon economy is an important path to achieve the goal of "double carbon", and the improvement and integration of legal system is the key to promote this process. Through in-depth analysis of economic logic, this study reveals the complementarity and synergistic possibility of circular economy and low-carbon economy at the legislative level, and emphasizes the necessity of cross-field legislative coordination. In the future, with the acceleration of the global sustainable development process, the collaborative legislation model should be further optimized to enhance the systematization and operability of the legal system, so as to more effectively guide market players to participate in green development, and provide a more stable legal guarantee for the realization of the "double carbon" goal.

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