

# Research on the Role of the Digital Economy in Promoting Low-Carbon Sustainable Development in China's Cities

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**Abstract.** Against the backdrop of globalization and industrialization, cities, as hubs of economic, cultural, and social activities, are increasingly facing issues of carbon emissions and energy consumption. To address climate change and achieve sustainable development goals, low-carbon urban development has become a global consensus. As an emerging economic form, the economy of digit, with its efficient, intelligent, and green characteristics, offers new solutions for urban development of low carbon. The digital economy is not merely an accumulation of technologies, but rather a key pathway to achieving low-carbon, sustainable urban development. Through the application of digital technologies, it is possible to optimize energy structures, promote industrial upgrading and transformation, enhance the level of intelligence in urban management, and foster the formation of green consumption and lifestyles. However, the digital economy is merely a means; the true goal is to realize the low-carbon sustainable development of cities. The application of digital technologies needs to be combined with the joint efforts of governments, businesses, and society to achieve the greatest impact. To this end, it is essential to focus on actual development situations, strengthen technological innovation and application, improve data security and privacy protection mechanisms, formulate targeted policy guidance and regulatory measures, and promote the deep integration of the digital economy with urban low-carbon development to meet the demands of sustainable urban growth.

**Keywords:** Economy of Digit; Urban Low-Carbon; Sustainable Development.

## 1. Introduction

As global climate change and environmental issues become increasingly prominent, development of low carbon has gradually become an important strategic direction for sustainable development in cities around the world. As an emerging economic form, the economy of digit, with its unique technological advantages and innovation capabilities, is becoming an important force in driving urban development of low carbon. Centered around new-generation information technologies such as big data, cloud computing, the Internet of Things, and artificial intelligence, the economy of digit supports urban development of low carbon by optimizing resource allocation, improving energy efficiency, and reducing energy consumption. However, despite its great potential, the economy of digit faces numerous challenges and issues. Issues such as technological innovation and application, data security and privacy protection, policy guidance and regulation, and urban infrastructure construction are key factors limiting the effectiveness of the economy of digit in development of low carbon. Therefore, a detailed analysis of the main pathways through which the economy of digit promotes urban development of low carbon and the challenges it faces is crucial for formulating effective policies and measures to deepen the integration of the economy of digit with urban development of low carbon. This analysis will also help us better understand the nature and potential of the economy of digit and provide new ideas and directions for future urban development.

## 2. The Main Pathways for the Digital Economy to Promote Low-Carbon and Sustainable Urban Development

### 2.1. Optimizing Energy Structure

Through the application of advanced technologies such as the Internet of Things and big data, the economy of digit not only achieves real-time monitoring and precise management of energy



consumption but also significantly enhances energy efficiency. This intelligent management approach makes energy supply more flexible and efficient, reducing energy waste and injecting new vitality into sustainable urban development[1-4]. Furthermore, the economy of digit actively promotes the development and application of clean energy, helping to reduce dependence on traditional energy sources. Smart energy management systems can adjust energy supply based on real-time data to ensure a balance between supply and demand and reduce carbon emissions. The rise of electric vehicle sharing platforms also encourages the use of clean energy transportation tools, further reducing carbon emissions in the transportation sector. These successful cases demonstrate that the economy of digit plays an increasingly important role in optimizing energy structure and promoting clean energy utilization. However, it is also important to recognize that the development of the economy of digit still faces many challenges, such as technological bottlenecks, funding, and policy support. Therefore, we need to further strengthen technology research and development, optimize the policy environment, and increase funding to promote the deep integration of the economy of digit with development of low carbon.

## **2.2. Promoting Industrial Upgrading and Transformation**

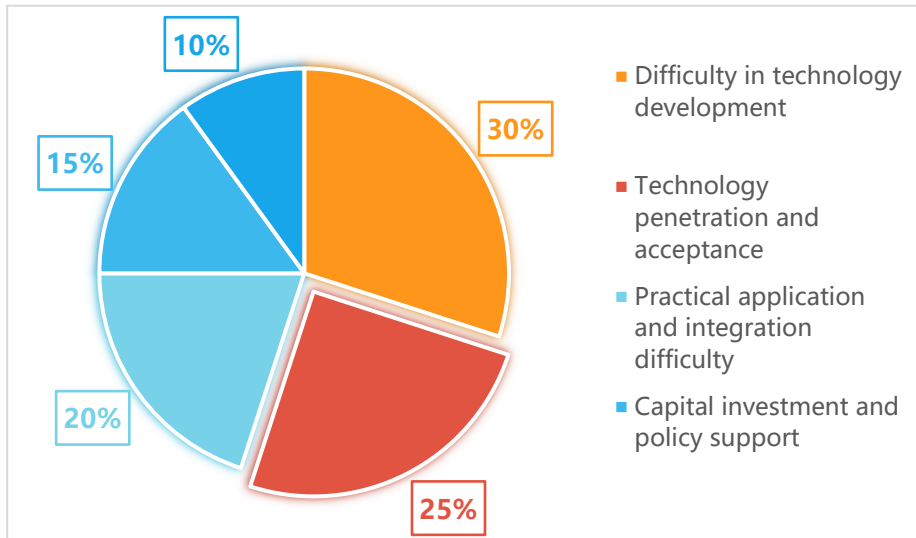
With its unique advantages in digitalization, networking, and intelligence, the economy of digit is becoming an important engine for promoting industrial upgrading and transformation. By deeply integrating with traditional industries, the economy of digit not only injects new vitality into these industries but also drives them towards low-carbon, green, and efficient development. In the industrial sector, the empowering role of the economy of digit is particularly evident. The introduction of advanced technologies such as intelligent manufacturing and the industrial internet optimizes traditional industrial production processes, significantly improves production efficiency, and reduces energy consumption, thereby significantly enhancing the competitiveness of enterprises and laying a solid foundation for achieving sustainable development of low carbon in the industrial sector. In the construction sector, the application of smart building technologies is equally impressive. Through intelligent management and control, buildings can achieve efficient energy use and environmental optimization. For example, smart lighting systems can automatically adjust the brightness of lights based on indoor lighting, ensuring lighting needs while reducing energy consumption; smart air conditioning systems can automatically adjust operating modes based on indoor and outdoor temperatures, ensuring a comfortable indoor environment while also reducing energy consumption. As technology continues to advance and application scenarios expand, the economy of digit will continue to inject new vitality into traditional industries, promoting their development in greener and more efficient directions.

## **3. Challenges Facing the Economy of Digit in Promoting Urban development of low carbon**

### **3.1. Challenges of Technological Innovation and Application**

In promoting low-carbon urban development, although technological innovation and application have made significant progress, a series of issues have also been revealed. To more vividly demonstrate the challenges of technological innovation and application in low-carbon development, a pie chart can be used for analysis, as shown in Figure 1. On one hand, due to the relatively high difficulty of technology research and development, there is a mismatch between the pace of technological innovation and the actual needs of low-carbon development. Although new technologies continue to emerge, many have not yet fully met the practical demands of urban low-carbon development, particularly in terms of breakthroughs in energy efficiency and carbon emission control, which are still insufficient and contradict the concept of sustainable development. On the other hand, some advanced technologies are often only applied in a few cities or regions, while the vast majority of small and medium-sized cities and rural areas are unable to enjoy the benefits of technological innovation, thus the potential of low-carbon development is not maximized. Furthermore, faced with massive amounts of data, the difficulty of practical application and integration is overwhelming,

compounded by a lack of sufficient funding and policy support. Currently, there is an inadequate reserve of talent involved in the field of low-carbon technology, posing a threat to the sustainability and stability of urban low-carbon development.



**Figure 1.** Challenges of technological innovation and application

### 3.2. Data Security and Privacy Protection Issues

In the process of promoting urban development of low carbon, issues of data security and privacy protection are becoming increasingly prominent. With the widespread use of technologies such as big data and cloud computing, vast amounts of personal, business, and government data are being collected, analyzed, and utilized, containing rich personal information and business secrets. Ensuring data security and privacy, preventing data leaks and misuse, has become a significant challenge for the economy of digit in driving urban development of low carbon. For example, in the context of digitalization and intelligence, many cities have introduced advanced technological methods to enhance urban management and services. However, during this process, some cities or institutions have engaged in the misuse of user data. In the push for intelligent management, personal data is collected, stored, and analyzed without the explicit consent of users, and sometimes even used for commercial promotions, advertising, and other profit-making activities. Such actions severely infringe upon users' privacy rights and undermine public trust in digital technologies. The misused data may include sensitive information such as users' personal identities, behavioral habits, and consumption records. If this data is leaked or exploited by criminals, it could cause significant losses to the users and seriously impede the widespread adoption and application of digital technologies in urban low-carbon development.

### 3.3. Insufficient Policy Guidance and Regulation

The digitized economy's development is crucial for advancing low-carbon initiatives, yet it currently lacks comprehensive policy guidance and regulation. There is a significant need to enhance our comprehension of how digital economics plays a pivotal role and possesses vast potential for promoting low-carbon growth. This sector not only bolsters technical support and sparks innovation for low-carbon initiatives but also aids in the low-carbon transformation of cities by enhancing resource distribution and energy efficiency. Nonetheless, the prevailing policy frameworks have not fully acknowledged these contributions of the digital economy, leading to a deficit in specific, targeted policies that support the confluence of digital and low-carbon development. In the journey of integrating digital economy with low-carbon development, the current policy framework lacks sufficient guidance. Policymakers have not yet formed a comprehensive understanding of the potential and value of the digital economy, resulting in policies that are too broad and lacking in specific, actionable guidelines. Furthermore, gaps in some regulatory systems provide opportunities

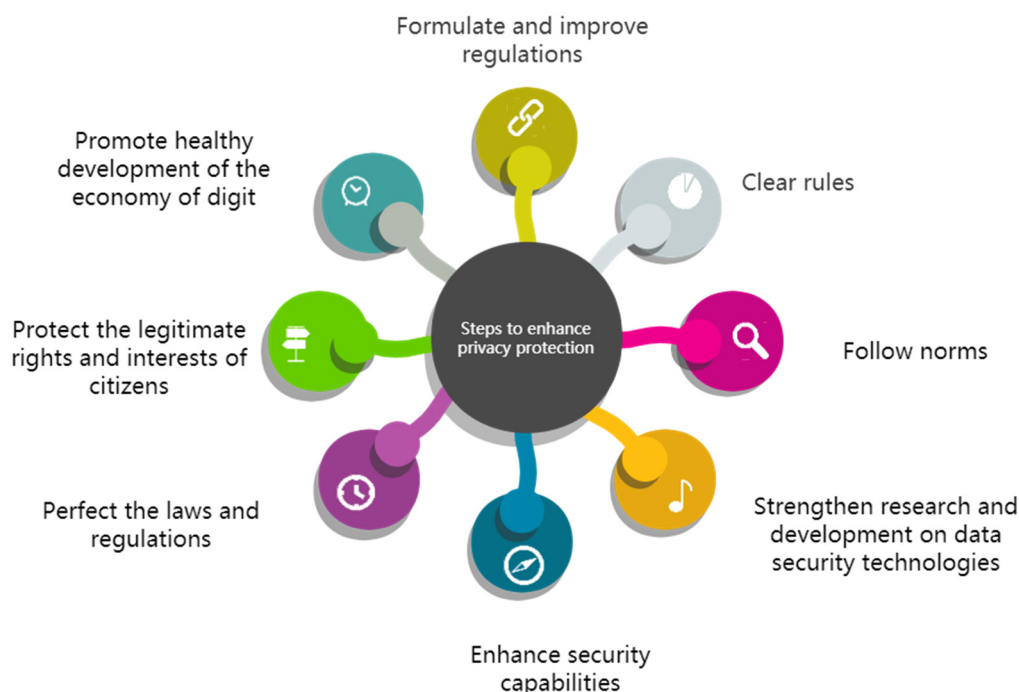
for illicit activities, making it difficult to respond promptly to new challenges in the digital economy sector.

#### 4. Countermeasures for the Economy of Digit to Promote Urban development of low carbon

##### 4.1. Strengthening Technological Innovation and Research and Development

As a critical engine for economic development in the new era, the economy of digit's technological innovation and R&D play an irreplaceable role in promoting urban development of low carbon. In recent years, significant progress has been made in China's economy of digit sector, with rapid development of key technologies such as big data, cloud computing, the Internet of Things, and artificial intelligence, providing strong support for urban development of low carbon. However, in the face of the urgent need for low-carbon transformation, further enhancement of technological innovation and R&D is still needed. To this end, businesses should be encouraged and supported to increase R&D investment in the economy of digit field, promoting breakthroughs and innovation in key technologies[7-8]. By strengthening the R&D capabilities of enterprises, a group of economy of digit businesses with core competitiveness can be nurtured, promoting the rapid sustainable development of the economy of digit industry. Additionally, establishing an integrated innovation system combining industry, education, and research is crucial. Through enhancing cooperation between industry, academia, and research institutions, the deep integration of economy of digit and low-carbon technologies can be fostered, leading to the development of a series of core technologies and products with independent intellectual property rights. This will enhance China's competitiveness in the global economy of digit field and provide strong technological support for urban sustainable development of low carbon.

##### 4.2. Enhancing Data Security and Privacy Protection



**Figure 2.** Steps to enhance privacy protection

Blockchain technology, as an emerging technology characterized by data sharing, immutability, value transfer, traceability, and multi-party maintenance, offers new solutions for data security and privacy protection within the digital economy. As issues of data security and privacy become increasingly prominent, they have become significant constraints on its healthy development. To protect the legitimate rights and interests of citizens and businesses, it is essential to develop and refine

regulations on data security and privacy protection in the digital economy sector, as outlined in Figure 2. First, through legislation, the rules for data collection, storage, usage, and sharing should be clearly defined. With the support of blockchain technology, the implementation of these rules will become more transparent and efficient. This requires that enterprises or individuals adhere to clear norms and standards when acquiring data to ensure its legal, compliant, and reasonable use. Additionally, corresponding security mechanisms need to be established for data sharing and transmission to prevent unlawful access or misuse. Secondly, enhancing the research and application of data security technology is indispensable. Blockchain technology itself is a powerful data security tool. By employing advanced encryption technologies, access control techniques, and security auditing methods, the security defenses of digital economy systems can be strengthened to effectively prevent data breaches and misuse. Moreover, enhancing the construction of data security monitoring and early warning mechanisms is critical to promptly detect and address potential security risks, providing a solid foundation for the sustainable development of the digital economy.

### **4.3. Perfecting Policy Guidance and Regulation**

To effectively promote urban development of low carbon and fully leverage the advantages of the economy of digit, it is particularly important to formulate specific policies aimed at driving urban sustainable development of low carbon through the economy of digit. This policy should clarify development goals, namely, using digital technology to enhance urban energy efficiency, reduce carbon emissions, and achieve sustainable development. At the same time, the policy should list key tasks, such as enhancing the application of digital technology in energy management, transportation optimization, green building, and other areas, and promoting the digital transformation of traditional industries. To ensure the effective implementation of policies, specific measures must be formulated[9-10]. These include financial support, tax incentives, talent cultivation, and technology research and development policies to stimulate the innovation vitality of businesses and individuals, promoting the deep integration of the economy of digit and sustainable development of low carbon. Additionally, strengthening the regulatory intensity in the economy of digit field is an indispensable part. By establishing a comprehensive regulatory mechanism to regulate market order, prevent market disorder and vicious competition, robust support can be provided for the healthy development of the economy of digit. Regulatory bodies should strengthen the routine supervision of economy of digit businesses to ensure their legal and compliant operation, intensify penalties for illegal and non-compliant behaviors, and maintain fair market competition.

### **4.4. Strengthening Urban Infrastructure Construction**

With the flourishing development of the economy of digit, increasing investment in urban information and communication networks, and enhancing network coverage and transmission speed have become important cornerstones for its continuous development. The information and communication network, as the infrastructure of the economy of digit, directly affects the application effectiveness of digital technologies and urban development of low carbon. On the one hand, increasing investment in information and communication networks not only means expanding the network's coverage to ensure every corner of the city enjoys high-speed, stable network services but also enhancing the network's transmission speed to meet the growing data transmission demands. This will help promote the widespread application of key technologies such as cloud computing, big data, and the Internet of Things in various urban sectors, providing strong support for the sustainable development of the economy of digit. On the other hand, accelerating the construction of smart cities is an important means to promote urban sustainable development of low carbon. By promoting the intelligent upgrade in transportation, energy, building, and other sectors, the efficiency of urban operations and the optimization of energy use can be achieved. Through continuously improving infrastructure and enhancing the level of intelligence, new momentum can be injected into the sustainable development of cities, achieving harmonious coexistence of economy, society, and the environment.

## 5. Conclusion

In the face of the severe challenges posed by global climate change, urban development of low carbon has become a focus of attention for countries worldwide. The economy of digit, with its strong technological advantages and innovative capabilities, offers unprecedented opportunities for urban sustainable development of low carbon. By optimizing resource allocation, enhancing energy efficiency, and reducing energy consumption, the economy of digit injects new vitality into urban development of low carbon. However, it is also crucial to recognize that the development of the economy of digit still faces multiple challenges, including technological innovation and application, data security and privacy protection, and policy guidance and regulation. These issues not only restrict the potential of the economy of digit in development of low carbon but may also adversely affect the sustainable development of cities. Therefore, a joint effort from governments, businesses, and all sectors of society is needed to strengthen technological innovation and R&D, and enhance urban infrastructure construction. By implementing these measures, further integration of the economy of digit and urban development of low carbon can be promoted, achieving a harmonious development of the economy, society, and environment.

## References

- [1] Manolis, M.; Giorgos, M. Broad strokes towards a grand theory in the analysis of sustainable development: A return to the classical political economy. *New Polit. Econ.* 2022, 27, 866–878.
- [2] Wang, S.; Tan, S.; Xu, J. Evaluation and Implication of the Policies towards China's Carbon Neutrality. *Sustainability* 2023, 15, 6762.
- [3] Dasgupta, P. The idea of sustainable development. *Sustain. Sci.* 2007, 2, 5–11.
- [4] Li, S.; Wang, J. Low-carbon city pilot policies, low-carbon literacy of residents and green technology innovation of enterprises. *China Popul. Resour. Environ.* 2023, 33, 93–103. (In Chinese)
- [5] Chen, M.; Zhang, C.; Chen, C.; Li, J.; Cui, W. Main Pathways of Carbon Reduction in Cities under the Target of Carbon Peaking: A Case Study of Nanjing, China. *Sustainability* 2023, 15, 8917.
- [6] Wen, J.; Su, S. An Empirical Analysis of the Synergistic Effect of Urban Pilot Policies in China. *Sustainability* 2023, 15, 6313.
- [7] Gao, D.; Cao, Y.; Liu, C. The Low-Carbon Policy and Urban Green Total Factor Energy Efficiency: Evidence from a Spatial Difference-in-Difference Method. *Int. J. Environ. Res. Public Health* 2023, 20, 3498.
- [8] Mao, Q.; Ma, B.; Wang, H.; Bian, Q. Investigating Policy Instrument Adoption in Low-Carbon City Development: A Case Study from China. *Energies* 2019, 12, 3475.
- [9] Zhao, T.; Zhi, Z.; Liang, S. economy of digit, entrepreneurial activity and high-quality development: Empirical evidence from Chinese cities. *Manag. World* 2020, 36, 65–76.
- [10] Beck, T.; Levine, R.; Levkov, A. Big bad banks? The winners and losers from bank deregulation in the United States. *J. Finance* 2010, 65, 1637–1667.
- [11] Kalogiannidis, S.; Kalfas, D.; Chatzitheodoridis, F.; Koutsas, S. The Impact of Digitalization in Supporting the Performance of Circular Economy: A Case Study of Greece. *J. Risk Finan. Manag.* 2022, 15, 349.