CKN China Kennisnetwerk

Sustainable Built Environment Cooperation Between the Netherlands and China

Development, Policy and Market Opportunities

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Foreword

This report was commissioned by the China Knowledge Network/Ministry of Foreign Affairs in the Netherlands, in response to policy research questions from the Ministry of Housing and Spatial Planning, the Ministry of the Interior and Kingdom Relations, and the Embassy of the Netherlands in China. The authors are grateful for the assistance received in their work from the Chinese Embassy in the Netherlands. The initiative reflects a growing recognition: that addressing the environment requires not only domestic innovation, but also international engagement rooted in mutual understanding, market alignment, and long-term trust.

While China and the Netherlands are competitors in various fields, they share common interests in tackling global environmental issues such as energy efficiency, CO_2 reduction, and circularity amongst others. The role of built environment plays a dominant role in these issues. For this reason, cooperation and knowledge sharing is highly desirable. Especially since the scale on which the shared knowledge is developed, and applied in China far exceeds the impact that can be observed in the Netherlands or even in Europe.

As the world's largest construction market, China has entered a new era of green transition. From low-carbon material certification to digitalized energy systems and circular urban design, the sustainability agenda is no longer confined to policy rhetoric—it is actively shaping planning frameworks, procurement rules, and industrial standards at scale. Yet, implementation across regions remains uneven, the pathway from regulation to realized environmental performance is still being tested.

For the Netherlands, this evolving landscape presents both opportunities and complexity. Dutch enterprises are global leaders in circular construction, green materials engineering, and digitally enabled design. Dutch research institutions offer deep expertise in lifecycle assessment, building performance modeling, and climate-adaptive urban planning. These strengths align well with China's goals—but effective cooperation requires much more than technical excellence. It demands awareness of regulatory, institutional hierarchies, and the logic of state-market interaction in China's construction ecosystem.

This report seeks to enhance global understanding of China's progress in sustainable development of the built environment, while providing a reference for cooperation between the Netherlands and China at multiple levels, such as in government, business, and research. By reviewing policy frameworks and practical experiences, it aims to foster collaboration in green construction, low-carbon transition, and circularity based on equality, mutual trust, and mutual benefit. Such joint efforts will not only strengthen both countries' competitiveness and leadership in the sustainable global manufacturing industry but also support the achievement of international climate goals and the advancement of global sustainable development.

Drawing on our combined experience in civil engineering materials, sustainable construction systems, and international project development, we see this report not just as a deliverable, but as a bridge: connecting ambitions with capabilities, and values with viable entry points. As China and the Netherlands pursue their respective climate goals, we believe bilateral cooperation in the built environment can deliver shared benefits—technical, economic, and institutional—while also contributing to the broader global sustainability transition.

All information and data contained in this report are obtained from publicly available sources, including open-access research, official reports, industry publications, and regulatory standards, and contain no classified or otherwise restricted information.

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2025

About the authors

Bowen Xu, Marie Skłodowska-Curie Fellow and currently a postdoctoral researcher at Eindhoven University of Technology (TU/e). His research focuses on sustainable structural design, structural applications of sustainable building materials, and the integration of circular economy principles into building systems. This report was written during his postdoctoral research at TU/e, with the aim of supporting Sino-Dutch cooperation in green buildings through evidence-based analysis of technologies, policies, and markets. Prior to his academic career, he worked at China State Construction Engineering Corporation, which provided him with practical experience and unique insights into China's construction industry and institutional environment.

Jos Brouwers, full professor at the Department of the Built Environment of Eindhoven University of Technology (TU/e), where he leads the Building Materials research group. His research covers sustainable cements and concretes, the circular use of industrial by-products in construction, particle packing theory, and durability modeling. He is widely recognized for his contributions to eco-efficient building materials, having published more than 250 scientific papers with over 24,000 citations.

Beyond academia, Professor Brouwers has extensive experience in bridging research and industry. He has coordinated and participated in numerous international research and industrial collaboration projects, ranging from the development of green building materials and the valorization of construction and demolition waste to the implementation of low-carbon construction systems. He maintains close partnerships with leading companies in Europe and worldwide, ensuring strong links between fundamental research and practical application. He also serves as a guest professor at Wuhan University of Technology and as an advisor to various multinational research initiatives and industrial projects, actively promoting the integration of science, industry, and policy in advancing sustainable construction.

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Institute of International Relations 'Clingendael' is a leading independent think tank and academy on international relations. The Leiden Asia Centre is an independent research centre affiliated with Leiden University. It serves as a hub for applied academic knowledge on modern Asia.

Summary of Conclusions and Strategic Recommendations

This report identifies strategic opportunities for advancing a sustainable built environment cooperation between the Netherlands and China. The following recommendations are drawn from the study's cross-sectoral findings:

1. Strengthen Bilateral Dialogue and Standard Alignment

- Establish a long-term Sino-Dutch dialogue mechanism on green building standards and certification compatibility, aligned with the broader framework of EU policies and technical guidelines.
- Promote dual-certification demonstration projects to accelerate market entry and mutual recognition.

2. Leverage Dutch Innovation in Targeted Niches

- Focus on circular building materials, climate-adaptive facades, energy-positive housing systems, and digital asset management solutions.
- Support Dutch SMEs through export guarantees and green project co-financing.

3. Collaborate with Chinese SOEs and Local Governments

- Partner with SOEs such as CSCEC and CECEP for access to large-scale urban renewal and industrial park projects.
- Engage with demonstration zones (e.g., Xiong'an, Yangtze Delta GBA) to pilot innovative building concepts.

4. Foster Joint Research and Talent Exchange

- Launch joint research hubs with Chinese institutions (e.g., Tsinghua, CABR) focusing on carbon-neutral design, lifecycle assessment, and circular materials.
- Expand bilateral PhD exchange programs and short-term residencies tied to live projects.

5. Pursue Third-Market Cooperation Models

- Develop Sino-Dutch consortia for green infrastructure in Southeast Asia, Africa, and Latin America.
- Position Dutch planning and sustainability technologies alongside China's financing and delivery capabilities.

6. Avoid Common Pitfalls

- Avoid directly contracting labor services in China.

- Align project messaging and objectives with Chinese narrative priorities (e.g., ecological civilization).
- Do not apply EU standards without adapting to local regulation and market conditions.
- Understand that SOEs operate under policy directives as well as market logic.
- Ensure proper IP and data governance agreements in all technology collaborations.

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1. Introduction

1.1 Research Background

As global sustainability efforts intensify, the construction industry—accounting for approximately 13% of global GDP[1]— remains one of the largest contributors to carbon emissions (39%) and energy consumption (36%) worldwide[2].

China, as the world's largest construction market[3], is a key actor in the global climate transition. The Chinese government has introduced a number of policy initiatives aimed at promoting green buildings, energy-efficient urban development, and circular economy principles, in support of its carbon peaking goal by 2030[4] and carbon neutrality target by 2060[5]. Despite these efforts, implementation challenges persist, including fragmented policy execution, limited financial incentives, market inertia, and technological gaps.

These challenges are further compounded by the legacy of rapid urbanization and infrastructure expansion over the past decades, during which the construction sector developed in a resource-intensive and loosely regulated manner. Addressing these issues requires not only technological and institutional reform but also structural transformation of the sector.

At the same time, these dynamics create opportunities for international cooperation, particularly in areas such as low-carbon materials, digital construction methods, and circular economy applications. China's construction sector could serve as a relevant context for testing and adapting emerging solutions, with potential global implications.

In comparison, the Netherlands and the broader European Union (EU) have accumulated considerable experience in sustainable construction policy, technical standardization, and circular economy implementation. Early development of the EU's Green Deal and sustainability frameworks has fostered a market environment where green construction is now increasingly industry-driven. Initiatives such as the Netherlands' "Betonakkoord"[6] (Concrete Agreement) and "Materials Passport" provide mature models for promoting resource efficiency, material reuse, and public–private collaboration.

Against this backdrop, there is growing potential for strategic cooperation between the EU and China, including the Netherlands. While developmental trajectories differ, there is scope for mutually beneficial engagement through knowledge exchange, joint pilot projects, and coordinated innovation in sustainable construction technologies. Such cooperation could

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[1] United Nations Environment Programme (UNEP) and Global Alliance for Buildings and Construction (GlobalABC), 2023 Global Status Report for Buildings and Construction: Beyond foundations - Mainstreaming sustainable solutions to cut emissions from the buildings sector. 2024.
[2] L. Huang, G. Krigsvoll, F. Johansen, Y. Liu, and X. Zhang, "Carbon emission of global construction sector," Renew. Sustain. Energy Rev., vol. 81, pp. 1906–1916, Jan. 2018.
[3] H. Wu et al., "Generation characteristics and disposal paths of construction waste in public building project: A case study," Clean. Waste Syst., vol. 10, p. 100211, Mar. 2025.
[4] State Council of the People's Republic of China. Action Plan for Reaching Carbon Peak Before 2030. October 26, 2021.
[5] "CPC Central Committee and the State Council. Opinions on Fully and Accurately Implementing the New Development Concept and Doing a Good Job in Carbon Peak and Carbon Neutrality. October 24, 2021.
[6] https://www.betonakkoord.nl/

contribute to both the acceleration of China's green transition and the international scaling of Dutch and EU sustainability innovations.

For Dutch businesses, these developments signal growing demand for advanced technologies, services, and project delivery models in areas such as green materials, digital construction tools, lifecycle assessment, and circular economy implementation. Understanding the evolving regulatory and market environment in China is therefore essential for identifying viable entry points and building long-term partnerships.

1.2 Objective

This study aims to objectively assess the sustainability status of China's built environment, analyze the gap between policy commitments and real-world implementation, and explore potential cooperation models and policy recommendations for China and the Netherlands (or the broader EU) in the field of sustainable construction. In doing so, the report seeks to serve as a practical bridge for bilateral collaboration—facilitating Dutch trade and investment in green building solutions, promoting the exchange and deployment of sustainable construction technologies, and supporting mutual learning between stakeholders in both regions.

Importantly, this study adopts a neutral, evidence-based perspective to navigate a field often characterized by polarized narratives. Discussions around China's environmental policies and sustainable construction efforts are frequently shaped by the strategic, commercial, or political orientations of commentators, leading to inconsistent or even conflicting interpretations. Against this backdrop, the report aims to clarify key information asymmetries—particularly those affecting Dutch and European stakeholders—and to offer a balanced, well-researched account of China's policy frameworks, implementation dynamics, and market conditions, thereby supporting informed decision-making for international engagement.

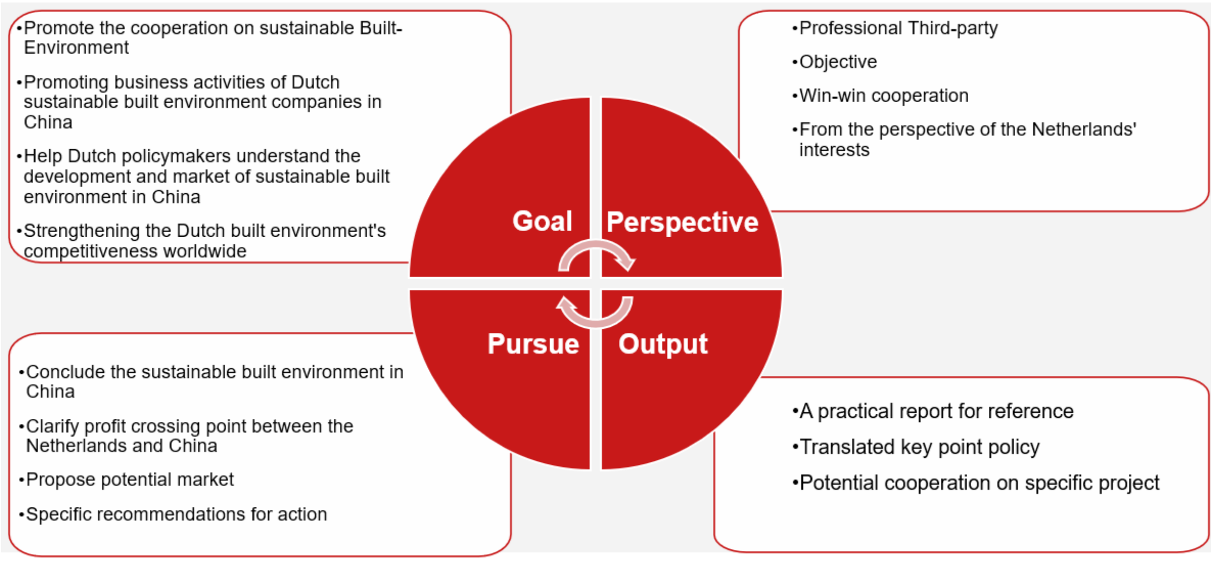
To ensure neutrality, this report is strictly technical and market-oriented. It does not evaluate political systems or engage in normative comparisons of governance. All analysis focuses on policy instruments, market mechanisms, technologies, and implementation pathways relevant to sustainable buildings, using publicly available or consented sources and aiming to support pragmatic, mutually beneficial cooperation.

Specifically, this research aims to:

- Objectively evaluate the current state of sustainable construction in China, including its policy framework, market trends, and key implementation challenges;
- Compare and contrast sustainable building policies and practices between China and the Netherlands (EU) to identify areas of convergence and divergence;
- Analyze cooperation models and barriers between China and the Netherlands, with a focus on government–industry–market interactions;

- Develop actionable and pragmatic policy recommendations to facilitate China–Netherlands (EU–China) collaboration in achieving low-carbon and sustainable construction goals;
- Bridge the knowledge gap and reduce information asymmetry between Chinese and Dutch stakeholders regarding sustainable building policies, technologies, and market opportunities;
- Contribute to the establishment of a fact-based platform for long-term cooperation, trade, and co-innovation in green building practices.

Figure 1.1: Overview of the study



1.3 Research Methods

This study employs a mixed-methods approach, integrating policy analysis, case studies, quantitative data analysis, and expert interviews to develop a comprehensive understanding of China's sustainable construction landscape and its cooperation potential with the Netherlands.

- Policy Analysis: A systematic review of China's and the Netherlands' (EU's) sustainable building policies, covering green building standards, carbon emission regulations, and circular economy strategies;
- Case Study Analysis: Examination of key sustainable construction initiatives (e.g., green building materials, energy infrastructure, urban planning) to provide in-depth insights into their effectiveness and scalability;
- Data Analysis: Synthesis of industry reports, government data, and market research to quantify sustainability trends in China's built environment;
- Expert Interviews: Engagement with policymakers, industry leaders, and sustainability experts to capture practical insights on policy implementation, market conditions, and cooperation opportunities.

Study adopts mixed methods, combining policy analysis, case studies, data analysis and interviews to fully understand the current status of sustainable development in China's construction industry and its potential for cooperation with the Netherlands.

1.4 Scope of the Report

This study focuses on five key domains related to sustainable construction:

- Sustainable Building Materials (e.g., low-carbon cement, engineered wood, recycled materials);
- Energy Infrastructure (e.g., building energy management systems, combined heat and power (CHP) integration, smart grids);
- Urban Planning & Regulatory Frameworks (e.g., material passport implementation, green building certification systems);
- China-EU Climate & Sustainability Collaboration (e.g., comparative analysis of policy coordination, investment mechanisms, and industry partnerships).
- These domains were selected based on their relevance to both China and the Netherlands, their potential for impactful policy interventions, and their significance in the global shift toward sustainable urban development.

Scope clarification: This report focuses primarily on civil buildings (residential and non-residential). Large-scale transport and utility infrastructure (e.g., roads, bridges, railways, airports, water and power networks) is outside the main scope, unless cited as contextual examples. Where "energy infrastructure" is mentioned, it refers to building-scale energy systems (e.g., BEMS, heat pumps, building-level CHP) and district-level interfaces directly serving buildings, not citywide infrastructure.

1.5 Structure of the Report

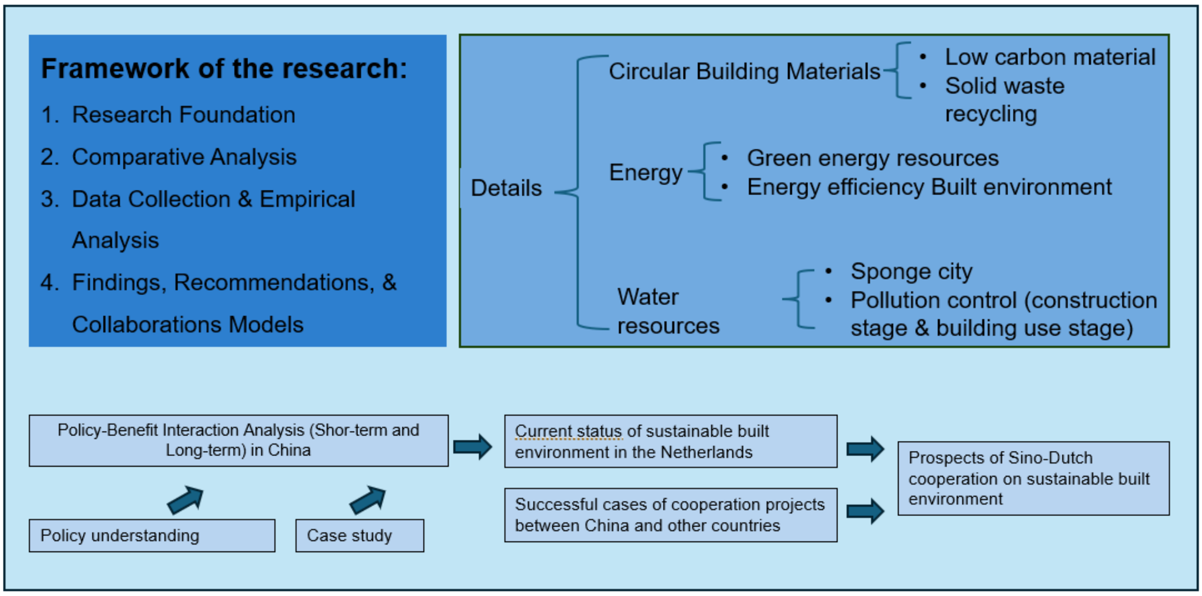
This report is organized in a logical progression from background context to comparative policy analysis, case studies, and practical recommendations, reflecting both the strategic and technical dimensions of sustainable construction in China and the Netherlands:

- **Chapter 1: Introduction**
  Outlines the background, objectives, scope, methodology, and structure of the report, setting the stage for a balanced and evidence-based analysis.
- **Chapter 2: History and Current Policy of Sustainability Development in China**
  Provides a historical and institutional overview of China's sustainable development agenda, highlighting its evolving environmental governance, regulatory bodies, and strategic outlook.
- **Chapter 3: Current Sustainable Building in China**
  Examines national policies, governance mechanisms, and technical standards shaping green construction practices. Subsections cover green certification, materials, urban design, prefabrication, digital construction, economic implications, and market trends.
- **Chapter 4: Case Studies of Sustainable Built Environment in China**

Presents in-depth analyses of selected cases illustrating the implementation of sustainability goals in three domains: green materials, building energy systems, and water resource management.

- **Chapter 5: China's International Partnerships for Sustainable Building Development**
  Introduce your cooperation between China and international partners in the field of sustainable built environment, explore the convergences and divergences between Chinese and Dutch (EU) policies, and identify opportunities and challenges for bilateral cooperation in sustainable construction.
- **Chapter 6: Opportunities and Challenges in Sino-Dutch Collaboration**
  Explore the potential possibilities and specific ways of cooperation between China and the Netherlands in the field of sustainable built environment, point out the challenges that may exist in possible cooperation, and discuss and look forward to specific existing cooperation cases.
- **Chapter 7: Conclusions & Recommendations**
  Summarizes the key findings and proposes strategic, actionable recommendations for policymakers, industry stakeholders, and international partners.

Figure 1.2: Framework of the study



2. History and Current Policy of Sustainability Development in China

This chapter offers a macro-level overview of China's sustainable development landscape, outlining its historical evolution, institutional drivers, policy architecture, market incentives, and implementation challenges. It aims to contextualize the national-level priorities that shape sustainability efforts across sectors, including—but not limited to—the built environment. By situating the built environment within this broader strategic framework, the chapter provides a critical foundation for understanding the logic, constraints, and opportunities that influence the development of sustainable construction practices in China. This context is essential for international stakeholders seeking meaningful and competitive engagement with China's green transition.

2.1 The History and Current Situation of Sustainability Development in China

China's early engagement with sustainability can be traced to the 1970s, marked by its participation in the 1972 United Nations Conference on the Human Environment in Stockholm[7]—widely regarded as a catalyst for environmental awareness in many developing countries. Prior to this, China had introduced some pollution control measures but lacked a systematic framework for environmental governance.

Figure 2.1: China Sustainability Development timeline

Following the conference, environmental concerns began to receive more formal recognition in national policymaking. In 1973, the First National Environmental Protection Conference was held, and the National Environmental Protection Leading Group was established—the country's

[7] https://www.un.org/en/conferences/environment/stockholm1972

first institution dedicated specifically to environmental affairs[8]. This entity would eventually evolve into the Ministry of Environmental Protection and, later, the Ministry of Ecology and Environment.

While the concept of sustainable development had not yet taken shape in its current form, the Stockholm conference played a formative role in initiating national level thinking on the balance between economic growth and environmental protection. This ideological shift led to foundational legislative activity, including the drafting of the 1979 Trial Environmental Protection Law[9], which laid the groundwork for China's subsequent environmental governance system.

Viewed retrospectively, China's participation in the Stockholm conference marked the beginning of sustained, state-led attention to environmental issues—a trajectory that would eventually inform broader sustainability policies and institutional arrangements in the decades that followed.

Following the initial phase (1970–1990), in which China began constructing the foundations of environmental protection, the 1990s marked a significant transition toward legislative and institutional formalization. During this period, environmental considerations were more systematically integrated into national development strategies, and the architecture of environmental governance began to take clearer shape.

In 1994, China launched its own "**Agenda 21**"[10], aligning with the United Nations' global framework and signaling an explicit commitment to harmonizing economic growth with environmental protection[11]. The decade witnessed the passage of several key environmental laws, including the **Air Pollution Prevention and Control Law** (1995, revised in 2000)[12], the **Water Pollution Prevention and Control Law** (1996)[13], and the **Solid Waste Pollution Prevention and Control Law** (1995)[14]. These legislative efforts introduced more stringent regulatory standards for both industry and local government actors.

Institutional reforms also advanced in parallel. In 1998, the National Environmental Protection Agency (NEPA) was upgraded to the State Environmental Protection Administration (SEPA)[15], providing the agency with stronger legal and administrative authority to enforce environmental

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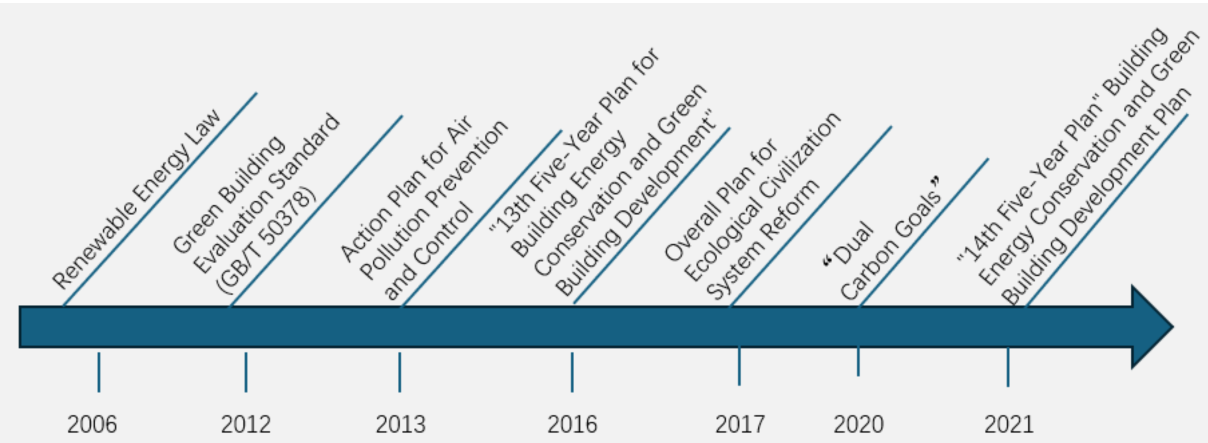
[8] China Council for International Cooperation on Environment and Development (CCICED). *China's Environmental Protection and Social Development: CCICED Task Force Summary Report*. 2013 Annual General Meeting, November 13–15, 2013, Beijing.
[9] Standing Committee of the National People's Congress. *Environmental Protection Law of the People's Republic of China (Trial)*. Adopted September 13, 1979, effective January 1, 1980.
[10] State Council of the People's Republic of China. *China's Agenda 21: White Paper on China's Population, Environment and Development in the 21st Century*. Beijing: State Council, 1994.
[11] United Nations. *Agenda 21: Programme of Action for Sustainable Development*. United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3–14 June 1992. New York: United Nations, 1993.
[12] Standing Committee of the National People's Congress. *Air Pollution Prevention and Control Law of the People's Republic of China*. Adopted in 1987, revised in 1995 and 2000. Beijing: National People's Congress.
[13] Standing Committee of the National People's Congress. *Water Pollution Prevention and Control Law of the People's Republic of China*. Revised version adopted on May 15, 1996. Beijing: National People's Congress.
[14] Standing Committee of the National People's Congress. *Solid Waste Pollution Prevention and Control Law of the People's Republic of China*. Adopted on October 30, 1995, effective April 1, 1996. Beijing: NPC.
[15] State Council of the People's Republic of China. *Institutional Reform Plan*, 1998. In this plan, the National Environmental Protection Agency (NEPA) was elevated to the ministerial level and renamed the State Environmental Protection Administration (SEPA).

regulations and guide implementation at local levels. This transition marked a shift from politically driven environmental signaling to more structured, legally anchored governance.

These policy and institutional reforms were accompanied by measurable improvements in environmental indicators. Forest coverage expanded from 12% in 1980 to 16.55% by 2000[16], bolstered by large-scale initiatives such as the **Natural Forest Protection Program** (1998)[17] and the **Grain for Green Program** (1999)[18]. Air quality also improved modestly, with sulfur dioxide (SO_2) emissions in key industrial regions declining by around 10% between 1995 and 2000[19], partly due to the implementation of the **Two Control Zones** policy (1998)[20]. In urban areas, wastewater treatment capacity increased significantly, with treatment rates rising from 15% in 1990 to over 30%[21] by decade's end.

In sum, the 1990s served as a bridge between early environmental awareness and the emergence of a more coherent and enforceable sustainability governance system. This decade laid the institutional and legal groundwork for the policy integration and enforcement mechanisms that would expand in the 2000s (please refer to Figure 2.1 for a timeline of key national milestones).

Figure 2.2: Recent milestone of China's sustainability policy



Building on the institutional and legislative foundations laid during the 1990s, the 2000s marked a phase of intensified environmental enforcement, policy systemization, and expanding investment in pollution control and renewable energy. The **Environmental Impact Assessment Law** (2003)[22] introduced mandatory environmental review processes for industrial projects, strengthening ex-ante regulatory oversight. In parallel, the **Renewable Energy Law** (2005)[23] established financial and policy mechanisms to promote the deployment of wind and solar

[16] State Forestry Administration of China. *China Forestry Development Report 2000*. Beijing: China Forestry Publishing House, 2001
[17] State Forestry Administration. *Natural Forest Protection Program Outline*. 1998.
[18] State Forestry Administration. *Grain for Green Program Implementation Plan*. 1999.
[19] State Environmental Protection Administration (SEPA). *Report on the State of the Environment in China 2000*. Beijing: SEPA, 2001.
[20] State Environmental Protection Administration (SEPA). *Plan for the Division of Acid Rain Control Zones and Sulfur Dioxide Pollution Control Zones (Two Control Zones)*. 1998. Beijing: SEPA.
[21] Ministry of Construction and State Environmental Protection Administration. *China Urban Environmental Infrastructure Development Report*. Beijing: MOHURD and SEPA, 2000.
[22] Standing Committee of the National People's Congress. *Environmental Impact Assessment Law of the People's Republic of China*. Adopted on October 28, 2002, effective September 1, 2003. Beijing: NPC.
[23] Standing Committee of the National People's Congress. *Renewable Energy Law of the People's Republic of China*. Adopted on February 28, 2005, effective January 1, 2006. Beijing: NPC.

technologies—laying the groundwork for China's later clean energy expansion. In 2008, the elevation of the State Environmental Protection Administration (SEPA) to the **Ministry of Environmental Protection (MEP)** [24] significantly enhanced its institutional standing and regulatory authority.

Quantifiable improvements were recorded during this period. Urban wastewater treatment rates rose from 30% in 2000 to over 75% by 2010[25], reflecting increased investment in municipal infrastructure. Sulfur dioxide (SO_2) emissions from coal-fired power plants declined notably, supported by the nationwide rollout of flue gas desulfurization systems[26]. Forest coverage increased from 16.55% in 2000 to over 20% by 2010, driven by continued investment in afforestation programs, including the ongoing **Grain for Green** initiative[27].

At the international level, China began engaging more visibly in global climate diplomacy. Notably, during the 2009 **Copenhagen Climate Summit**[28], the Chinese government pledged to reduce the carbon intensity of its economy—signaling the beginning of formal alignment with global low-carbon development objectives. This period thus represents an important step toward integrating environmental goals with economic modernization and global governance agendas.

During the 2010s, China's environmental governance entered a phase marked by more stringent enforcement, targeted air quality interventions, and a significant acceleration in renewable energy deployment. The **Air Pollution Prevention and Control Action Plan** (2013)[29] sought to reduce urban air pollution by curbing coal dependence, phasing out outdated industrial facilities, and targeting emissions in priority regions. These actions contributed to notable declines in PM2.5 concentrations in major cities, including Beijing.

In 2015, a major revision of the **Environmental Protection Law** [30] introduced enhanced enforcement tools—such as increased penalties for non-compliance, compulsory public disclosure of pollution data, and expanded channels for public participation. Further institutional integration followed in 2018 with the creation of the **Ministry of Ecology and Environment (MEE)** [31], which consolidated environmental functions across multiple agencies to improve coherence in policy implementation and regulatory oversight.

This period also saw the rapid expansion of China's clean energy capacity. By 2019, non-fossil energy sources accounted for over 15% of total energy consumption[32], with China emerging as

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[24] State Council of the People's Republic of China. *Institutional Reform Plan of 2008*. Beijing: State Council, 2008.
[25] Ministry of Housing and Urban-Rural Development (MOHURD) and Ministry of Ecology and Environment (formerly SEPA/MEP). *China Urban Environmental Sanitation Development Report 2010*. Beijing: MOHURD, 2011.
[26] Ministry of Environmental Protection. *China Environment Yearbook 2010*. Beijing: China Environmental Science Press, 2011.
[27] State Forestry Administration. *China Forestry Development Report 2010*. Beijing: China Forestry Publishing House, 2011.
[28] National Development and Reform Commission (NDRC). *China's Policies and Actions for Addressing Climate Change – The 2009 Annual Report*. Beijing: NDRC, 2009.
[29] State Council of the People's Republic of China. *Air Pollution Prevention and Control Action Plan*. Beijing: State Council, 2013.
[30] Standing Committee of the National People's Congress. *Environmental Protection Law of the People's Republic of China* (Revised). Adopted April 24, 2014, effective January 1, 2015. Beijing: NPC.
[31] State Council of the People's Republic of China. *Institutional Reform Plan of the State Council 2018*. Beijing: State Council, 2018.
[32] National Energy Administration. *China Energy Development Report 2019*. Beijing: NEA, 2020.

the global leader in wind and solar power generation. Forest coverage expanded to 23% by 2020[33], driven by sustained investment in afforestation and ecological restoration programs.

At the international level, China broadened its participation in global climate governance. It launched multiple regional carbon trading pilots, laid groundwork for a national carbon market, and committed to increasingly ambitious renewable energy targets. These developments signaled China's intention to position itself as a proactive actor in shaping global sustainability norms—although the balance between domestic priorities and international expectations remains a dynamic and evolving issue.

Since 2020, China has entered a new policy phase centered on structural decarbonization, green industrial transformation, and more visible engagement in global climate governance. The announcement of the country's "dual carbon" goals—to peak carbon emissions before 2030 and achieve carbon neutrality by 2060—marked a strategic shift in national planning[34]. These targets have since been institutionalized through major planning documents such as the **14th Five-Year Plan (2021–2025)**[35], which outlines a broad range of measures including improved energy efficiency, reduced coal dependency, and scaled-up incentives for clean technology deployment.

To support this transition, China launched its **national Emissions Trading System (ETS)** in 2021[36], beginning with the power sector and with plans to expand to carbon-intensive industries such as steel and cement. The share of non-fossil energy in the national energy mix has continued to increase, underpinned by record investments in solar, wind, battery storage, and hydrogen. By 2023, China accounted for nearly half of global installed solar and wind capacity[37]. In parallel, the adoption of electric vehicles (EVs) accelerated sharply, with EVs comprising more than 30% of new car sales in 2023[38]—a trend driven by a combination of industrial policy support and manufacturing innovation.

Internationally, China reaffirmed its climate-related commitments at UN Climate Change conferences framework at **COP26 (2021)** and **COP28 (2023)**[39], including pledges to reduce methane emissions and to end the financing of overseas coal projects under the Belt and Road Initiative[40]. These moves indicate a growing emphasis on green investment and climate-aligned infrastructure development. However, structural challenges remain—particularly the tension between short-term economic stabilization and long-term decarbonization goals. Temporary

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[33] State Forestry and Grassland Administration. *China Forestry and Grassland Development Report 2021*. Beijing: China Forestry Publishing House, 2021.
[34] Xi Jinping. *Statement at the General Debate of the 75th Session of the United Nations General Assembly*, September 22, 2020.
[35] State Council of the People's Republic of China. *The 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Long-Range Objectives Through the Year 2035*. Beijing: State Council, 2021.
[36] Ministry of Ecology and Environment. *Interim Regulations on the Management of Carbon Emissions Trading*. Beijing: MEE, 2021.
[37] International Energy Agency (IEA). *World Energy Outlook 2023*. Paris: IEA, 2023.
[38] China Association of Automobile Manufacturers (CAAM). *China Automotive Industry Annual Report 2023*. Beijing: CAAM, 2024.
[39] Ministry of Ecology and Environment. *China's Position Paper on Climate Cooperation and COP Commitments*. Beijing: MEE, 2021 & 2023.
[40] Xinhua News Agency. *President Xi Jinping's Speech at the UN General Assembly*, September 2021.

increases in coal production and consumption[41], for instance, underscore the complexities of managing this dual agenda.

Looking forward, China is expected to continue refining its carbon market architecture, promoting low-carbon industrial transitions, and investing in next-generation clean energy systems. While the pace and consistency of implementation will vary across regions and sectors, these shifts are likely to influence regulatory environments and reshape market opportunities. For countries such as the Netherlands, maintaining close observation of these developments is crucial—not only for anticipating risks and avoiding policy mismatches, but also for identifying areas of strategic alignment and targeted cooperation in green building technologies, materials innovation, and sustainable infrastructure solutions.

2.2 Guidance System and Corresponding Supervision Departments on Sustainability

Before examining China's environmental policy documents in detail, it is essential to understand the structure of its sustainability governance system. This includes the institutional hierarchy, functional roles of relevant actors, and the relationships among legal instruments, administrative bodies, and enforcement mechanisms.

Figure 2.3: Policy document system of China's sustainability management

Type of documents	Features
Laws and regulations	It is binding and is a top-level design at the national level, which clarifies the basic requirements and legal responsibilities in the field of construction engineering.
Policy Documents	Issued by the State Council or ministries, it clarifies the national strategic goals and implementation paths and has strong guiding and binding force.
Standards	It is issued by the state or industry, has technical binding force, is the concretization of laws, regulations and policy documents, and directly guides engineering practice.
Technical guide	Issued by government departments or industry associations, it provides specific technical requirements and operating methods, and is a supplement and refinement of standard documents.
Plan	Issued by government departments or industry associations, it provides specific technical requirements and operating methods, and is a supplement and refinement of standard documents.
Local documents	The specific implementation plans formulated by various regions based on national policies are highly regionally targeted, but have limited scope of application.
Pilot projects	Promoting advanced technologies and experiences through specific cases has a strong demonstration effect, but its binding force and scope of application are limited.
Industry Reports and White Papers	It provides industry development trends, data analysis and policy recommendations, which are of reference value but not binding.

[41] International Energy Agency. *Coal 2023: Analysis and Forecasts to 2026*. Paris: IEA, 2023.

At the national level, the **National People's Congress (NPC)** is China's highest legislative authority, responsible for enacting, amending, and repealing laws. Within the NPC, the **Environment and Resources Protection Committee** reviews environment-related legislation and oversees policy implementation, while the **Legislative Affairs Committee** is tasked with drafting and revising legal texts.

The **State Council**, China's top executive body, plays a central role in implementing laws and coordinating policy across ministries. Under its jurisdiction, the **Ministry of Ecology and Environment (MEE)** serves as the primary regulatory authority for environmental protection. The MEE is responsible for setting national environmental standards, monitoring compliance, and enforcing relevant regulations. It also collaborates with other ministries to promote integrated approaches to sustainability and ecological governance.

The **National Development and Reform Commission (NDRC)** occupies a strategic role by integrating environmental objectives into broader macroeconomic planning. Its functions include setting energy efficiency goals, formulating carbon reduction strategies, and supporting investment in green technologies. As the central body for economic planning, the NDRC helps shape long-term trajectories toward low-carbon development.

Other ministries with significant roles in sustainability governance include:

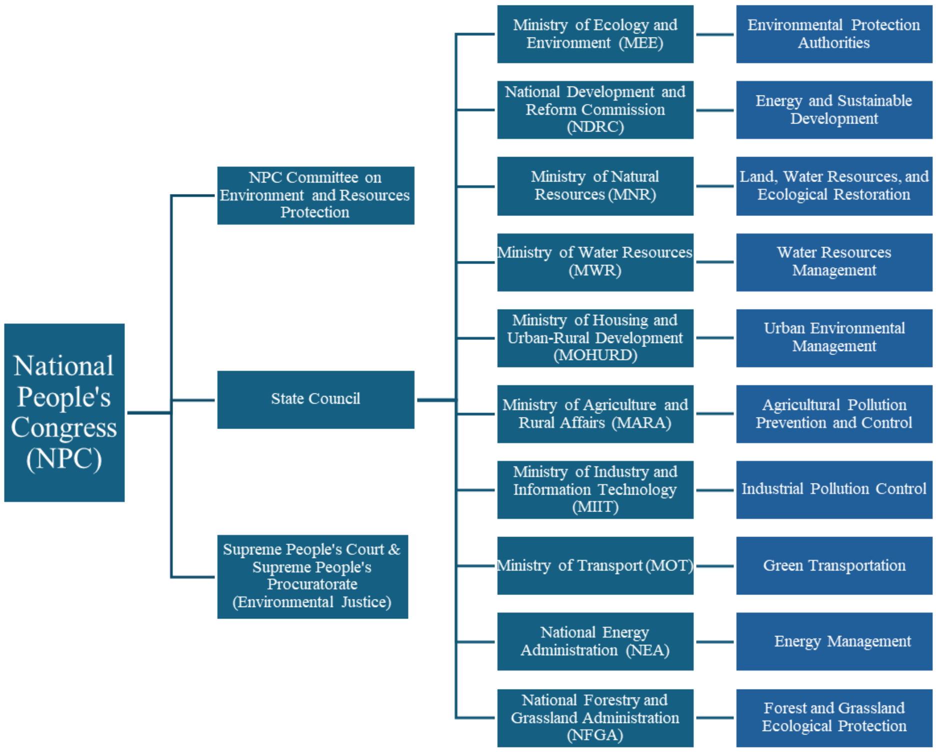
- The **Ministry of Natural Resources (MNR)**, which oversees land use, mineral resource management, and ecological restoration, embedding environmental objectives into spatial planning;
- The **Ministry of Water Resources (MWR)**, which manages water conservation, river basin systems, and pollution control;
- The **Ministry of Housing and Urban-Rural Development (MOHURD)**, which directs sustainable urbanization policies, including green building development, municipal infrastructure, and waste management systems.

At the subnational level, **provincial, municipal, and county governments** are responsible for implementing national sustainability policies through their respective **Ecology and Environment Bureaus**. These local departments are tasked with adapting national policies to local conditions, ensuring compliance with regulatory standards, and coordinating with industries and agricultural sectors. Their responsibilities include conducting environmental impact assessments (EIAs), enforcing pollution control measures, and promoting circular economy practices.

China has also developed a range of **supervisory and legal accountability mechanisms** to strengthen environmental governance. The **National Supervisory Commission**, along with the judicial system—including the **Supreme People's Court** and the **Supreme People's Procuratorate**—can investigate and prosecute environmental violations. In addition, **environmental public interest litigation** has emerged as a growing legal tool for enforcement, often initiated by non-governmental organizations (NGOs) or public prosecutors.

Together, these legislative, executive, and judicial bodies form a multi-tiered institutional structure for sustainability governance. This framework facilitates inter-agency coordination, enhances enforcement capacity, and supports the achievement of long-term environmental and climate objectives. A schematic overview of this system is presented in **Figure 2.4**, which visually maps the main supervisory bodies and their respective functional linkages across administrative levels.

Figure 2.4: Institutional framework of China's sustainability governance system



2.3 Future Planning and Strategic Prospects

Building upon the phased development of environmental governance (Section 2.1) and the increasingly institutionalized regulatory system (Section 2.2), China's sustainability agenda is now entering a new stage. This transition is shaped by both domestic environmental pressures and international climate commitments—most notably the "dual carbon" targets of peaking carbon emissions before 2030 and achieving carbon neutrality by 2060. Future planning is expected to focus on deeper integration between long-term national strategies and sector-specific implementation pathways.

China's evolving sustainability governance is likely to emphasize five interrelated strategic directions:

1) Advancing Climate Governance and Emissions Control

China is expected to further develop its national **emissions trading system (ETS)**, with possible expansion into construction, transport, and other carbon-intensive sectors. Complementary instruments—such as carbon taxation, performance-based standards, and sectoral emissions caps—are also being explored to strengthen regulatory reach and improve market-based enforcement.

2) Strengthening Cross-Sectoral Coordination

Inter-ministerial coordination will become increasingly important—particularly among the **NDRC**, **MEE**, **MOHURD**, and other central agencies—to align sustainability objectives with spatial planning, infrastructure financing, and industrial transformation. Integrated planning across sectors such as energy, mobility, housing, and water will be key to building a coherent sustainability model.

3) Promoting Green Technology and Financial Innovation

Strategic support will continue for emerging low-carbon technologies, including green hydrogen, advanced battery storage, carbon capture and storage (CCS), and intelligent urban infrastructure. Meanwhile, **green finance instruments—**such as ESG disclosure rules, sustainability-linked bonds, and green credit channels—are expected to mobilize capital toward innovation-driven and climate-aligned investments.

4) Deepening Legal and Institutional Reform

China is likely to expand its environmental legal framework through new standards for pollution control, energy performance, and ecosystem protection. The role of **environmental courts**, **public interest litigation**, and **citizen participation mechanisms** is also expected to grow, reinforcing the legal accountability of industries, local governments, and other stakeholders.

5) Expanding International Cooperation

China is anticipated to maintain an active presence in global sustainability governance through ongoing participation in international climate agreements and cooperation frameworks under the **Belt and Road Initiative (BRI)**. Collaborative efforts—including joint research, low-carbon technology exchanges, and sustainable finance partnerships with the EU, ASEAN, and other regions—will further embed China within international sustainability networks.

While these strategic priorities define the broader national agenda, their practical significance will hinge on how they are implemented across key sectors. Among these, the **built environment** stands out as a particularly impactful domain, given its large share of China's total energy use, material consumption, and carbon emissions. The way cities are designed, buildings constructed, and infrastructure managed will play a decisive role in determining the country's ability to meet its environmental goals.

Within this context, approaches such as sustainable architectural design, circular use of green materials, energy-efficient construction systems, and nature-based urban infrastructure (e.g., **sponge cities**) are gaining traction in both national and local policy agendas.

Taken together, these developments indicate a shift in China's sustainability governance—from a centrally driven model toward one that increasingly emphasizes policy experimentation, market mechanisms, and implementation effectiveness. This shift will be further explored in the next chapter, which focuses on the evolution of China’s green building sector as a practical manifestation of these strategic trends.

3. Current Sustainable Building in China

3.1 National Policies and Governance Framework

This section examines the national governance architecture and policy instruments that shape China's transition toward a more sustainable built environment. Given that the construction sector accounts for over 40% of the country's energy consumption and more than 50% of raw material use[42], the institutional design and regulatory logic behind sustainability policies in this domain carry significant implications—not only for China's domestic decarbonization, but also for international cooperation and market entry strategies.

The analysis begins by outlining the institutional responsibilities and technical standard-setting mechanisms that govern the sector (Section 3.1.1), followed by a review of recent national action plans and regulatory initiatives aimed at accelerating energy conservation, carbon reduction, and material circularity (Section 3.1.2).

3.1.1 Institutional Responsibilities and Technical Governance

China's governance of the sustainable built environment operates through a multi-layered institutional framework that integrates central ministries, technical bodies, expert committees, and local implementation agencies. This system supports both top-down policy coordination and bottom-up experimentation, enabling national sustainability goals to be translated into regulatory codes, technical standards, and sectoral enforcement tools.

At the central level, the **Ministry of Housing and Urban-Rural Development (MOHURD)** serves as the lead policymaking authority for the building sector. MOHURD is responsible for setting national strategies on energy efficiency, carbon emissions control, green construction methods, and urban ecological development. It also issues baseline regulatory documents that guide local governments and construction enterprises.

Under the State Council's unified coordination, MOHURD works alongside the **Ministry of Ecology and Environment (MEE)** and the **National Development and Reform Commission (NDRC)**. These agencies provide technical input, integrate environmental targets into broader national planning, and contribute to cross-sectoral alignment—particularly in areas such as carbon accounting, lifecycle emissions, and sustainable infrastructure investment.

From a technical governance standpoint, the **China Academy of Building Research (CABR)** plays a pivotal role. As China's national-level research institution in the field of construction science, CABR is entrusted with the drafting of key technical codes, pilot testing of policy instruments, and dissemination of evaluation frameworks. In summary, all national building and green construction standards in China are formally issued by the Ministry of Housing and Urban-Rural Development (MOHURD), while the China Academy of Building Research (CABR) typically serves as the lead drafting body. This institutional configuration means that any international dialogue on technical code alignment or joint standard development must engage with MOHURD

[42] United Nations Environment Programme (UNEP). *2020 Global Status Report for Buildings and Construction*. Nairobi: UNEP, 2020.

as the formal policymaking authority and CABR as the designated technical counterpart. It leads the development of standards such as:

- **GB/T 50378: Green Building Evaluation Standard**[43], which evaluates buildings across five dimensions (land saving, energy saving, water saving, material efficiency, and indoor environmental quality), assigning star-level performance ratings;
- **GB 55015-2021: General Code for Energy Efficiency and Renewable Energy Application in Buildings**[44], a more recent code that outlines mandatory requirements for the integration of renewables and high-efficiency systems in public and commercial projects.

These technical standards are supported by a network of expert bodies, including the **China Green Building and Energy Conservation Committee**, the **National Environmental Advisory Committee**, and municipal-level technical review panels. These committees conduct compliance assessments, policy reviews, and third-party evaluations for green building certification or pilot project approval.

Local **construction bureaus at the provincial and municipal levels** play a key role in interpreting and applying national standards. They are responsible for issuing project-level construction permits, conducting on-site inspections, managing annual sustainability targets, and offering local financial or procedural incentives. Some cities—such as Shenzhen, Chengdu, and Ningbo—have established their own green building regulations that exceed national baselines, often supported by digital tracking systems and local certification platforms.

Institutional coordination is maintained through a combination of vertical accountability (from central to local levels) and horizontal mechanisms such as inter-ministerial working groups or joint action plans. This hybrid system allows for policy flexibility while ensuring top-level alignment on long-term targets such as carbon neutrality and circular construction.

For international actors—particularly from countries such as the Netherlands—understanding the roles of MOHURD, CABR, and local construction authorities is essential for identifying points of entry into China's sustainable construction market. Dutch institutions and companies may find opportunities to contribute to technical standard setting, joint demonstration projects, or material certification processes, especially in regions prioritized for policy innovation or international cooperation.

3.1.2 Major National Action Plans and Policy Instruments

To advance its national "dual carbon" goals—peaking carbon emissions before 2030 and achieving carbon neutrality by 2060—China has introduced a series of targeted strategies for greening the construction sector. Among these, the most recent and influential is the **Action Plan**

[43] Ministry of Housing and Urban-Rural Development. *GB/T 50378—Green Building Evaluation Standard* (2019 Edition). Beijing: China Architecture & Building Press, 2019.
[44] Ministry of Housing and Urban-Rural Development. *GB 55015-2021—General Code for Energy Efficiency and Renewable Energy Application in Buildings*. Beijing: China Architecture & Building Press, 2021.

for Accelerating Energy Conservation and Carbon Reduction in the Construction Sector[45], issued by the **Ministry of Housing and Urban-Rural Development (MOHURD)** in 2024.

This three-year policy initiative sets out two primary targets:

- **By 2025**: Establish a comprehensive regulatory and technical system for energy conservation and carbon mitigation in buildings, including updated codes and clearer enforcement pathways;
- **By 2027**: Expand the implementation of ultra-low energy buildings and retrofit existing structures at scale across major urban clusters.

To operationalize these goals, the plan identifies **eleven core action areas**, which are grouped under three strategic pillars:

1) Building Operation Energy Management

This pillar focuses on improving the energy performance of buildings throughout their lifecycle:

- Enhance design standards for lighting, ventilation, and thermal insulation;
- Replace traditional fossil fuel systems with renewable energy sources such as solar and geothermal;
- Retrofit existing buildings with smart energy management systems for lighting, heating, and cooling;
- Promote large-scale adoption of **ultra-low energy buildings**, particularly in high-density regions such as the **Beijing–Tianjin–Hebei area** and the **Yangtze River Delta**.

2) Green Building Materials and Circular Construction

To reduce embodied carbon and resource intensity, the plan calls for:

- Expanding the use of **prefabricated and modular construction systems**;
- Upgrading and standardizing the **national green building materials certification system**;
- Developing a **digital database** for green materials to enable traceable, project-level material tracking and life cycle assessment;
- Encouraging the **reuse of construction and demolition waste**, including recycled aggregates and secondary materials.

3) Regulatory Enforcement and Financial Incentives

To ensure implementation, the plan emphasizes:

- Strengthening oversight mechanisms, performance audits, and data transparency;
- Offering **fiscal subsidies, tax incentives**, and preferential procurement for green buildings and certified materials;

[45] Ministry of Housing and Urban-Rural Development & National Development and Reform Commission. *Action Plan for Accelerating Energy Conservation and Carbon Reduction in the Construction Sector*. Beijing: MOHURD & NDRC, 2022.

- Supporting the creation of **public-private partnerships (PPPs)** and regional pilot zones to test and scale innovative technologies.

In addition to its technical mandates, this action plan functions as a **policy sandbox**, encouraging local governments to tailor implementation strategies based on regional conditions while maintaining national alignment. Local adaptation is particularly emphasized in **demonstration zones, industrial parks**, and **publicly funded construction projects**.

Table 3.1 summarizes the 11 core tasks outlined in the 2024 national action plan, structured according to the plan's three strategic pillars. The categorization highlights how technical measures (e.g., energy systems and material flows) are supported by regulatory and financial mechanisms to accelerate implementation.

Importantly, the experience gained in economically advanced areas is expected to be codified and disseminated as **mandatory practice** in less-developed regions over time—indicating a progressive nationwide rollout of stricter sustainability standards.

For international stakeholders, including Dutch companies and research institutes, this action plan offers valuable entry points. These include participation in local demonstration projects, provision of certified low-carbon materials, digital design and monitoring tools, or advisory services on circular building practices. Strategic engagement at this stage may help position international actors ahead of future national standardization cycles.

Table 3.1: Core Tasks of China's 2024 Construction Sector Decarbonization Action Plan

Strategic Pillar	Core Tasks
1. Building Operation Energy Management	- Improve energy-efficient design for lighting, ventilation, and insulation
	- Replace fossil fuel systems with renewable energy (e.g., solar, geothermal)
	- Retrofit existing buildings with smart lighting and HVAC systems
	- Promote large-scale adoption of ultra-low energy buildings in key urban regions
2. Green Building Materials and Circularity	- Expand use of prefabricated and modular construction systems
	- Enhance and standardize national green building material certification
	- Develop a digitalized material tracking system for project-level management
	- Encourage reuse of demolition waste and recycled aggregates
3. Regulatory Enforcement and Financial Incentives	- Strengthen regulatory oversight, audits, and performance tracking
	- Offer fiscal subsidies, tax incentives, and green procurement mechanisms
	- Promote public-private partnerships (PPPs) and pilot zones for innovative technology deployment

3.2 Practices in China's Sustainable Built Environment

To support the transition toward green and energy-efficient construction, China has established a nationwide green building evaluation and certification framework. This system not only sets technical benchmarks for environmental performance but also guides project-level design and investment decisions across different building types.

Building on the national governance framework and strategic targets outlined in Section 3.1, this section examines how China is translating high-level sustainability goals into concrete practices within the construction and urban development sectors. The transformation toward a greener built environment is being driven not only by policy mandates, but also by evolving technical standards, market incentives, and spatial design principles.

To operationalize its dual objectives of carbon reduction and resource efficiency, China has developed a comprehensive set of institutional mechanisms targeting four critical domains:

1. **Green building evaluation and labeling**, which guides sustainable design, construction, and retrofitting at the project level;
2. **Green materials and circular construction**, focusing on decarbonizing the supply chain and promoting resource reuse;
3. **Sustainable urban space design**, which redefines planning norms to create compact, resilient, and people-oriented urban environments;
4. **Prefabrication and intelligent construction**, which introduces industrialized building systems and digital technologies for low-carbon and high-efficiency delivery.

Each of these domains involves its own technical standards, policy frameworks, and incentive mechanisms, while collectively contributing to China's broader green development strategy. Moreover, they provide actionable reference points for international cooperation, particularly with countries like the Netherlands that have advanced experience in energy-efficient buildings, digital urban planning, and circular construction technologies.

The following subsections detail China's evolving approaches in each domain, highlighting national and local practices, policy tools, and potential touchpoints for cross-border collaboration.

3.2.1 Green Building Evaluation and Labeling System

To promote environmentally responsible and energy-efficient construction, China has established a nationwide **Green Building Labeling System** [46] that sets unified technical benchmarks while allowing for regional flexibility. This system serves as a critical regulatory and market mechanism to guide project-level design, certification, and investment decisions across new construction, renovation, and industrial applications.

3.2.1.1 Labeling Framework and Evaluation Standards

Formally institutionalized in 2021 through the release of the *Green Building Label Management Measures*, the labeling system is structured across three performance tiers—**one-star**, **two-star**, and **three-star**—each representing progressively higher sustainability criteria.
Project evaluation is conducted based on building type, using the following national technical standards:

[46] Ministry of Housing and Urban-Rural Development. *Administrative Measures for Green Building Evaluation Labels* (2014 Revision). Beijing: MOHURD, 2014.

- **New civil buildings** are assessed under the ***Green Building Evaluation Standard (GB/T 50378)***[43]**,** which covers seven evaluation dimensions:
    - Mandatory baseline compliance,
    - Innovation,
    - Structural safety and durability,
    - Health and indoor comfort,
    - User convenience,
    - Resource efficiency,
    - Environmental integration.
- **Industrial buildings** follow the ***Green Industrial Building Evaluation Standard (GB/T 50878)***[47]**,** which emphasizes energy performance, pollution control, and occupational health. Evaluation is based on full operational performance, conducted **one year after stable use**, reflecting a lifecycle-based assessment model.
- **Renovated existing buildings** are evaluated under ***Evaluation Standard for Green Warehouse (GB/T 51141–2016)***[48], which shares the same core structure as GB/T 50378 but applies **adjusted thresholds** to accommodate retrofit limitations.

3.2.1.2 Certification Authorities and Regional Adaptation

Labeling responsibilities are tiered according to certification level:

Label Level	Approval Authority
Three-star	Ministry of Housing and Urban-Rural Development (MOHURD)
Two-star	Provincial housing and urban development departments
One-star	Municipal-level authorities

While the technical standards are nationally unified, local governments are permitted to refine implementation rules for **one-star and two-star certifications**, as long as they remain within national regulatory bounds. This enables localized adaptation to different climatic, economic, or policy priorities.

3.2.1.3 Incentive Mechanisms and Regional Variation

Participation in the green labeling program is **voluntary**, and its uptake is largely incentivized through a mix of financial support, regulatory preferences, and reputational advantages. However, **incentive policies are not standardized nationally**, resulting in significant variation across regions:

[47] Ministry of Housing and Urban-Rural Development. *GB/T 50878—Green Industrial Building Evaluation Standard*. Beijing: China Architecture & Building Press, 2013.
[48] Ministry of Housing and Urban-Rural Development & National Development and Reform Commission. *GB/T 51141–2016—Evaluation Standard for Green Warehouse*. Beijing: China Architecture & Building Press, 2016.

- **Beijing** offers subsidies of RMB 50/m^2 for two-star projects and RMB 80/m^2 for three-star projects, with a maximum of RMB 8 million per project.
- **Shanghai** applies a similar financial model but does not impose a funding cap.
- **Heilongjiang**, constrained by budgetary limitations, does not offer direct subsidies. Instead, it grants **bonus points in project evaluations** and is exploring mortgage interest reductions for homebuyers of certified green buildings.

Subsidies for green buildings vary from province to province and may fluctuate over time, so interested readers are advised to contact the relevant local government's Housing and Urban-Rural Development Bureau directly to inquire.

3.2.1.4 Strategic Implications and International Relevance

China's Green Building Labeling System represents a **standardized yet adaptive framework** that accommodates diverse building functions and regional conditions. By tightly coupling certification with policy incentives and design regulations, it has become a **cornerstone of the national green construction strategy**.

For international stakeholders—especially Dutch firms with expertise in sustainable design, energy performance modeling, or green certification—the system offers several **potential entry points**:

- Collaboration on aligning international and Chinese green certification frameworks (e.g., BREEAM or WELL with GB/T 50378);
- Technical assistance in digitalizing the certification and evaluation process;
- Joint development of benchmarking tools for lifecycle performance in retrofitted or industrial projects.

As China continues to refine its environmental performance standards and green procurement mechanisms, the green building labeling system will remain a critical platform for both **policy innovation and market engagement**.

While the Green Building Labeling System has significantly advanced China's sustainability agenda, future improvements are likely to emphasize performance-based monitoring, integration with carbon accounting mechanisms, and cross-sector interoperability with smart city platforms. A key challenge remains the consistency of evaluation practices across regions, particularly as local governments retain discretion in interpreting and applying one- and two-star standards.

The uneven distribution of policy incentives across provinces further contributes to fragmented market signals, complicating national coherence and investor predictability. For foreign firms, especially those exploring entry into China's sustainable construction market, this underscores the need for region-specific feasibility assessments and adaptive business strategies.

At the same time, these evolving dynamics present opportunities for international cooperation—such as the co-development of digital certification platforms, joint pilot zones, or mechanisms for mutual recognition of green building standards between China and the EU.

3.2.2 Green Materials and Circular Construction

As China advances its green building agenda, the sustainability of construction materials and the circular management of resources have become central policy concerns. This section examines how national certification systems, waste recovery policies, and local implementation efforts are converging to promote low-carbon, resource-efficient construction practices. It also highlights emerging opportunities for international collaboration in material standards, lifecycle tools, and industrial innovation zones.

3.2.2.1 Certification Framework for Green Materials

To support China's shift toward sustainable construction practices, a nationally coordinated certification framework for green building materials was launched in 2020 with the release of the ***Green Building Materials Product Certification Implementation Rules*** [49]. This system categorizes certified materials into three levels—**Basic**, **Preferred**, and **Leader**—based on increasingly stringent environmental performance indicators.

The certification process is overseen by the **Certification and Accreditation Administration of China (CNCA)** [50] and applies to a wide range of materials, including cement, steel, glass, ceramics, insulation, waterproofing, and coatings. Accredited institutions evaluate these materials according to criteria such as:

- Sourcing of raw materials
- Energy intensity during production
- Emission levels and pollutant control
- Durability and environmental impact
- End-of-life recyclability

Certified products are listed in the **Green Building Materials Product Catalog**[51], which functions as an official reference for public procurement and infrastructure projects. For international suppliers, inclusion in this catalog may become a prerequisite for accessing China's publicly funded construction market, thus presenting opportunities for cooperation in third-party testing and standard alignment.

Compared to LEED (US)[52] or BREEAM (UK)[53], China's green material certification emphasizes carbon intensity and traceability within domestic supply chains. Opportunities may emerge for harmonizing evaluation metrics or enabling mutual recognition protocols in international construction projects.

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[49] China National Certification and Accreditation Administration (CNCA). *Green Building Materials Product Certification Implementation Rules*. Beijing: CNCA, 2020.
[50] https://www.cnca.gov.cn/
[51] Ministry of Industry and Information Technology & Ministry of Housing and Urban-Rural Development. *Green Building Materials Product Catalog (First Batch)*. Beijing: MIIT & MOHURD, 2021.
[52] U.S. Green Building Council. *LEED Reference Guide for Building Design and Construction*. Washington, D.C.: USGBC, 2019.
[53] BRE Global. *BREEAM Fees Sheet – New Construction and In-Use Schemes (2025 Edition)*. Watford, UK: BRE Global, 2025

To facilitate comparison and enhance transparency for both domestic and international stakeholders, **Table 3.2** provides a structured overview of China's three-level green building material certification system against key environmental performance criteria. This matrix highlights how requirements intensify from the Basic to Leader levels—ranging from raw material sourcing and manufacturing energy use to recyclability and lifecycle assessment documentation.

Such a framework not only guides domestic manufacturers in improving product sustainability but also offers a reference point for foreign firms seeking alignment with China's evolving green material standards and potential participation in public construction procurement.

Table 3.2: Comparison of Green Building Material Certification Levels by Evaluation Criteria

Evaluation Criteria	Basic Level	Preferred Level	Leader Level
Sourcing of Raw Materials	Meets minimum requirements	Higher proportion of sustainable sources	High share of renewable/recycled inputs
Energy Consumption During Manufacturing	No strict limit	Moderate energy use required	Low energy use required
Greenhouse Gas Emissions	Not explicitly required	Emission control standards apply	Advanced GHG reduction performance
Indoor Environmental Impact	Standard compliance	Improved performance expected	Substantial improvement over baseline
Recyclability and Disassembly	Recommended but not required	Partially required	Mandatory
Lifecycle Assessment (LCA)	Not required	LCA encouraged	LCA required and weighted in score
Documentation and Technical Submission	Minimal documentation	Moderate documentation, third-party test reports	Comprehensive documentation including LCA

3.2.2.2 Procurement Pilots and Incentive Mechanisms

To promote certified green materials, the central government in 2020 launched a pilot initiative—*Government Procurement Support for Green Building Materials to Improve Building Quality*—in eight cities including Shenzhen, Tianjin, Hangzhou, and Foshan. These pilots mandate the use of **preferred level or higher** certified materials in public sector projects.
Participating projects benefit from several incentives:

- Fast-track administrative approvals
- Bonus points in green building evaluations
- In certain cases, direct financial subsidies

These pilots represent a shift from voluntary use toward procurement-based enforcement. As China expands such programs, international companies may find entry points through partnerships with local governments, green material suppliers, or certification bodies.

3.2.2.3 Integration with Green Building Evaluation System

The ***Green Building Evaluation Standard (GB/T 50378)***[54] reinforces this system by directly linking the use of certified green materials to performance scores within the green building labeling process. In doing so, it creates a coordinated incentive structure where materials and building performance evaluation systems are aligned—encouraging consistent adoption of environmentally responsible products throughout the supply chain.

3.2.2.4 Circular Economy and Construction Waste Utilization

In parallel, China has advanced its policies on circular construction and waste recovery. The 2020 release of the ***Guidance on Promoting the Resource Utilization of Construction Waste***[55] established a national-level policy framework for promoting the recycling, reuse, and industrial-scale treatment of construction and demolition waste.

This was reinforced in the ***14th Five-Year Plan for Building Energy Efficiency and Green Building Development (2022)***[56], which set specific targets:

- By 2025, over 60% of construction waste is to be recycled nationally
- All new urban districts must be equipped with construction waste recycling infrastructure

Several technical standards were introduced to support this push, including:

- ***Green Building Materials Evaluation Guidelines – Recycled Aggregates (T/CBMF 83-2020)***[57]
- ***Technical Standard for Construction Waste Treatment and Recycling (GB/T 25179)***[58]

These documents define requirements for recycled aggregates, concrete, and prefabricated components in terms of quality control, processing methods, and applicable use cases.

3.2.2.5 Local Implementation and Case Examples

As with other aspects of green policy in China, local governments play a decisive role in implementation. For example:

- **Shenzhen** mandates the use of recycled aggregates in all public housing and municipal infrastructure such as sidewalks and landscaping bases.
- **Xiong'an New Area** enforces a 100% recycling rate for construction and demolition waste, with the repurposed materials used in prefabricated components and green infrastructure.

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[54] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *Assessment Standard for Green Building (GB/T 50378-2019)*. Beijing: China Architecture & Building Press, 2019.
[55] Ministry of Housing and Urban-Rural Development & National Development and Reform Commission. *Guidance on Promoting the Resource Utilization of Construction Waste*. Beijing: MOHURD & NDRC, 2019.
[56] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *14th Five-Year Plan for Building Energy Efficiency and Green Building Development*. Beijing: MOHURD, 2022.
[57] China Building Materials Federation, *T/CBMF 83-2020 – Green Building Materials Evaluation Guidelines: Recycled Aggregates* (Beijing: CBMF, 2020).
[58] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *Technical Standard for Construction Waste Treatment and Recycling (GB/T 25179-2010)*. Beijing: China Architecture & Building Press, 2010.

Local authorities are required to embed waste recovery into the planning and approval process. Construction firms must submit waste management plans at the project application stage, and regulatory bodies oversee sorting, transport, and reuse throughout the construction lifecycle. Projects with high recycled content may qualify for land-use bonuses, preferential procurement, or direct subsidies.

3.2.2.6 Strategic Outlook and International Opportunities

The combination of **top-down certification** and **bottom-up implementation** has created a diverse yet evolving policy landscape for green materials in China. While incentive structures are currently fragmented across provinces, a national trend toward stricter standards and performance monitoring is emerging.

For international stakeholders—particularly those in Europe experienced in LCA-based ecolabeling, recycled content verification, or digital traceability systems—China's growing emphasis on material sustainability presents several cooperation opportunities:

- Joint development of product-level lifecycle assessment (LCA) tools
- Collaboration on cross-border green materials databases and traceability platforms
- Participation in industrial pilot zones or demonstration projects focused on low-carbon construction supply chains

Strategic engagement at this stage could enable Dutch and EU firms to co-shape the material standards and data systems that will underpin China's next phase of green building transformation.

3.2.2.7 End-of-Life Building Treatment: China–Netherlands Comparison

The treatment of buildings at the end of their lifecycle—through demolition, waste recovery, and material recycling—represents a critical component of sustainable construction. Both China and the Netherlands have made significant policy and technical advances in this domain, yet their approaches differ in terms of institutional maturity, implementation effectiveness, and industrial integration.

China: Policy-led Pilot Programs with Implementation Gaps

China's strategy is largely driven by top-down policy frameworks. The *Guidance on Promoting the Resource Utilization of Construction Waste* (2020) and the *14th Five-Year Plan for Building Energy Efficiency and Green Building Development* (2022) set ambitious targets, including:

- A national construction and demolition (C&D) waste recycling rate of over 60% by 2025.
- Mandatory inclusion of recycling facilities in all new urban districts.
- Promotion of recycled aggregates and prefabricated components.

Technical standards such as GB/T 25179 (*Technical Standard for Construction Waste Treatment and Recycling*) and T/CBMF 83-2020 (*Green Building Materials Evaluation Guidelines – Recycled Aggregates*) offer guidance for quality control and use cases.

However, implementation remains uneven:

- Local variation: Cities like Shenzhen and Xiong'an enforce strict recycling mandates, but other regions lack infrastructure or oversight.
- Low market uptake: Many developers still rely on virgin materials due to cost, supply, or specification limitations.
- Fragmented supply chains: The recycling sector remains dominated by small-scale operators with limited traceability or standardization.

Netherlands: Circular Construction Embedded in Practice

In contrast, the Netherlands leads globally in end-of-life treatment integration:

- Over 90% of construction and demolition waste is recycled, driven by regulatory mandates and market incentives (Eurostat, 2023).
- Tools like Madaster provide digital material passports that enable transparent tracking and reuse of components, from demolition planning through to new construction.
- Pilot projects such as CIRCL and The Green House demonstrate the feasibility of reversible construction and high-quality reuse of prefabricated elements.

Key enablers include:

- A stable national policy framework supporting circular economy targets (50% raw material reduction by 2030, full circularity by 2050).
- Industry-wide adoption of LCA-based deconstruction planning.
- Advanced public-private collaboration among ministries, researchers, and builders.

Table 3.3: Comparative Analysis on the end-life of buildings

Dimension	China	Netherlands
Recycling Rate	Target 60% by 2025; uneven across regions	Over 90%, consistently high
Regulatory Approach	National policy + local pilot enforcement	Binding regulations + market-based instruments
Technical Tools	GB/T 25179, local demo zones	Madaster, LCA, BIM-integrated deconstruction
Implementation Maturity	Emerging, pilot-focused	Mature, industrialized

It is found that opportunities exist for joint exploration in:

- **Digital deconstruction tools**: Introducing Dutch material passport and BIM protocols into China's green pilot zones.
- **Joint standards**: Co-developing specifications for high-value recycled materials (e.g., geopolymer concrete).
- **Industrial symbiosis**: Partnering Dutch firms with Chinese industrial parks for large-scale material reuse pilots.

These collaborations could accelerate China's transition from policy aspiration to market-embedded circularity.

3.2.3 Sustainable urban space design

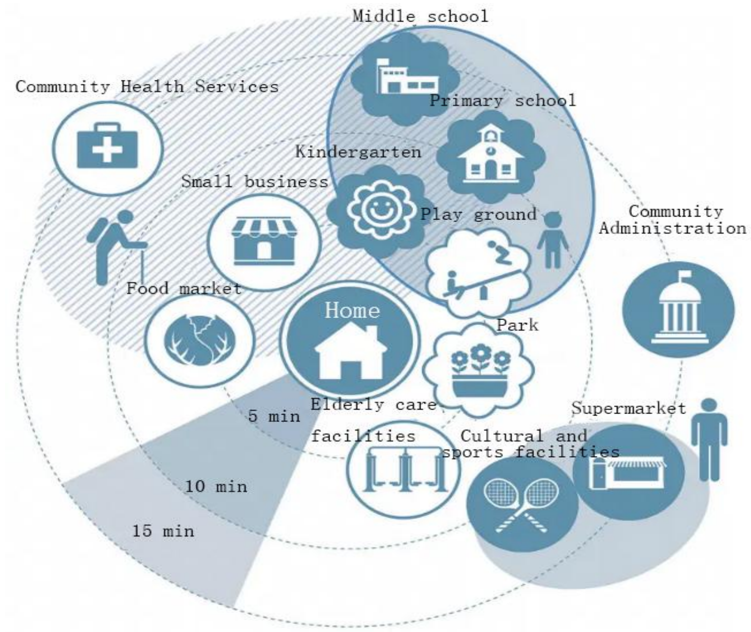
As built environments extend beyond individual buildings to include the broader urban public realm, sustainable urban space design has become a key pillar of China's green development strategy. In recent years, China has increasingly emphasized this domain as a strategic component of national urban planning. The goal is to create urban environments that are resource-efficient, ecologically resilient, and inclusive for all residents. A major policy underpinning this effort is the ***"14th Five-Year Plan for Urban and Rural Human Settlement Environment Improvement"*** (2021)[59], which outlines national objectives for enhancing the livability, ecological performance, and resilience of urban public spaces.

Urban space design in China is increasingly guided by "people-oriented" and "green-oriented" planning principles, shifting away from car-centric layouts toward compact, walkable, and mixed-use communities. The national standard "Urban Residential Area Planning and Design Standard" GB 50180-2018 was updated to reflect these priorities, incorporating metrics for public green space accessibility, pedestrian-friendly layouts, and integration of blue-green infrastructure.

One important element of sustainable urban design is the 15-minute community life circle concept, which aims to ensure that residents can access essential services—such as schools, parks, medical care, and grocery stores—within a 15-minute walk or bike ride from home (Figure 3.1). This concept was piloted in cities such as Shanghai, Chengdu, and Guangzhou, and has since been promoted by the Ministry of Natural Resources as part of spatial planning reforms.

[59] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *14th Five-Year Plan for Urban and Rural Human Settlement Environment Improvement*. Beijing: MOHURD, 2021.

Figure 3.1: Schematic diagram of the 15-minute life circle[60]



To support climate resilience and ecological sustainability, urban design also integrates green infrastructure systems, including sponge cities, urban forests, bioswales, and permeable pavements. These approaches are supported by the *"Technical Guidelines for Sponge City Construction"*, and have been implemented in more than 30 pilot cities across China.

In addition, the "National Territorial Spatial Planning System", finalized in 2023, incorporates sustainable urban design goals into long-term spatial zoning, land use efficiency requirements, and ecological redline protection. Local governments are now required to align land development with national targets for green open space ratio, non-motorized transport share, and ecosystem services.

Key Features of China's Sustainable Urban Design Approach:

- Encourage compact, mixed-use, and high-density land development
- Prioritize pedestrian- and cyclist-friendly street networks
- Incorporate blue-green infrastructure such as bioswales and sponge systems
- Promote inclusive, human-scale public spaces (e.g., pocket parks, community plazas)
- Ensure equitable spatial access to public amenities and ecosystem services

Although national guidelines provide strategic direction, local governments play a crucial role in adapting and implementing urban space design. For example, Beijing's Urban Master Plan (2016–2035) prioritizes "compact city form" and "public transit-oriented development (TOD)", while Shenzhen focuses on digital twins and smart city integration for adaptive planning. These

[60] Z. Qian, Q. Liu, D. Huang, "Three Scales and Planning Trends of 15-Minute Life Circle", *International Urban Planning*, 1673-9493（2022）05-0063-08, doi:10.19830/j.upi.2021.448

localized adaptations reflect the diverse geographic, economic, and demographic conditions across Chinese cities.

For international stakeholders—particularly urban planners, climate adaptation experts, and public space designers—China's experience presents both practical models and strategic collaboration opportunities. European partners may engage in joint demonstration zones, resilient landscape design, or spatial planning innovation in areas such as digital twins, 15-minute neighborhoods, and green infrastructure retrofits.

Table 3.4: Key Policy Milestones Shaping Sustainable Urban Space Design in China (2014–2023)

Year	Policy / Document Title	Issuing Authority	Content and Significance
2014	Technical Guidelines for Sponge City Construction (Trial)	Ministry of Housing and Urban-Rural Development	Introduced the concept of 'Sponge City' for the first time, promoting urban rainwater utilization and green infrastructure development
2015	Launch of Sponge City Construction Pilot	Ministry of Finance, Ministry of Housing and Urban-Rural Development, Ministry of Water Resources	Initiated pilots in 16 cities including Wuhan, Chongqing, and Shenzhen, promoting green stormwater management systems
2016	Draft Release of Beijing Urban Master Plan (2016~2035)	Beijing Municipal Planning Authority	Clarified concepts such as 'compact urban form' and transit-oriented development (TOD)
2017	Introduction of the National '15-Minute Community Life Circle' Concept	National Development and Reform Commission (NDRC), Ministry of Housing and Urban-Rural Development	Introduced planning for community services within 15-minute walking distance, becoming a key element of people-oriented urban design
2018	Revision of Urban Residential Area Planning and Design Standards (GB 50180-2018)	Ministry of Housing and Urban-Rural Development	Added requirements for pedestrian-friendly environments, green space accessibility, and sustainable community service design indicators
2020	Opinions on Strengthening Urban Planning, Construction and Management	Central Committee of the Communist Party of China & State Council	Emphasized people-oriented, ecologically prioritized, and multifunctional approaches to urban spatial restructuring
2021	14th Five-Year Plan for Urban and Rural Living Environment Construction	National Development and Reform Commission, Ministry of Housing and Urban-Rural Development	Outlined the promotion of green city development, 15-minute living circles, urban renewal, and public space enhancement
2021	Sponge City Construction Guidelines (2021 Edition)	Joint release by the Ministry of Housing and Urban-Rural Development and two other ministries	Updated the 2014 version with stronger alignment to urban renewal and carbon neutrality goals
2022	Implementation Plan for Carbon Peaking in the Urban and Rural Construction Sector	Ministry of Housing and Urban-Rural Development	Encouraged carbon reduction through urban form optimization and green infrastructure, enhancing urban carbon sink capacity
2023	Release of the National Territorial Spatial Plan (2021~2035)	Ministry of Natural Resources	Established ecological priority and green development as spatial planning baselines; emphasized coordinated management of green space quantity, layout, and functions

3.2.4 Industrialized and Intelligent Construction: Prefabrication and Digital Transformation

3.2.4.1 Implementation Background

In recent years, China has been promoting prefabricated construction (also known as industrialized or assembly-style building) as part of its national strategy for sustainable and high-quality development in the construction industry. Prefabrication refers to the off-site production and on-site assembly of building components, which can significantly reduce construction waste, labor demand, energy consumption, and carbon emissions.

To support this shift, the State Council released the *"Guidelines on Vigorously Developing Prefabricated Buildings"* [61]in 2016, setting a target that by 2025, prefabricated buildings should account for over 30% of new construction nationwide. This target has since been reinforced by the *"14th Five-Year Plan for Construction Industry Development" (2022)*[62], which emphasizes digitalization, low-carbon construction, and full-lifecycle building information modeling (BIM) integration.

3.2.4.2 Features

China is actively advancing the development of prefabricated building systems with a focus on high industrialization and environmental efficiency. The aim is to fully leverage the advantages of prefabricated components—namely, eliminating the need for on-site production, reducing dust and noise, shortening the construction period, and enhancing quality control through standardized industrial processes. In essence, China's strategy is to shift the core construction activities from traditional on-site operations to controlled factory environments, thereby building a comprehensive system governed by the principles of industrial production and process management.

3.2.4.3 Policy & management

To guide the adoption of prefabricated construction, China has developed a comprehensive framework of technical standards and policy instruments that define core requirements for design, production, and implementation. Among the most influential are **GB/T 51231-2016** (*Technical Standard for Prefabricated Concrete Structures*)[63] and **GB/T 51232-2016** (*Technical Standard for Prefabricated Steel Structures*)[64], which are widely adopted in engineering practice to ensure component compatibility and structural safety. In parallel, the *Guidelines on the Implementation of Prefabricated Buildings by Region* issued by MOHURD provide local authorities with policy direction based on regional industrial capacity and development priorities.

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[61] General Office of the State Council of the People's Republic of China. *Guidance on Vigorously Developing Prefabricated Buildings*. Beijing: State Council, 2016

[62] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *14th Five-Year Plan for Urban and Rural Human Settlement Environment Improvement*. Beijing: MOHURD, 2021.

[63] Ministry of Housing and Urban-Rural Development of the People's Republic of China. Technical Standard for Prefabricated Concrete Structures (GB/T 51231-2016). Beijing: MOHURD, 2016.

[64] Ministry of Housing and Urban-Rural Development of the People's Republic of China. Technical Standard for Prefabricated Steel Structures (GB/T 51232-2016). Beijing: MOHURD, 2016.

Table 3.5: Key Policy Milestones Supporting Prefabricated and Intelligent Construction in China

Time	Policy / Document Name	Publishing Agency	Main content and significance
2016	Guiding Opinions on Vigorously Developing Prefabricated Buildings	State Council	Aims for prefabricated buildings to account for over 30% of new construction by 2025; encourages the establishment of dedicated industrial bases.
2017	Evaluation Standards for Prefabricated Buildings	Ministry of Housing and Urban-Rural Development	Introduces a scoring systesm to evaluate prefabrication rate, component integration, and construction efficiency.
2018	Technical standards for prefabricated concrete structures（GB/T 51231）andTechnical standards for prefabricated steel structures（GB/T 51232）	National Standardization Administration	Establishes national-level technical standards for structural design and construction of prefabricated buildings.
2020	Several opinions on accelerating the development of new building industrialization	National Development and Reform Commission, Ministry of Housing and Urban-Rural Development and other nine ministries	Promotes transformation of construction methods by supporting the integration of green materials, industrialized design, and prefabricated building systems.
2020	Guiding Opinions on Accelerating the Coordinated Development of Intelligent Construction and Building Industrialization	Ministry of Housing and Urban-Rural Development & Ministry of Industry and Information Technology	Encourages the development of intelligent construction and promotes the application of BIM, digital twins, and artificial intelligence throughout the building lifecycle.
2021	Various provinces have gradually incorporated prefabricated buildings into the "14th Five-Year Plan" construction plan	Local housing construction system	Defines target ratios for prefabricated buildings in urban areas, typically ranging from 30% to 50%.
2022	14th Five-Year Plan" Construction Industry Development Plan	Ministry of Housing and Urban-Rural Development	Emphasizes intelligent construction, green building practices, and prefabrication rate assessment, with strengthened alignment to carbon peaking targets.
2023	Guidelines for Typical Cases and Standard System Construction of Digital Building Development	Building Information Modeling Center of the Ministry of Housing and Urban-Rural Development	Defines a digital building standard framework based on BIM, integrated with AI and IoT technologies.

A key regulatory mechanism is the **National Evaluation Standard for Assembly-type Buildings (Trial, 2017)**[65], which applies a point-based methodology to assess the degree of prefabrication in building projects. Under this framework, a building qualifies as prefabricated if at least **50%** of its structural components are factory-assembled. Higher prefabrication rates are incentivized

[65] Ministry of Housing and Urban-Rural Development of the People's Republic of China. National Evaluation Standard for Assembly-type Buildings (Trial). Beijing: MOHURD, 2017.

through mechanisms such as **preferential land-use approval**, **fast-tracked permitting**, and **eligibility for public procurement programs**.

To contextualize these instruments within a broader policy landscape, **Table 3.5** outlines the key national-level policy milestones that have shaped China's prefabricated and intelligent construction agenda over the past decade. This timeline illustrates how technical standardization, digital integration, and implementation targets have evolved in parallel to support systemic change across both public and private sectors.

From an international perspective, China's coordinated approach—combining centralized standard-setting with regionally adaptive implementation—offers valuable insights for countries seeking to advance their own industrialized construction systems or explore joint demonstration projects with Chinese partners.

3.2.4.4 Intelligent Construction Integration

Alongside the promotion of prefabrication, China is advancing a national agenda for intelligent construction, which emphasizes the integration of digital technologies into the building lifecycle. This approach includes the use of:

- Building Information Modeling (BIM) for planning, coordination, and lifecycle management;
- Artificial intelligence (AI) tools to assist in design optimization and construction sequencing;
- Internet of Things (IoT) systems for real-time monitoring of safety, quality, and resource consumption on site;
- Digital twin technologies and robotics to support precision work, especially in repetitive or technically complex assembly tasks.

To support this development, the ***"Guidelines on Accelerating Intelligent Construction"*** [66] were issued in 2020 by the Ministry of Housing and Urban-Rural Development (MOHURD) and the Ministry of Industry and Information Technology (MIIT). The document sets out a national framework to guide the rollout of intelligent construction practices, including the designation of pilot demonstration zones, the establishment of enterprise-level innovation platforms, and the implementation of specialized training programs for construction professionals.

While the integration of digital construction methods is still evolving, China's experience demonstrates a policy-driven pathway to scaling up intelligent technologies across regions. These efforts may provide reference points for other countries considering similar digital transitions in the construction sector, especially where large-scale public infrastructure or industrialization of building processes is underway.

[66] Ministry of Housing and Urban-Rural Development of the People's Republic of China. *Guidelines on Accelerating Intelligent Construction*. Beijing: MOHURD, 2021.

3.2.4.5 Examples of Implementation

Several cases across China illustrate how intelligent construction is being applied in practice. In **Shenzhen**, the local government has launched a Smart Construction Site Platform that integrates BIM [67], drone-based site monitoring, and real-time scheduling systems to enhance the management of large-scale public housing projects. This approach improves construction transparency and enables more effective coordination between developers, contractors, and regulators.

At the **Beijing Daxing International Airport**, one of China's most complex infrastructure projects[68], prefabricated steel structures were combined with digital twin technologies to assist in the precise assembly of the terminal's large-span roof. The project demonstrates the application of intelligent tools in managing both geometric complexity and construction safety.
In the **Lin-gang Area of Shanghai**, prefabrication is being promoted within a broader vision of low-carbon industrial development[69]. The area is developing a series of industrial parks that adopt smart logistics systems and digitally coordinated workflows, aiming to reduce material waste and improve on-site efficiency.

These examples reflect how digital construction technologies are being integrated into both large-scale public infrastructure and regional industrial development. For international observers, they offer practical models for understanding how intelligent construction policies are translated into site-level operations, particularly under strong government coordination and urban-scale planning systems.

3.2.4.6 Local Incentives and Implementation Progress

In addition to national policy guidance, various provinces and municipalities in China have introduced region-specific incentives to promote the adoption of prefabricated and intelligent construction. These incentives reflect local policy priorities and industrial capabilities, and serve as important drivers for scaling up implementation.

In Beijing, projects that achieve a prefabrication rate of at least 50% are eligible for floor area ratio (FAR) bonuses and fast-track administrative approvals, particularly in the residential and public building sectors[70]. These incentives are designed to reduce approval timelines and improve land-use efficiency for qualified developments.

Shanghai offers direct subsidies of up to RMB 600 per square meter for prefabricated public housing projects[71]. The city also encourages integration with Building Information Modeling (BIM) and green building practices, linking prefabrication with broader urban sustainability goals.

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[67] https://www.sz.gov.cn/en_szgov/news/latest/content/post_10269051.html
[68] https://www.airport-technology.com/projects/beijing-daxing-international-airport-china
[69] https://en.lingang.gov.cn/
[70] Jiang, M., Luo, C., Wu, Z., Fei, J., & Yu, T. (2019). *An Investigation of the Effectiveness of Prefabrication Incentive Policies in China*. Sustainability, 11(19), 5149. https://doi.org/10.3390/su11195149
[71] Shanghai Municipal Commission of Housing and Urban-Rural Development, Shanghai Municipal Development and Reform Commission, and Shanghai Municipal Finance Bureau. *Special Support Measures for Building Energy Efficiency and Green Building Demonstration Projects in Shanghai*. Shanghai: Shanghai Municipal Government, 2020.

In Shandong Province, local regulations require that at least 30% of new buildings in designated cities use prefabricated components[72]. This requirement is especially emphasized in industrial parks, educational facilities, and healthcare infrastructure, where standardization and construction speed are critical.

Guangdong Province focuses on industrial capacity building by supporting the establishment of prefabrication industrial bases and digital construction innovation centers. These platforms are intended to facilitate the integration of AI-assisted tools and BIM systems in both pilot zones and commercial development areas[73].

Together, these regional approaches demonstrate how China's national targets are being translated into localized implementation strategies, and how subnational governments play a key role in shaping the pace and direction of technological adoption. For other countries exploring prefabrication or intelligent construction, these cases may offer insights into the use of targeted policy tools to accelerate sector-wide transformation.

For international stakeholders—particularly those in the Netherlands with expertise in modular construction, BIM integration, or construction robotics—China's prefabrication and digitalization agenda offers a growing field for technical cooperation, joint ventures, and pilot project participation. Aligning standards and collaborating on industrial platform development may help accelerate green construction transitions in both regions.

As China moves toward its 2030 and 2060 carbon goals, prefabrication and intelligent construction are expected to converge further—supported by deeper integration of AI, carbon tracking platforms, and national-level digital infrastructure. For foreign stakeholders, early participation in standard-setting, data sharing protocols, and intelligent manufacturing supply chains may offer strategic long-term positioning.

3.2.5 China's Non-Residential Building Stock: Scale, Regulatory Focus, and Sino-Dutch Opportunities

In addition to the residential and redevelopment markets discussed above, China's non-residential building stock represents a critical segment for advancing the green transition. As of 2021, non-residential buildings accounted for approximately **27.2%** of China's total building floor area, covering over **20.1 billion square meters**, according to the *China Building Energy Statistical Yearbook*. This category includes a wide range of property types—such as **offices, schools, hospitals, shopping centers, airports**, and other public-use buildings. In urban megaregions like the **Yangtze River Delta** and the **Greater Bay Area**, this share can exceed **35%** due to commercial density and infrastructure investment.

[72] Shandong Provincial Department of Housing and Urban-Rural Development. *Guidelines for the Management of Prefabricated Buildings in Shandong Province (Trial)*. Jinan: Shandong Provincial Department of Housing and Urban-Rural Development, 2024.
[73] Guangdong Provincial Department of Housing and Urban-Rural Development, et al. (2022). *Implementation Opinions on Promoting the Coordinated Development of Intelligent Construction and Building Industrialization* (Document No. Yuejian Shi [2021] No. 234)

From an energy perspective, the non-residential sector consumes over **38%** of total building-sector energy, despite comprising less than a third of total floor space. This is largely attributed to the high energy intensity of **HVAC systems, lighting, elevators, and IT infrastructure** in commercial and institutional settings.

To address this challenge, China has introduced a series of targeted green building and retrofit programs, including:

- **The Public Building Energy Efficiency Retrofit Program**, prioritizing upgrades for government offices, educational institutions, and hospitals;
- **Mandatory application of the Green Building Label (GBL)** in large-scale commercial and public sector projects;
- **Renewable energy integration pilots**, such as photovoltaic rooftops in airports, data centers, and industrial parks;
- **Digital control systems** for operational energy management in complex-use buildings.

These trends create concrete opportunities for **Sino-Dutch collaboration** in areas where Dutch expertise is particularly strong:

- Smart building management systems (BEMS) and AI-assisted operational analytics;
- Passive design optimization and envelope retrofitting;
- Digital twin modeling for hospital, campus, and transport hub operations;
- EPD-based lifecycle design integration in public procurement projects.

By combining China's policy ambition with the Netherlands' technology and planning know-how, the non-residential sector offers a high-potential platform for impactful bilateral cooperation.

3.3 Comparison with European Policies and Market Trends

China and the European Union (EU) both regard the built environment as a strategic sector for achieving climate neutrality. Yet, their policy frameworks for advancing sustainability in construction differ significantly in structure, priority, and enforcement—reflecting contrasting governance models, development trajectories, and market dynamics.

3.3.1 Policy Framework Comparison

China and the European Union (EU) both recognize the built environment as a key sector in achieving climate neutrality goals. However, their policy frameworks for promoting sustainability in the building sector differ in structure, emphasis, and enforcement mechanisms, shaped by their respective governance systems, market conditions, and stages of development.

3.3.1.1 Policy Drivers and Strategic Objectives

The EU's building-related climate agenda is anchored in the **European Green Deal**[74] and **Fit for 55**[75] package, targeting a 55% reduction in net greenhouse gas emissions by 2030 (compared to 1990 levels). A cornerstone policy is the **Energy Performance of Buildings Directive (EPBD)**[76], which mandates that all new buildings must meet nearly zero-energy standards (NZEB) and promotes deep renovation of the existing building stock to enhance energy performance.

In China, the building sector plays a critical role in achieving the country's **"Dual Carbon" goals—**peaking emissions before 2030 and attaining carbon neutrality by 2060. The **Work Plan for Accelerating Energy Conservation and Carbon Reduction in the Building Sector**, issued by MOHURD, sets ambitious milestones: by 2025, a comprehensive energy-saving regulatory system should be in place; by 2027, ultra-low-energy buildings should be scaled up in major urban clusters. China's approach emphasizes administrative coordination, regional pilots, and integration with broader industrial policy.

3.3.1.2 Policy Instruments and Enforcement

The EU employs **legally binding directives** that require member states to transpose EU-level targets into national legislation. For example, Germany enforces energy performance through its **Building Energy Act**, while the Netherlands applies the **BENG (Bijna Energie Neutraal Gebouw)** standard, which imposes strict thresholds on energy demand, renewable use, and building envelope efficiency. Compliance is further supported by tools such as **energy performance certificates (EPCs)**, **renovation subsidies**, and **carbon pricing mechanisms**.

China, by contrast, adopts a hybrid model characterized by **central guidance and localized enforcement**. The national **Green Building Label System** (based on GB/T 50378) is technically voluntary but has been made mandatory for public projects in some cities (e.g., Beijing, Shanghai, Shenzhen). Rather than legal compulsion, compliance is encouraged through **subsidies** (e.g., RMB 50–80/m^2), **expedited permitting**, and **bonus points in public land auctions or procurement scoring**. Implementation strength varies by locality, creating a patchwork of regulatory environments and incentive schemes.

Table 3.6: A comparison of sustainability developments between China and Europe

Dimension	China	European Union (e.g. Germany, Netherlands)
Strategic Goal	Carbon peaking by 2030, neutrality by 2060	Climate neutrality by 2050
Core Directive	Work Plan for Energy Conservation and Carbon Reduction in Buildings	Energy Performance of Buildings Directive (EPBD)
Legal Status	Guiding documents + administrative incentives	Binding legislation implemented via national laws
Building Label System	Green Building Label (1–3 stars, voluntary in most areas)	Mandatory EPCs and NZEB certification for new buildings

[74] European Commission. (2019). *The European Green Deal*. Retrieved from
[75] European Commission. (2021). *Fit for 55: Delivering the EU's 2030 Climate Target on the Way to Climate Neutrality*.
[76] European Union. (2024). *Directive (EU) 2024/1275 of the European Parliament and of the Council of 8 May 2024 on the energy performance of buildings (recast)*. Official Journal of the European Union, L 127, 1–50.

Key Focus Areas	Energy efficiency, green materials, prefabrication, digitalization	Energy efficiency, building renovation, low-carbon heating/cooling
Enforcement Mechanism	Ministry-led evaluation + local adaptation and incentives	Independent auditing, market regulation, and legal compliance

3.3.1.3 Evaluation and Performance Systems

The EU's sustainability assessment systems are increasingly **life-cycle oriented**, with emphasis on both **operational and embodied carbon**. Tools such as **Energy Performance Certificates** and **Life Cycle Assessment (LCA)** are widely used. The recently introduced **Level(s) framework** [77] provides a voluntary but structured platform for measuring environmental performance, circularity, and climate impact throughout the building lifecycle—aligning with the EU taxonomy and ESG regulations.

In China, green building performance is evaluated through **multi-criteria scoring systems**. Standards such as GB/T 50378 assess projects across dimensions including energy efficiency, water use, indoor comfort, durability, and innovation. While **whole-life carbon accounting** is not yet mainstream, it is being piloted in demonstration zones like Xiong'an New Area and Shenzhen. The integration of LCA tools and digital monitoring systems is expected to accelerate in the coming years, especially in first-tier cities and international cooperation projects.

Strategic Implications

These differences suggest distinct opportunities and risks for international engagement. The EU framework offers **stable, mature policy instruments and market predictability**, while China presents **dynamic, policy-driven growth with room for innovation and localized partnerships**. For Dutch stakeholders, aligning with China's **green pilot zones**, contributing to **LCA tool development**, or partnering on **cross-recognition of standards and materials** could be highly strategic paths forward.

3.3.2 Industry Development and Economic Impact

The development of a sustainable built environment has not only contributed to environmental objectives but also created significant economic opportunities and transformed the construction industry in both China and Europe. While both regions have seen progress in market expansion and industrial modernization, they differ in terms of development models, maturity, and economic impacts.

3.3.2.1 Industry Growth and Structural Shifts

In Europe, the green building sector has steadily matured over the past two decades. According to the World Green Building Council, green buildings now account for over 40% of new constructions in Western European countries[78], supported by strong regulatory frameworks and an environmentally aware market. The transition toward low-carbon renovation, especially in

[77] https://green-forum.ec.europa.eu/levels_en
[78] World Green Building Council. (n.d.). *Global Green Building Trends*.

residential and public buildings, has become a key growth driver, particularly in countries like Germany and the Netherlands.

In China, the green building industry has experienced rapid policy-driven growth since 2012. By 2022, certified green buildings exceeded 3 billion m^2 in total floor area, with strong regional growth in eastern and coastal cities such as Shanghai, Shenzhen, and Hangzhou. The prefabricated construction sector alone reached over 1 trillion RMB in annual output in 2021, accounting for roughly 25% of new buildings nationwide, with plans to exceed 30% by 2025[79].

The development of green building has also shifted the construction industry toward standardization, industrialization, and digitalization, leading to increased demand for specialized services such as BIM modeling, green certification, and carbon accounting.

3.3.2.2 Employment and Economic Transformation

Sustainable construction reshapes the employment landscape by transitioning from traditional labor-intensive work toward high-skilled and technology-driven roles. In Europe, the emphasis on energy-efficient retrofitting and renewable systems has spurred job creation in areas such as energy auditing, envelope design, and smart systems integration.

Similarly, China's push for prefabrication and intelligent construction has led to the emergence of new professional roles, including:

1. BIM engineers
2. Prefabrication logistics coordinators
3. Green building assessors
4. Low-carbon project planners

According to estimates from China's Ministry of Housing and Urban-Rural Development, every 1 million m^2 of green buildings can directly or indirectly create over 10,000 jobs across design, manufacturing, transportation, and construction sectors.

Moreover, the development of green building materials (e.g., recycled concrete, low-carbon cement) has stimulated regional industrial clusters, particularly in provinces like Jiangsu, Guangdong, and Sichuan, where the government provides land, tax breaks, and demonstration project opportunities.

3.3.2.3 Public Investment and Market Dynamism

In Europe, market-based mechanisms such as green finance, renovation subsidies, and energy efficiency auctions play a critical role in sustaining green building markets. Financial tools like green bonds and EU renovation wave programs help de-risk private investment and foster innovation.

In China, the development of the green building industry remains heavily reliant on government-led investment, land policy incentives, and public procurement mandates. However, with the

[79] Ministry of Housing and Urban-Rural Development of the People's Republic of China. (2022). *China Green Building Development Report 2022*

recent rise of carbon asset markets and ESG investing in real estate, there is growing private sector interest in sustainable buildings, especially in first-tier cities and high-end commercial developments.

Notably, in both regions, green construction is increasingly seen not only as a climate solution but also as a driver of green economic recovery, especially post-COVID-19.

3.3.3 Market Potential in China

China's sustainable built environment sector presents significant market potential, driven by a combination of national carbon reduction goals, urbanization, policy support, and technological advancement. With the country aiming to peak carbon emissions before 2030 and reach carbon neutrality by 2060, the construction industry—responsible for over 50% of total urban energy consumption and over 20% of total emissions—is under increasing pressure to transition toward greener and more efficient models.

Although population growth is stabilizing, China’s urbanization continues. As of 2023, over 65% of the population resides in urban areas, and the demand for infrastructure renewal, affordable housing, and public facilities remains robust. Projections suggest that by 2030, more than 2 billion m^2 of new floor area will be added annually[80]. A significant portion of this growth is expected in second-tier and inland cities, where development is increasingly tied to green construction targets. This context creates demand for low-carbon building systems, including prefabrication, digitalized design, and intelligent construction platforms.

3.3.3.1 Housing Tenure Patterns and Real Estate Composition in China

China’s residential property market is predominantly owner-occupied. According to the Seventh National Population Census (2020), the national homeownership rate exceeded 90%, one of the highest in the world[81]. This figure includes both self-owned and family-shared housing, reflecting deep-rooted cultural and social preferences for property ownership.

In parallel, the urban rental market has expanded steadily—particularly among young professionals and migrant workers. As of 2022, approximately 200 million people in China lived in rented accommodations, accounting for roughly 21% of the urban population [82]. Major cities such as Beijing, Shanghai, and Shenzhen exhibit higher rental shares (30–45%)[83], supported by the growth of large-scale institutional landlords and government-led rental housing schemes.

The social housing system remains limited compared to European benchmarks. Although affordable housing initiatives exist—including public rental housing and economically affordable housing—they only cover a small share of total housing stock (estimated below 5%)[84]. Recent

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[80] Rocky Mountain Institute. (2024). *Unlocking New Opportunities for Carbon Neutrality in China's Building Sector*.
[81] National Bureau of Statistics of China (2021). *The Seventh National Population Census Communiqué*.
[82] Beike Research Institute (2022). *China Rental Housing Development Report*.
[83] China Real Estate Index System (CREIS). Urban Housing Rental Ratio Data (2022).
[84] Ministry of Housing and Urban-Rural Development (MOHURD). *China Housing Development Annual Report 2021*.

policies are attempting to expand this segment, especially for new graduates and low-income groups.

In terms of non-residential real estate, the sector is dominated by office buildings, retail, and logistics facilities. In 2023, newly completed office buildings in major Chinese cities totaled around 48 million m^2[85], while logistics and warehouse properties have surged due to e-commerce expansion. Non-residential buildings now account for roughly 15–20% of total new floor space annually[86], though the ratio varies by region and development stage.

These dynamics shape the growth prospects of sustainable real estate in China. Owner-occupied housing often faces limited renovation incentives due to fragmented ownership, whereas rental housing and commercial real estate provide better leverage points for scaling green design and energy retrofits. Understanding these market divisions is crucial for Dutch stakeholders aiming to engage in China's green real estate transformation.

3.3.3.2 Regional Green Building Markets

The spatial distribution of market potential across China is uneven but increasingly structured:

1. **First-tier cities** (e.g., Beijing, Shanghai, Shenzhen) have adopted stricter building energy codes and mandatory green certification for public buildings. These cities show strong interest in high-performance construction and digital building technologies, and often serve as demonstration hubs for national policy pilots.
2. **Second-tier cities and emerging districts** (e.g., Chengdu, Xi'an, Hefei) are advancing large-scale urban development projects—frequently linked to sponge city programs, ecological communities, and urban regeneration—which increasingly adopt green building targets.
3. **Special zones** such as **Xiong'an New Area** are being used to trial full-lifecycle green building practices, including Building Information Modeling (BIM), digital twins, and closed-loop material management systems, providing opportunities for technological and systems integration.

3.3.3.3 Subsector Potential: Where the Growth Lies

Subsector	Market Drivers
Green Building Certification	Increasingly required for public and commercial projects; local subsidies boost adoption
Green Building Materials	Expanding green material certification system, growing demand for low-carbon materials
Prefabricated Construction	Standardization, reduced labor, and fast delivery favored in large-scale housing projects
Building Digitalization	National push for BIM, smart monitoring, and energy management systems

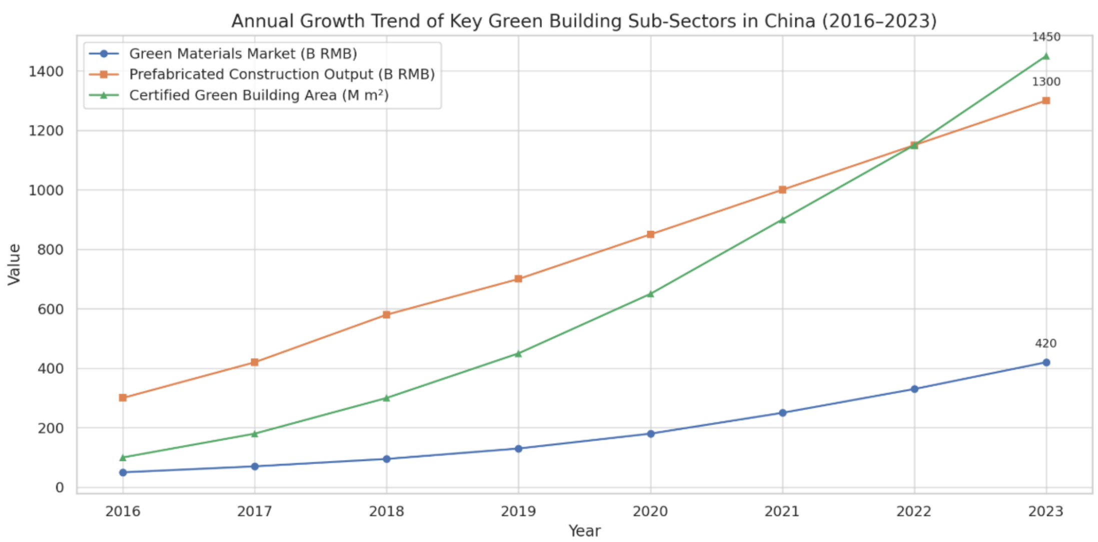
[85] CBRE (2024). *China Major Cities Office Market Annual Report*.
[86] National Bureau of Statistics of China (2023). *Annual Statistical Bulletin on Construction and Real Estate Investment*.

Green Renovation of Existing Stock	Massive aging building stock (pre-2000), especially in northern cities, targeted for retrofitting

Figure 3.3 illustrates the substantial growth across three core sub-sectors of China's green building industry: green building materials, prefabricated construction, and certified green building area. Between 2016 and 2023, the certified green building stock expanded from 200 million to 1.45 billion m^2, while the green materials market grew more than fourfold. These trends reflect the cumulative impact of policy incentives, industrial scaling, and urban development demand.

Such growth trajectories suggest potential synergies with Dutch strengths in sustainable material engineering, modular design, and digitalized construction methods—particularly in areas where lifecycle tools, certification systems, and circular practices are becoming more central to China's green transition.

Figure 3.2: Annual Growth Trend of Key Green Building Sub-Sectors in China (2016-2023) (Source: China National Bureau of Statistics, "National Statistical Yearbook")



3.3.3.4 Investment and Finance Landscape

China's green building sector is seeing increased interest from both government funding and private capital, particularly in:

- Green bonds and REITs tied to certified green projects;
- PPP models in ecological urban infrastructure;
- Carbon credit and ESG investing linked to low-carbon construction practices.

At the same time, foreign investment opportunities are expanding, especially for firms providing:

- Advanced energy modeling and LCA tools;

- Low-carbon or circular construction materials;
- Smart construction platforms, sensors, and AI-based monitoring systems.

3.3.3.5 Market Barriers and Opportunities

While the market potential is considerable, several challenges must be addressed:

1. Fragmented local policy implementation limits scalability across provinces;
2. Lack of unified carbon accounting standards in buildings;
3. Skills mismatch: demand for BIM and green design professionals exceeds supply.

Nevertheless, these gaps also represent opportunities for domestic innovation and international collaboration in standard-setting, training, and joint ventures.

China's sustainable built environment market is entering a phase of expansion + specialization, where policy-driven growth is increasingly supplemented by technological innovation, market demand, and global investment interest. With the right alignment of national standards, digital infrastructure, and cross-sector collaboration, China could become the largest green building market in the world over the next decade.

3.3.3.6 Strategic Outlook

As China transitions from policy-driven adoption to a more innovation-led green construction model, its market is entering a phase of diversification and specialization. Dutch stakeholders—particularly those active in material innovation, performance benchmarking, and integrated design—are well-positioned to engage through technical partnerships, demonstration projects, or upstream material supply. In this context, early engagement and regional tailoring of strategies will be critical to navigating local regulatory environments and aligning with China's evolving sustainability priorities.

3.4 Green Building and Economic Development in China

This section examines the growing macroeconomic role of green building within China's sustainability transition. It highlights how green construction contributes to GDP, employment, and industrial modernization, while also addressing emerging challenges in implementation and institutional coordination. Given the evolving importance of this sector, the discussion also reflects on potential entry points for international cooperation—particularly in technology, materials, and green finance.

3.4.1 Green Building as a Macroeconomic Driver

Amid China's efforts to shift from a traditional real estate–driven growth model, green building has emerged as a strategic sector that links environmental goals with economic restructuring. In 2023, clean energy industries—including renewable power, energy efficiency technologies, and green construction—contributed approximately **9.0% to China's GDP**, up from 7.2% in 2022. These sectors accounted for **40% of total GDP growth**, underscoring their growing influence in the national economy.

Green construction plays a pivotal role in this transformation. Retrofitting of existing buildings, modular and prefabricated systems, and energy-efficient technologies are being promoted not only for emissions reduction, but also for economic stabilization, especially in second-tier cities and post-industrial regions. This opens avenues for regional development and diversification, with policy frameworks increasingly linking green building to job creation and innovation.

3.4.2 Financial Instruments and Policy Support

China has significantly expanded its green finance infrastructure in recent years. As of the end of 2023:

- **Green loan balances** reached **RMB 30.08 trillion** (approx. USD 4.26 trillion), representing a 36.5% year-on-year increase;
- Green loans accounted for **12.7% of all domestic loans**, a historically high share.

This financial growth has supported building-related sectors, including green materials, retrofitting programs, and low-carbon infrastructure. In parallel, key regulatory and incentive mechanisms are reinforcing market development:

- **Mandatory energy performance standards** apply to all new public buildings and are strongly encouraged in the private sector;
- **Local retrofit funds** (e.g. Beijing 2023) subsidize upgrades to insulation, HVAC systems, and building envelopes;
- **Urban performance metrics** now increasingly include green building indicators as part of government evaluation frameworks.

These developments reflect China's evolving approach: using financial and administrative tools to drive sustainability-oriented construction practices.

3.4.3 Implementation Gaps and Institutional Challenges

Despite strong top-level momentum, on-the-ground implementation remains uneven. Key barriers include:

- **Regional disparities**: Provinces vary in their enforcement capacity and technical standards application;
- **Performance shortfalls**: Some certified buildings fall short of expected energy savings, due to limited post-occupancy monitoring or outdated scoring systems;
- **Institutional limitations**: Local governments and small-scale developers often lack the technical capacity or financial resources to pursue advanced green building solutions.

Addressing these gaps requires systemic coordination across ministries, municipal agencies, the construction industry, and the finance sector. In particular, **data transparency**, **performance auditing**, and **capacity-building programs** will be essential to support more consistent outcomes.

3.4.4 Strategic Position in National Development Planning

Green building is now embedded in China's long-term economic and planning frameworks. The **14th Five-Year Plan** explicitly identifies green construction as a cross-cutting priority tied to:

- **New urbanization** and infrastructure renewal;
- **Industrial upgrading**, especially through digital construction and low-carbon materials;
- **Climate commitments**, including dual-carbon goals.

As such, the sector is no longer viewed as a cost center, but rather as a strategic domain for structural reform, innovation, and international engagement. It supports:

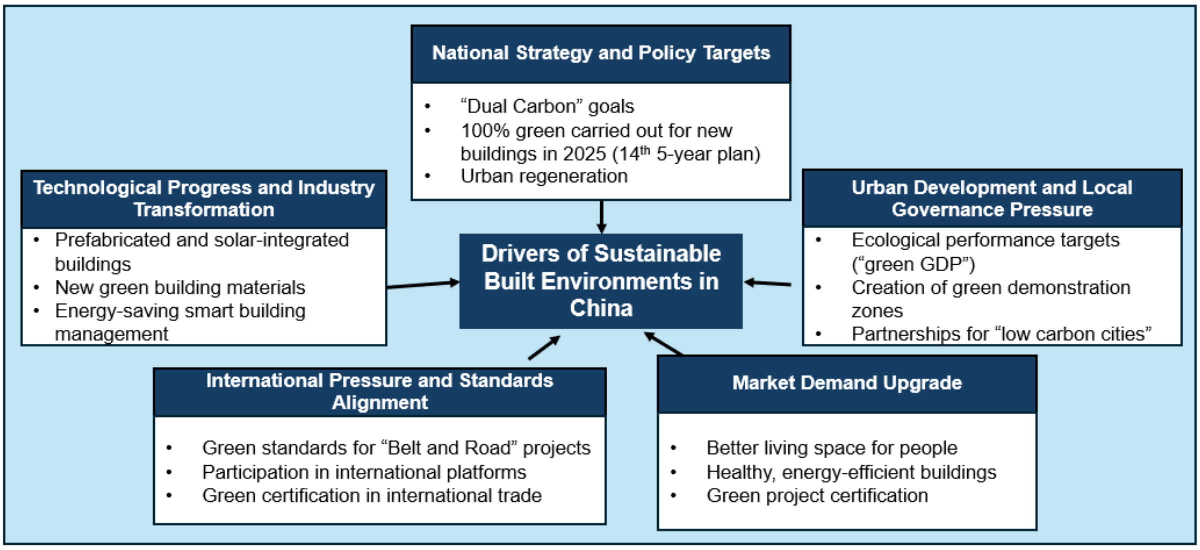
- Growth in **clean-tech** and **digital construction platforms**;
- Job creation in **materials, design, retrofitting, and carbon services**;
- Potential synergies with European and Dutch expertise in **circular economy**, **building lifecycle analysis**, and **green investment mechanisms**.

This evolving trajectory presents meaningful opportunities for Dutch stakeholders—not only in export-oriented material supply chains, but also in joint ventures, digital twin applications, and policy-oriented pilot projects.

3.5 Market Potential and Growth Outlook

This section provides a forward-looking assessment of China's green building market, emphasizing investment potential, emerging growth areas, financial mechanisms, and strategic entry points for international collaboration—particularly with Dutch stakeholders. It draws on market data, policy targets, and sectoral trends to identify how the sustainable construction sector is evolving from a regulatory requirement to a diversified investment landscape.

Figure 3.3: Driving force of sustainable built environment in China



3.5.1 Market Size and Growth Trajectory

In 2023, the value of China's green building market was estimated at USD 101.3 billion, with a projected compound annual growth rate (CAGR) exceeding 10%, expected to reach USD 197.5 billion by 2030[87]. The green building materials sub-sector—encompassing insulation, coatings, structural components, and recycled aggregates—is forecast to grow from USD 38.2 billion in 2024 to USD 72.7 billion by 2030[88], driven by demand for low-carbon, high-performance, and prefabricated solutions.

Parallel trends in certification reinforce this expansion:

- Over 25,000 projects have been certified under China's national Green Building Evaluation Standard (GBES)[89].
- China ranked first globally in 2023 for LEED-certified floor area outside the U.S., with 1,860 projects totaling more than 25 million m^2 [90].

These developments signal not only regulatory alignment but also growing market confidence in sustainable construction as a value-generating asset class.

3.5.2 Sectoral Opportunities

Several sub-sectors within the green building ecosystem demonstrate strong commercial potential:

- **Energy-efficient retrofitting**: Rising demand for building performance upgrades is creating market space for insulation materials, HVAC modernization, and smart energy management systems.
- **Prefabrication and circular construction**: Industrialized building methods and material reuse are gaining policy traction as strategies to reduce embodied carbon and improve productivity.
- **Climate-adaptive urban infrastructure**: Urban heat mitigation, rainwater harvesting, and nature-based design elements are being integrated into city master plans.
- **Smart building systems**: Technologies such as BIM, digital twins, and AI-powered controls are increasingly deployed in demonstration zones and public-private pilot projects.
- **Green financing mechanisms**: Financial innovation is expanding access to capital through green bonds, ESG-linked loans, and performance-based subsidies.

These niches align closely with Dutch strengths in sustainable materials, circular construction logistics, digital design systems, and retrofit engineering.

[87] GlobalData (2023). "China Green Building Market Forecast." https://www.globaldata.com
[88] Grand View Research (2024). "China Green Building Materials Market Outlook." https://www.grandviewresearch.com
[89] Baker McKenzie Resource Hub (2023). "Green Building Incentives and Certifications in China." https://resourcehub.bakermckenzie.com
[90] GBCI (2023). "LEED Top Countries and Regions 2023." https://www.gbci.org

3.5.3 Financial Instruments and Market Enablers

China's green finance ecosystem is maturing quickly, with multiple instruments now in play to support green construction:

- **Green REITs** focused on certified commercial assets
- **Municipal carbon trading pilots** integrating building-level emissions
- **Preferential interest rates** and credit scoring tied to third-party certification or building performance ratings

Such instruments aim to derisk investment and stimulate market-led participation in sustainable building projects. Dutch financial institutions and technology providers could explore collaboration in green verification, data standardization, and carbon valuation models.

3.5.4 Strategic Outlook for Sino-Dutch Collaboration

Looking ahead, China is expected to add over 2 billion m^2 of urban building area annually by 2030, with green buildings projected to account for more than 70% of new urban construction in major cities by 2025[91]. This scale offers considerable opportunities for knowledge exchange and commercial partnerships.

Potential areas of cooperation include:

- Co-development of digital tools (e.g., LCA software, building energy simulation)
- Joint pilot projects on modular, low-carbon building systems
- Integration of Dutch innovations in water management, indoor air quality, and smart facade systems
- Consulting on ESG frameworks or sustainable project certification standards

3.5.5 Policy Recommendations for Market Development

To further unlock market potential, the following measures could support both domestic progress and international cooperation:

1. Strengthen national guidance on carbon accounting and life cycle performance metrics
2. Encourage convergence between Chinese and European green building standards to facilitate cross-border recognition
3. Expand international access to green finance mechanisms (e.g., allow foreign firms to issue RMB-denominated green bonds for use in pilot zones)
4. Invest in workforce training for digital and sustainable construction skills

[91] Baker McKenzie Resource Hub (2023). "Green Building Incentives and Certifications in China." https://resourcehub.bakermckenzie.com

4. Case Studies of Sustainable Built Environment in China

This chapter presents in-depth case studies from China's built environment sector to illustrate how national sustainability goals are being operationalized through materials innovation, energy system optimization, and water resource management in construction. Each case focuses on one of three key thematic areas:

1. Green construction materials
2. Building energy systems
3. Water use and recycling in buildings

Rather than offering a promotional account, these cases provide an evidence-based view of how institutional mechanisms, technical standards, and market structures are interacting in practice. They also shed light on specific areas where Dutch expertise in sustainable construction—such as digital tracking, low-carbon materials, and system-level integration—may contribute to high-impact collaborations or market entry.

4.1 Green construction materials

Green construction materials are foundational to sustainable building design, offering pathways to reduce embodied carbon, improve resource circularity, and enhance structural durability. In China, recent national policy shifts have accelerated the adoption of green-certified materials, supported by digital platforms and regional demonstration projects. This section explores how these frameworks are operationalized at the city level, focusing on two key case studies in Xiong'an and Shenzhen.

4.1.1 National Context and Policy Background

Building on China's national green materials certification system introduced in 2020—which classifies products into **Basic**, **Preferred**, and **Leader** levels—several cities have begun operationalizing these standards through digital tools, public procurement mechanisms, and regulatory incentives (as discussed in Chapter 3). Certified materials are increasingly integrated into public project workflows and referenced in national evaluation systems such as **GB/T 50378**[92]. The following case studies illustrate how urban regions such as **Xiong'an** and **Shenzhen** are translating these national frameworks into concrete implementation strategies, offering insights into both policy localization and industrial scaling.

[92] Ministry of Housing and Urban-Rural Development of the People's Republic of China. Assessment Standard for Green Building (GB/T 50378). Beijing: MOHURD, 2019.

4.1.2 Case Study 1: Xiong’an New Area – Integrated Green Material Management

As one of China’s most prominent national-level development zones, **Xiong’an New Area** in Hebei Province has positioned green materials at the center of its planning framework. All new buildings are required to meet high-performance green and low-carbon construction standards.

A key feature of the Xiong’an model is the integration of certified green materials with a digital traceability platform. Materials—including structural concrete, reinforcement steel, insulation, and interior finishes—must be sourced from suppliers holding **Preferred-level** certification or higher. These products are embedded with **QR codes** and integrated into a **Building Information Modeling (BIM)** system, enabling lifecycle tracking from procurement to installation and eventual performance monitoring.

Key material applications include:

- **Geopolymer concrete** formulated with fly ash and slag;
- **Natural fiber-reinforced panels** replacing conventional synthetic boards;
- **Recycled aggregates** processed from local construction and demolition waste;
- **Phase-change insulation materials** for enhanced thermal regulation.

Policy Integration and Local Incentives

To support this system, the local government offers:

- **Fast-track project approvals** and **land-use bonuses** for developers using ≥80% certified materials;
- **Technical training programs** for designers and contractors;
- **Digital procurement platforms** to streamline supplier access.

This integrated model—linking national policy, digital infrastructure, and local incentives—is being examined for replication in other strategic zones such as **Shenzhen Qianhai** and **Suzhou Industrial Park**.

Environmental and Market Impact

By 2023, more than **80% of public construction projects** in Xiong’an had adopted certified materials. Preliminary assessments suggest that using **geopolymer concrete** has reduced embodied carbon emissions by **25–35%** compared to traditional Ordinary Portland Cement (OPC)-based systems. Meanwhile, over **500,000 tons** of construction waste have been diverted from landfills and reintroduced into the building supply chain.

These achievements demonstrate that meaningful reductions in environmental impact are achievable through coordinated material certification, local incentives, and digital tracking tools.

4.1.3 Case study 2: Shenzhen Building Industrialization Park – Scaling Green Materials in Prefabrication

The **Shenzhen Building Industrialization Park**, located in Longhua District, serves as a dedicated hub for prefabricated construction and green material integration. Since 2021, the park has mandated the use of **Preferred-level or above certified materials** in all prefabricated components, from wall panels to bathroom pods.

Key implementation features include:

- A **jointly developed digital traceability system** linking batch-level material records to BIM workflows;
- Enforcement of green material use as a condition for supplier admission into the park;
- Integration of materials such as low-carbon concrete, recycled steel, and plant-based insulation.

To stimulate market uptake, the **Shenzhen Housing and Construction Bureau** offers:

- Land-use bonuses and tax incentives for certified suppliers;
- Fast-track project approvals for developers using ≥70% certified materials;
- Procurement preference for public projects using locally sourced certified components.

By the end of 2023, over **30% of Shenzhen's new public housing** units had adopted components manufactured within the park, with **80% of materials certified**. The model has yielded:

- Up to **28% reduction** in material-related embodied carbon;
- Shortened construction timelines by **20–30%**;
- Significant job creation in green materials manufacturing.

4.1.4 Discussion and lesson learned

The case studies of Xiong'an New Area and the Shenzhen Building Industrialization Park illustrate how China's national green materials certification framework can be translated into effective implementation at the city and district levels. Several key insights emerge from these examples, offering implications for both domestic policy development and international collaboration.

1. Institutional Coordination Is Crucial for Scale-Up

Both cases highlight the importance of strong coordination among policy makers, certification bodies, local governments, and industry stakeholders. In Xiong'an, the alignment between national standards, digital traceability platforms, and local incentive structures enabled a coherent rollout. Shenzhen's example shows how coordination between municipal authorities and industrial suppliers can accelerate adoption in prefabrication. For other regions—inside or outside China—replicability depends heavily on institutional readiness and cross-agency cooperation.

2. Digital Infrastructure Enhances Compliance and Transparency

The use of BIM-linked QR code systems for material tracking demonstrates how digital tools can enhance material compliance, simplify auditing, and improve project transparency. This kind of system, while technically demanding, could serve as a model for regions seeking to align building material supply chains with carbon and sustainability objectives. Dutch firms with experience in digital lifecycle tools and smart construction platforms may find alignment opportunities in joint technology pilots or knowledge exchange.

3. Green Materials Policy Can Drive Local Industry Development

Both case studies show how green certification not only steers construction toward sustainability but also stimulates the formation of regional supply chains. In Shenzhen, certification compliance requirements have supported the growth of green prefab manufacturing. In Xiong'an, integration of recycled and low-carbon materials created demand for localized waste processing and alternative binder production. These dynamics suggest that green building policies—when tied to procurement and land-use incentives—can serve as levers for industrial innovation.

4. Implementation Gaps Remain Outside Pilot Zones

Despite the successes observed, the advanced systems in Xiong'an and Shenzhen remain the exception rather than the rule. Many cities in central and western China still face challenges such as limited certified suppliers, insufficient digital infrastructure, or lack of enforcement capacity. This regional disparity highlights the need for capacity-building support, which may present openings for international cooperation in training, digital certification, and policy benchmarking.

5. Ambitious Standards in Xiong'an: Symbolism vs. Speed

Xiong'an's role as a national demonstration zone has led to the adoption of unusually high green material thresholds and full digital traceability requirements. While this positions the area as a pioneer in ecological urbanism, it has also contributed to slower-than-expected construction progress, especially in large-scale residential and commercial projects. These delays have triggered public debates and some media skepticism regarding the project's feasibility and economic outlook. This tension illustrates a broader dilemma: how to balance ambition in sustainability with implementation feasibility, particularly under strong political and symbolic expectations.

6. Relevance for Dutch Stakeholders

For Dutch companies and knowledge institutions, these cases illustrate where their comparative strengths—such as sustainable material innovation, lifecycle assessment, and digital construction technologies—could support China's scaling ambitions. However, successful engagement will likely require alignment with regional pilot programs, local government partnerships, and adaptation to evolving Chinese standards and procurement mechanisms.

4.2 Building energy systems

Energy systems are at the core of China's building-sector decarbonization efforts. With operational and embodied energy together accounting for over 20% of national emissions, regulatory and technological interventions have focused on efficiency, electrification, and integration of renewables. This section reviews recent national energy performance standards, followed by a detailed case study of the Beijing Winter Olympic Village and emerging trends in smart building management.

4.2.1 Regulatory Framework: GB 55015-2021 and Policy Evolution

In 2022, China enacted a comprehensive regulatory upgrade with the release of the mandatory national standard **GB 55015-2021: General Code for Energy Efficiency and Renewable Energy Application in Buildings**[93]. This code replaces previously fragmented energy-saving standards and now serves as the baseline for building energy performance nationwide.

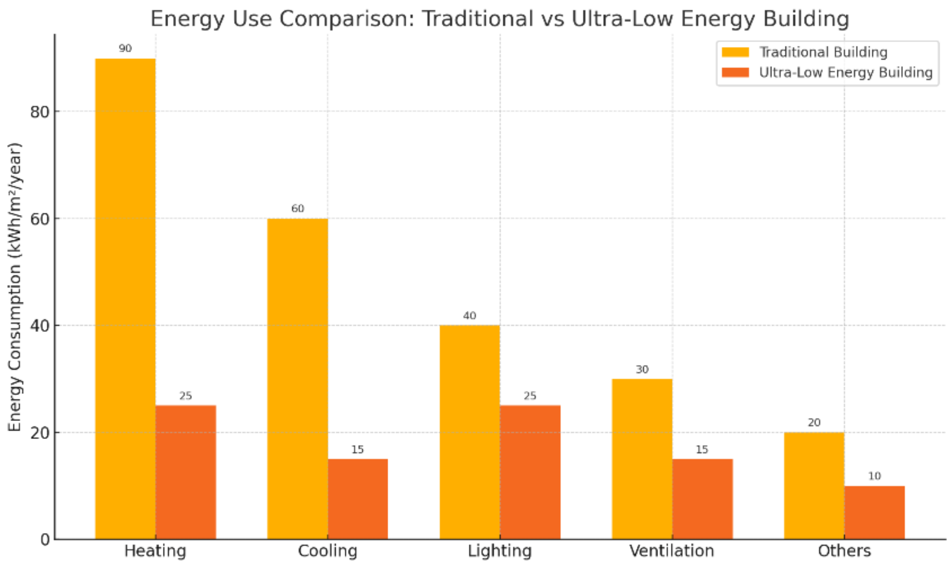
Key features of GB 55015-2021 include:

- Mandatory integration of passive design strategies, energy-efficient equipment, and renewable energy systems;
- Requirements for energy modeling and simulation during building design;
- Promotion of ultra-low energy buildings in strategic regions such as Beijing–Tianjin–Hebei, the Yangtze River Delta, and the Pearl River Delta;
- A shift from operational efficiency to whole-life carbon performance as a key evaluation metric.

By unifying disparate codes, this regulation marks a significant policy milestone. It lays a national foundation for performance-based building design, construction, and retrofitting. **Figure 4.1** illustrates the functional breakdown of energy consumption in traditional versus ultra-low energy buildings, highlighting significant reductions in heating, cooling, and lighting demand.

[93] Ministry of Housing and Urban-Rural Development of the People's Republic of China. (2021). *GB 55015-2021: General Code for Energy Efficiency and Renewable Energy Application in Buildings*

Figure 4.1: Energy Use Comparison Between Traditional and Ultra-Low Energy Buildings by Function



(Source: This figure is based on literature-based estimates and national standards (GB/T 51350, GB 55015-2021) to demonstrate the general differences between traditional and ultra-low energy buildings. Actual consumption may vary by climate zone, building function, and technology selection.)

4.2.2 Case Study: Beijing Winter Olympic Village – Demonstration of Ultra-Low Energy Performance

The **Beijing Winter Olympic Village**, located in Zhangjiakou, exemplifies how policy standards can be effectively implemented in practice. Originally built as athlete accommodation for the 2022 Winter Games, the complex has since been repurposed as public rental housing.

Technical Highlights:

- High-performance envelopes featuring airtight construction, advanced insulation, and triple-glazed windows;
- Passive solar architecture with optimal orientation and shading;
- Ground-source heat pump systems for heating and cooling;
- Integrated photovoltaic panels on façades and rooftops;
- A centralized Building Energy Management System (BEMS) for real-time monitoring and control of HVAC, lighting, and indoor environmental conditions.

Measured Outcomes:

- Heating and cooling energy use reduced by over 60% compared to conventional baselines;
- Thermal comfort achieved primarily through passive and low-energy systems;
- Certified as a Three-Star Green Building under China's GB/T 50378 system.

This project demonstrates the feasibility of applying GB 55015-2021 to large-scale public housing. It also offers a replicable model for future applications in residential, educational, and healthcare buildings.

Table 4.1 below summarizes several representative ultra-low or near-zero energy building projects across China. These cases reflect variations in climate zones, building types, and energy-saving strategies, providing a broader view of how GB 55015-2021 is being applied in practice.

Table 4.1: Representative Ultra-Low and Near-Zero Energy Building Projects in China

Project Name	Location	Building Type	Estimated Energy Use (kWh/m^2·yr)	Energy Saving (%)	Key Features
Beijing Winter Olympic Village (D6)	Zhangjiakou, Beijing	Public Rental Housing	30–40	60–70%	Passive design, ground-source heat pump, BEMS
Wukesong Ice Hockey Training Hall	Beijing	Sports Facility	60–80	50–60%	High insulation, solar panels, solution dehumidification
Shanghai Ultra-Low Energy Housing	Shanghai	Residential	~50	50%	Efficient HVAC, solar thermal, insulated envelope
Shandong Jianzhu Univ. Teaching Complex	Jinan, Shandong	Educational Facility	~50	50%+	Steel structure, high airtightness, solar PV
Guangdong Near-Zero Energy Building	Multiple Cities, Guangdong	Mixed-use Demonstration	40–60	40–60%	Natural ventilation, renewables, energy-efficient equipment

4.2.3 Digital Energy Management and Smart Building Systems

China is simultaneously pursuing a digital transformation of building energy systems. Smart building pilots in cities such as **Shenzhen** and **Shanghai** are pioneering the integration of data-driven technologies to optimize energy performance and occupant comfort.

Key Innovations Include:

- **IoT sensors** for real-time monitoring of temperature, humidity, occupancy, and energy use;
- **AI algorithms** for predictive control of HVAC and lighting systems;
- **Integrated platforms** combining BIM (Building Information Modeling), EMS (Energy Management Systems), and carbon tracking for full lifecycle oversight.

For example, in Shenzhen’s Smart Housing Project, dynamic control algorithms automatically adjust ventilation and lighting in response to usage patterns, achieving energy savings of approximately 30% without sacrificing comfort.

These advances align with China’s broader “digital city” agenda and signal a growing policy emphasis on intelligent energy infrastructure.

4.2.4 Comparison of Energy Policies between China and the Netherlands

China's building energy systems are evolving rapidly through a combination of regulatory enforcement, technical demonstration, and digital innovation. **GB 55015-2021** establishes a strong baseline, while projects like the **Winter Olympic Village** illustrate what is technically and institutionally achievable. Digital systems now offer the next frontier, enabling continuous optimization across design, construction, and operation phases. In China, building energy services—particularly space heating and cooling—are dominated by electricity and fossil fuel sources, with limited integration of renewables at scale. According to national estimates, electricity accounts for over 50% of operational energy use in commercial and residential buildings, while natural gas and district heating systems (powered primarily by coal or gas) supply a significant share of heating needs in northern cities. Cooling is almost exclusively electric, driven by air-conditioning units and centralized chiller systems.

In contrast, the Netherlands has rapidly increased the share of renewable sources in its building energy mix, supported by policies promoting heat pumps, district heating with biogenic fuels, and rooftop solar PV. Dutch buildings rely increasingly on low-temperature heating systems, which are compatible with renewable sources and energy-efficient design.

This Dutch approach is underpinned by the **Trias Energetica** principle—a foundational concept in sustainable building design and energy planning in the Netherlands. First proposed by Delft University of Technology, the Trias Energetica outlines a three-step strategy for achieving long-term carbon neutrality in the built environment:

1. **Reduce energy demand** as much as possible through passive design measures such as insulation, airtight construction, natural ventilation, and efficient building orientation;
2. **Maximize the use of renewable energy sources**, including solar PV, wind power, and geothermal heating;
3. **Use fossil fuels and non-renewable energy sources as efficiently as possible**, only when renewable sources are insufficient.

Dutch energy performance standards—such as the *BENG* regulation and *NTA 8800* calculation framework—are structured around these steps, promoting an integrated design approach that links building envelopes, system efficiency, and renewable integration.

While China's GB 55015-2021 also emphasizes energy reduction and encourages the adoption of renewables, it does so through prescriptive performance thresholds without explicitly embedding a staged principle like Trias Energetica. Nonetheless, China's growing focus on smart energy systems, district-level decarbonization pilots, and electrification strategies suggests potential convergence with this conceptual model. Introducing Trias Energetica or similar phased frameworks into China's energy code development may support greater coherence and design flexibility across building lifecycle stages.

The divergence in energy structure presents both challenges and opportunities for collaboration. While China's energy infrastructure remains carbon-intensive, its policy push for electrification and renewables integration—especially under GB 55015-2021 and regional decarbonization pilots—creates openings for Dutch technologies and expertise in clean heating, smart grid integration, and demand-side flexibility solutions.

A comparative analysis of **GB 55015-2021** and the Netherlands' **BENG standard (Bijna Energieneutrale Gebouwen)** highlights both shared goals and contextual differences. The following tables provide a side-by-side comparison of key policy frameworks and technical implementation details.

Table 4.2: Policy comparison between China's GB 55015-2021 and the Netherlands' BENG Standard

Aspect	GB 55015-2021 (China)	BENG (Netherlands)
Implementation Date	Effective from April 1, 2022; applies to new construction, expansions, renovations, and retrofitting projects.	Enforced from January 1, 2021; applies to all new residential and non-residential buildings.
Legal Nature	Mandatory national standard covering the full lifecycle from design to operation.	Mandatory regulation integrated into the Dutch Building Decree (Bouwbesluit 2012) and aligned with the EU Energy Performance of Buildings Directive (EPBD).
Energy Performance Metrics	Focuses on energy consumption per unit area (kWh/m^2·a) and carbon emission intensity (kgCO_2/m^2·a). Targets include: - 75% energy savings for residential buildings in cold and severe cold regions. - 72% for public buildings. - 40% reduction in carbon emissions compared to the 2016 baseline.	Defines three key indicators: - **BENG 1**: Total energy demand (kWh/m^2·a). - **BENG 2**: Primary fossil energy consumption (kWh/m^2·a). - **BENG 3**: Renewable energy share (minimum 40% for new residential buildings).
Calculation Methods & Tools	Requires energy consumption, renewable energy utilization, and carbon emission analysis at feasibility, design, and implementation stages.	Based on the NTA 8800 calculation method, replacing the former EPC (Energy Performance Coefficient) approach.
Renewable Energy Requirements	Encourages maximized use of renewable energy (solar, wind, geothermal) to reduce fossil energy consumption.	Mandates a minimum of 40% renewable energy share in new residential buildings.
Scope of Application	Applies to new, expanded, renovated, and retrofitted civil and industrial buildings.	Applies to all new residential and non-residential buildings; exemptions possible for certain temporary or specialized structures.
Compliance & Enforcement	Requires submission of energy consumption and carbon emission analyses during construction; design documents must specify energy-saving measures and renewable systems.	Compliance demonstrated through BENG calculations and post-construction energy certificates; local authorities oversee enforcement.
Digitalization & Smart Technologies	Encourages adoption of digital systems to optimize energy efficiency and renewable energy utilization during design, construction, and operation phases.	Promotes smart building solutions, advanced energy modeling tools, and integrated building systems to meet BENG requirements.

A detailed policy comparison of China's GB 55015-2021 and the Netherlands' BENG standard reveals both shared goals and systemic differences that present opportunities for knowledge exchange and capacity building. On one hand, GB 55015-2021 sets a strong regulatory baseline by mandating energy performance and carbon reduction targets—such as 75% energy savings for residential buildings and a 40% carbon emissions reduction compared to 2016 levels—applying to new, expanded, and retrofitted buildings. However, its calculation methods are largely prescriptive, focusing on static performance at the design stage and lacking a dynamic performance monitoring mechanism across the lifecycle. While it encourages renewable energy use and some passive design strategies (such as insulation, window-to-wall ratios, and shading), the standard does not yet fully integrate adaptive, modular, or reversible design principles, limiting the flexibility and circularity potential of buildings.

In contrast, the Netherlands' BENG standard, implemented through the NTA 8800 calculation framework, adopts a performance-based and dynamic approach. It emphasizes total energy demand (BENG 1), primary fossil energy consumption (BENG 2), and a clear renewable energy share requirement (minimum 40%) for new residential buildings. BENG regulations and leading Dutch architectural practices strongly emphasize passive design—including optimized building orientation, high-performance thermal envelopes tailored to climate zones, natural ventilation systems, and external shading. Moreover, Dutch projects increasingly adopt modular construction techniques, reversible building systems, and circular material selection, which allow for future adaptation, disassembly, and reuse—principles exemplified by projects such as CIRCL and The Green House.

China's current regulatory framework focuses on energy performance compliance through specified component requirements, but has yet to mainstream advanced design concepts such as modular prefabrication, material passports, or reversible connections. However, with the push towards carbon neutrality, these innovations offer significant potential for integration.

Beyond regulatory frameworks and energy targets, the design and construction details as shown in Table 4.3 embedded in both systems further underscore their differences and the potential for collaboration.

Table 4.3: Technical comparison between China's GB 55015-2021 and the Netherlands' BENG Standard

Aspect	China (GB 50189-2015 / JGJ 26-2018)	Netherlands (BENG / NTA 8800)
Core Thermal Indicator	**K-value (thermal transmittance), W/(m²·K)**, maximum allowable values specified by climate zone; R-value implicit in material thickness and conductivity calculations.	**U-value (thermal transmittance), W/(m²·K)**, and **R-value (thermal resistance), m²·K/W** explicitly defined, with specific requirements based on climate and building type.
Calculation Method	Static calculation at the design stage, using prescriptive tables for material selection and construction layers.	Dynamic calculation using **NTA 8800**, incorporating energy simulations, BIM, and material passports across the building lifecycle.

External Wall Transmittance	Severe cold zone ≤0.35 $W/m^2 \cdot K$; cold zone ≤0.45; hot summer/cold winter ≤0.70.	Typically ≤0.20–0.30 $W/m^2 \cdot K$ (climate and project-dependent), corresponding to R-values around 3–5 $m^2 \cdot K/W$, indicating higher insulation.
Roof Transmittance	Severe cold zone ≤0.25 $W/m^2 \cdot K$; cold zone ≤0.30; hot summer/cold winter ≤0.50.	Roofs ≤0.15–0.20 $W/m^2 \cdot K$, R-values around 5–7 $m^2 \cdot K/W$, showing stricter requirements for thermal resistance.
Window Transmittance	Typically ≤2.0–2.5 $W/m^2 \cdot K$, limited use of triple glazing or low-emissivity coatings.	Window U-values ≤1.2–1.5 $W/m^2 \cdot K$, incorporating advanced technologies like multiple glazing layers, inert gas fillings, and low-e coatings.
Airtightness Design	Basic requirements, dependent on construction quality, no mandatory airtightness testing (blower door).	Strong focus on airtightness, mandatory **blower door tests** with strict leakage requirements (n50 ≤0.6–1.0 h^{-1}).
Thermal Bridge Handling	Guidance provided but enforcement limited, with thermal bridges often present.	Explicit requirements for minimizing thermal bridges, using continuous insulation, structural detailing, and quality control.
Passive Design Strategies	Encouraged but not mandatory; includes shading, natural ventilation, orientation optimization.	Mandated passive strategies including optimal building orientation, external shading devices, natural ventilation, and daylighting.
Material and Construction Strategy	Encourages green materials (e.g., energy-saving wall systems, low-VOC), but lacks integrated material tracking systems.	Uses **Madaster and similar material passport systems** to track materials over their lifecycle, emphasizing circularity and reuse.
Design Approach	Compliance-focused, aiming to meet prescriptive minimum requirements; reliant on standard design catalogs and experience.	Performance-based design emphasizing dynamic simulations, digital tools, and lifecycle assessment.

This detailed comparison underscores how China's GB standards prioritize prescriptive compliance through static design parameters, while the Netherlands' BENG framework promotes a performance-based and adaptive approach rooted in dynamic simulations, material traceability, and lifecycle assessment. China's focus on maximum allowable K-values and limited enforcement of airtightness and thermal bridge requirements contrasts with the Netherlands' stricter U-value and R-value definitions, mandatory airtightness testing, and integrated passive design strategies.

Moreover, the adoption of modular, reversible design concepts and circular material strategies—supported by tools such as Madaster and dynamic performance modeling—highlights the advanced integration of sustainability in the Netherlands' building sector. In contrast, China's codes, while encouraging green materials and passive design elements, lack the comprehensive digital tracking and performance optimization mechanisms found in Dutch practice.

Building on these insights, targeted knowledge exchange and joint pilot projects can help China enhance its capacity in dynamic energy performance management, advanced material utilization, and adaptive building design. The following section outlines specific pathways for Sino-Dutch collaboration to bridge these gaps and accelerate the transition towards a circular and carbon-neutral building environment.

To accelerate this transition, Dutch expertise in building design innovation can offer tangible pathways for enhancing China's capacity. Knowledge transfer could focus on:

- Integrating modular and prefabricated systems into building codes to reduce construction waste and facilitate adaptability.
- Promoting reversible design principles, where building components can be easily disassembled, relocated, or upgraded, extending building lifespans.
- Introducing circular material strategies, combining recycled aggregates, low-carbon cement alternatives (such as geopolymers), and biobased materials (e.g., cross-laminated timber) into mainstream construction.
- Sharing best practices in climate-responsive passive design, including envelope optimization, daylighting, and natural ventilation, supported by dynamic simulation tools.

Such cooperation, combining China's regulatory enforcement with Dutch architectural innovation and circular economy principles, could transform China's building sector into a more adaptive, resource-efficient, and carbon-neutral system.

4.2.5 Comparative Energy Mix and Emissions in the Built Environment: China vs. the Netherlands

The built environment is a significant source of national energy consumption and carbon emissions. According to the International Energy Agency (IEA), buildings in China accounted for approximately 25% of total final energy consumption and nearly 22% of energy-related CO_2 emissions in 2022. The majority of energy use in Chinese buildings is attributed to space heating, cooling, appliances, and hot water, with coal and electricity from fossil-fuel-based generation still playing a major role—though the share of renewables is steadily growing due to national policy efforts.

In contrast, the Netherlands has made considerable progress in decarbonizing its building stock. Buildings represent about 14% of final energy consumption and roughly 11% of CO_2 emissions (IEA, 2022). The Dutch energy mix for buildings relies heavily on natural gas but has seen growing integration of district heating, heat pumps, and solar energy, driven by the Netherlands' energy transition goals and "natural gas phase-out" policies in residential buildings.

Table 4.4: Comparative Overview of Building Sector Energy Use and Emissions (2022, IEA)

Indicator	China (2022)	Netherlands (2022)
Final Energy Use in Buildings	~25% of total energy use	~14% of total energy use
Share of Buildings in CO_2 Emissions	~22%	~11%
Dominant Energy Sources	Coal, electricity (fossil-based), increasing renewables	Natural gas, electricity, solar, district heating
Key Decarbonization Tools	Building codes (GB 55015), retrofit campaigns, electrification	Heat pumps, solar PV, insulation retrofits, natural gas ban

4.3 Water resource management in buildings

Water resource management is increasingly recognized as a vital component of urban sustainability—particularly in response to climate change, urban flooding, and rising water demand. In China, policies such as the Sponge City initiative and updated building codes have spurred the adoption of integrated water-saving technologies. This section examines national policy frameworks and presents two leading examples—Shanghai's Hongqiao Business District and Chongqing's Lijia Eco-City—to illustrate how smart water systems are being applied at scale.

4.3.1 Policy Framework and Technical Pathways

China's approach to water sustainability in buildings is supported by a multi-tiered policy framework and an expanding set of technical standards. Key initiatives include:

- **Sponge City Program (2015–present):** Promotes integrated urban water management, including the use of green infrastructure, rainwater harvesting, and permeable surfaces to control stormwater runoff and mitigate urban flooding.
- **Green Building Evaluation Standard (GB/T 50378):** Includes dedicated scoring criteria for water-saving design, non-traditional water sources (e.g., greywater and rainwater reuse), and smart water monitoring.
- **Building Water-Saving Design Standards (GB 50015-2019)[94]:** Mandates water-efficient fixtures, zoning of potable and non-potable water use, and metering systems in new construction projects.

At the project level, these policies are operationalized through a variety of technical measures, such as:

- Installation of low-flow faucets, toilets, and showers;
- Collection and reuse of rainwater for landscaping and sanitation;
- Greywater recycling systems for flushing and irrigation;
- Smart metering, leak detection, and consumption analytics;
- Landscape integration of bioretention zones, green roofs, and permeable pavements.

These technologies collectively enhance both water efficiency and urban flood resilience, while reducing reliance on conventional municipal water infrastructure.

4.3.2 Case Study: Hongqiao Business District (Shanghai)

The Hongqiao Business District, one of Shanghai's flagship commercial zones, demonstrates a comprehensive integration of Sponge City principles at district scale.

Key features:

[94] Ministry of Housing and Urban-Rural Development of the People's Republic of China. (2019). *GB 50015-2019: Standard for Design of Building Water Supply and Drainage*

- **Green roofs** and **permeable pavements** to slow stormwater runoff;
- **Underground detention tanks** with smart pumping for stormwater regulation;
- **Rainwater harvesting systems** used for public sanitation and landscaping;
- **Building Water Efficiency Monitoring Platforms** deployed in over 100 commercial buildings.

Outcomes (as of 2022):

- Surface runoff reduction of over 60% during peak rainfall events;
- Annual reuse of approximately 15,000 m^3 of rainwater;
- Improved stormwater quality and reduced urban heat island effect.

This case demonstrates how spatial planning, building technology, and digital tools can combine to form an adaptive, scalable model for water-sensitive urban development.

4.3.3 Case Study: Lijia Smart Eco-City, Chongqing

Located in a mountainous and high-precipitation area, the Lijia Smart Eco-City in Chongqing showcases advanced water resource management in a mixed-use urban setting.

Core strategies:

- **Dual-pipe systems** in residential blocks for greywater collection and reuse;
- **IoT-based leak detection** and real-time water metering at the appliance level;
- **Constructed wetlands** and **bio-retention zones** for landscape filtration;
- Public-facing **water monitoring dashboards** to promote behavioral change and transparency.

Performance results:

- Potable water demand reduced by up to 30% in residential areas;
- Enhanced stormwater buffering capacity, mitigating flash flooding risk;
- Model adopted by municipal authorities as a reference for new urban developments in Western China.

Table 4.2 compares a selection of urban projects across China that have implemented advanced water management strategies aligned with national green building and Sponge City goals. These examples highlight the range of technological pathways used—such as rainwater harvesting, greywater reuse, and digital metering—and illustrate the scale of potential potable water savings. The table also underscores the geographical spread of implementation, spanning first-tier cities and emerging eco-zones.

Table 4.5: Selected Water-Efficient Building Districts in China: Strategies and Outcomes

Project Name	City	Main Strategies	Annual Reused Water (m^3)	Potable Water Savings (%)
Hongqiao Business District	Shanghai	Green roofs, permeable pavement, rainwater harvesting	15,000	20–25%
Chongqing Lijia Smart Eco-City	Chongqing	Greywater recycling, dual-pipe systems, smart metering	12,000	30%
Qianhai Water City	Shenzhen	Flood-adaptive landscape, stormwater reuse, wetland zones	20,000+	25–35%
Sino-Singapore Eco-City	Tianjin	Integrated rainwater reuse, sponge blocks, smart irrigation	18,000	20–30%
Suzhou Industrial Park	Suzhou	Rainwater retention, eco-filtration, sponge city pilot zone	14,500	25%
Hangzhou Future Sci-Tech City	Hangzhou	Building-scale reuse + regional stormwater control system	13,200	22–28%
Ningbo Eastern Green Cluster	Ningbo	Rain gardens, underground tanks, intelligent irrigation	11,800	20–25%
Tianfu Eco-Island (Chengdu)	Chengdu	Green roofs + rainwater collection + underground recharge	12,500	25–30%

4.3.4 Discussion and Outlook

China's water management practices in buildings are evolving from basic conservation measures toward holistic, digitally enabled systems. While performance is uneven across regions, best-practice cases like Shanghai and Chongqing illustrate what is possible when infrastructure, technology, and policy align.

For Dutch stakeholders, these developments present clear cooperation opportunities in:

- Smart water infrastructure design and digital metering;
- Modular rainwater and greywater treatment systems;
- Data platforms for urban water performance benchmarking;
- Nature-based solutions for stormwater and runoff management.

As China continues to implement its dual goals of ecological protection and urban modernization, sustainable water management is expected to play an increasingly central role in both public and private construction projects. This creates a growing niche for innovation and investment—particularly in second-tier cities and new urban zones, where infrastructure systems are still being shaped.

4.4 Environmental Product Declarations and Construction Product Regulations

In addition to operational energy and emissions, the environmental performance of individual building materials has become an increasingly important regulatory focus. Within the European Union, the revised Energy Performance of Buildings Directive (EPBD, 2024) and the Construction Products Regulation (CPR) emphasize lifecycle carbon assessment and set requirements for the Global Warming Potential (GWP) of buildings based on a 50-year reference period. These calculations rely on Environmental Product Declarations (EPDs)—standardized digital profiles that quantify the lifecycle environmental impacts of individual building components.

European EPDs are uniformly based on the EN 15804+A2:2019 standard, ensuring comparability and transparency. In the Netherlands, the Nationale Milieudatabase (NMD) provides thousands of verified EPDs, which are used to calculate the MilieuPrestatie Gebouwen (MPG)—a mandatory environmental score required for all new buildings since 2018. Similar EPD systems exist in France (INIES), Denmark (LCAbyg), and other EU member states, forming the backbone of lifecycle-based building performance regulation.

In contrast, China currently lacks a centralized and unified EPD system. Existing platforms—such as the Green Building Label product database, energy-efficient product directories, and sectoral databases managed by the China Academy of Building Research (CABR)—are fragmented in terms of structure, scope, and methodological standards. While China issued its national standard GB/T 32161 for EPD preparation in 2015, it has not been widely adopted or integrated into a comprehensive policy framework equivalent to the EU's CPR or EN 15804 family of standards.

This fragmentation presents challenges for both domestic policy development and international cooperation. For example, Dutch construction products with EN 15804-compliant EPDs cannot currently be recognized in China unless additional local certifications are obtained. Conversely, Chinese green products lack digital EPDs that meet EU norms, limiting their export potential in green building markets abroad.

To address this gap and promote mutual recognition, China could benefit from:

- Establishing a national EPD platform with a unified format and verification framework;
- Aligning methodological rules with EN 15804+A2 to ensure data comparability;
- Exploring mutual recognition mechanisms between Chinese and EU databases to lower market entry barriers for sustainable building products.

The following table compares the national EPD systems of the Netherlands, France, Denmark, and China:

Table 4.6: Comparison of National EPD Systems: Netherlands, France, Denmark, China

Country	EPD Database	Underlying Standard	Mandatory Use	Coverage & Integration	Remarks
Netherlands	NMD (Nationale Milieudatabase)	EN 15804+A2:2019	Yes (MPG since 2018)	Used in MPG score for all new buildings	Linked to digital building permits; broad manufacturer participation
France	INIES	EN 15804+A2:2019	Yes (for all building LCAs)	Covers construction materials and systems	Operated in coordination with French Ministry of Ecology
Denmark	LCAbyg, EPD Denmark	EN 15804+A2:2019	Yes (for public projects)	Integrated into lifecycle tools like LCAbyg	Aligned with building permitting and BIM integration
China	CABEE, Green Label DB, sectoral product lists	GB/T 32161 (2015); fragmented implementation	No unified requirement	Multiple databases managed by MOHURD, CABR, MIIT	Lack of integration, standardization, and third-party verification

This comparison highlights both the maturity of European EPD infrastructure and the need for harmonization efforts in China. Addressing this gap would not only strengthen China's domestic green building policy framework but also facilitate cross-border technology transfer and product trade within a carbon-conscious regulatory context.

In addition to differences in EPD infrastructure, the regulatory foundations governing construction products also diverge significantly between China and the European Union. The EU Construction Products Regulation (CPR 305/2011, revised 2024) provides a harmonized framework for product standards, performance declarations, and CE marking across member states. It mandates third-party verification and full digital documentation through the Digital Product Passport (DPP).

By contrast, China's system remains more fragmented. The national product standards are managed by multiple ministries (e.g., MOHURD, MIIT, SAMR), and while a quality supervision system exists, it does not yet fully align with lifecycle-based environmental disclosure requirements.

The following table compares the key features of the EU CPR and China's current system to highlight opportunities for regulatory alignment and trade facilitation:

Table 4.7: Comparison Between the EU Construction Products Regulation (CPR 2024) and China's Construction Product Framework

Aspect	EU CPR (2024 Revision)	China
Legal Basis	Regulation (EU) No 305/2011 + 2024 update	Administrative regulations under multiple agencies (e.g., MOHURD, MIIT)
Standard System	Harmonized European Standards (hENs), aligned with EN 15804	National GB/T standards, industry-specific JGJ, CJ, etc.
Environmental Declarations	Mandatory EPD under EN 15804+A2 and GWP thresholds per EPBD	GB/T 32161 optional; no GWP limits; fragmented EPD implementation
Certification Mechanism	CE marking with third-party verification	CCC mark or local quality certifications (e.g., CABR testing)
Digital Integration	Digital Product Passport (DPP) for traceability & LCA data	Partial integration via product databases; no unified digital passport
Market Access & Trade	Mutual recognition within EU Single Market	Bilateral certification needed for imported/exported products
Lifecycle Approach	Fully embedded via EPDs and building-level LCA (e.g., MPG)	Still emerging; limited integration into building performance assessment
Potential for Mutual Alignment	Through standard convergence, digital system linkages, and pilot projects	Requires reform of data format, verification protocols, and platform unification

To operationalize this alignment, the following actions are proposed: Aligning Chinese certification systems with CPR principles could unlock mutual recognition, simplify cross-border material exchange, and promote lifecycle-based regulation in China. Key steps may include:

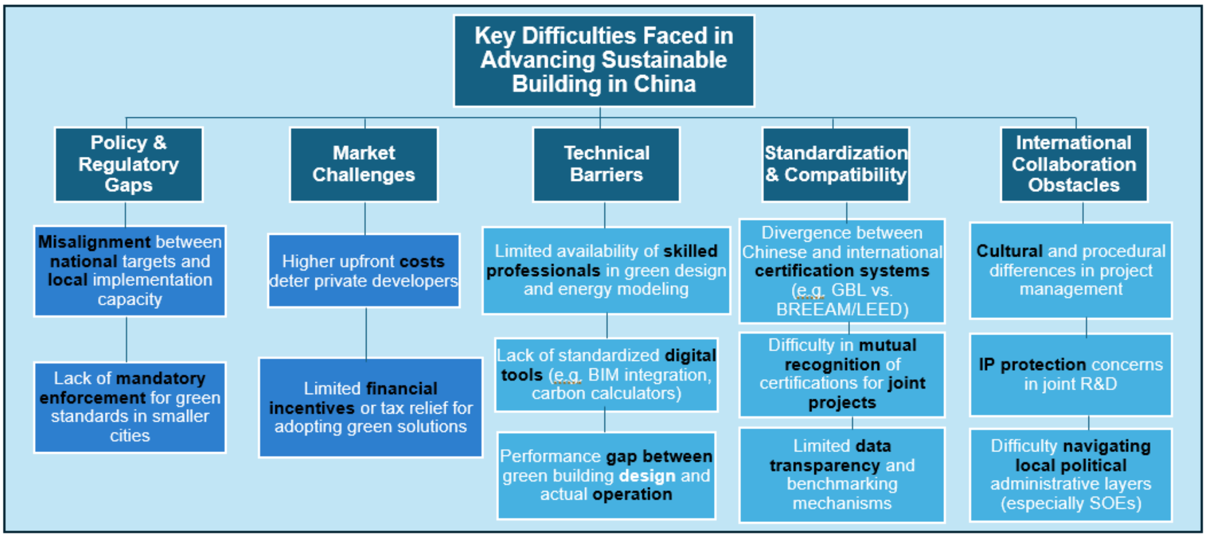
- Launching pilot projects testing dual EPD recognition;
- Integrating EPDs into China's national procurement;
- Establishing a bilateral standard alignment taskforce under EU-China green cooperation platforms.

4.5 Conclusion: Toward Scalable and Collaborative Solutions

The case studies presented in this chapter illustrate how China's sustainability goals are being translated into practice across three key technical areas: materials, energy, and water. Each example reflects not only advancements in engineering and design but also the growing importance of digital tools, certification systems, and localized policy innovation.

Despite significant achievements in pilot zones like Xiong'an, Shenzhen, and Chongqing, challenges persist in scaling these practices across the country—particularly in regions with weaker institutional or technical capacity. This variation presents both a caution and an opportunity: while progress is uneven, the ambition for transformation is evident, and leading examples provide tested models for broader adoption.

Figure 4.2: Sustainable Built-Environment in China——Difficulties faced



For Dutch stakeholders, these developments highlight specific entry points for collaboration: green construction materials with lifecycle performance tracking; ultra-low energy buildings supported by digital energy management; and modular, intelligent water systems tailored to urban resilience. As China deepens its dual-carbon transition and refines urban sustainability frameworks, joint demonstration zones, co-development of standards, and public-private pilots could serve as effective mechanisms for bilateral cooperation.

5. China’s International Partnerships for Sustainable Building Development

5.1 Collaboration scale and mode

China's engagement in international cooperation on sustainable building has grown steadily over the past decade, reflecting both needs from development and globalization pressure. With the increasing urgency of climate change mitigation and the ambition to achieve carbon neutrality, collaboration with global partners has become an essential component of China's strategy to advance technological innovation, enhance green standards, and align with international best practices.

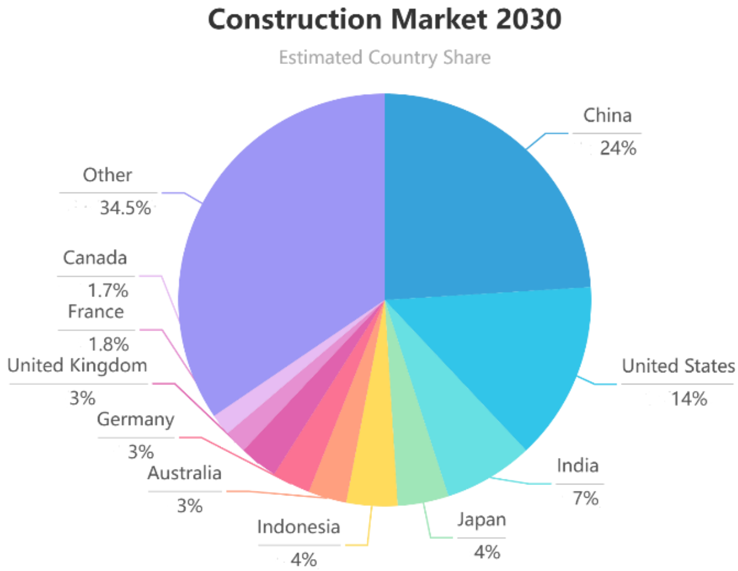
The scale of such collaborations varies significantly, from localized demonstration projects and bilateral or multilateral research initiatives to large-scale multinational programs. These efforts involve a wide range of stakeholders, including government agencies, research institutions, private enterprises, and international organizations. The modes of collaboration are similarly diverse, encompassing government-led frameworks, market-driven joint ventures, and academic research alliances.

This section outlines the key drivers and organizational forms of China’s international cooperation in the sustainable building sector. It first examines the roles of domestic market demand and governmental policy in shaping the agenda for collaboration. It then explores the primary channels through which such cooperation is implemented, setting the stage for a deeper analysis of selected cooperation cases in the following sections.

5.1.1 Market-Driven Catalysts for International Cooperation

The rapid evolution of China's domestic market has become a key driver for international cooperation in the sustainable building sector. As the world's largest construction market now, and the estimated largest construction market in 2030 (Figure 5.1), China faces both environmental imperatives and socio-economic transitions that create significant demand for green solutions, technical innovation, and international expertise.

Figure 5.1: Construction Market share in 2030[95]



(1) Expansion of the Green Building Sector

China's green building market has experienced unprecedented growth over the past decade. According to the Ministry of Housing and Urban-Rural Development (MOHURD), the total floor area of certified green buildings exceeded 11 billion square meters by 2022[96], and 2021-over 90% of new urban buildings between 2021 and 2024[97] meet green building standards. This surge has stimulated demand for advanced materials, energy-efficient technologies, and green design strategies—many of which are pioneered or standardized internationally. In response, Chinese developers and engineering firms increasingly engage in partnerships with foreign design consultancies and technology providers to ensure performance benchmarks, gain certifications such as LEED and BREEAM, and integrate global best practices.

(2) Rising Demand from Urban Middle-Class Consumers

The emergence of a large urban middle class, especially in tier-1 and tier-2 cities, has led to a shift in consumer expectations toward healthier, smarter, and more environmentally friendly built environments. Building users are now more concerned about indoor air quality, thermal comfort, energy savings, and intelligent building management. These evolving preferences encourage developers to pursue high-end green housing products—often in collaboration with foreign partners who offer experience in passive design, bioclimatic architecture, and healthy building standards such as WELL. This trend also pushes forward the adoption of international design norms and fosters competition in delivering high-quality green spaces.

[95] Source: Oxford Economics/Haver Analytics, Future of Construction, Marsh & Guy Carpenter.
[96] National Bureau of Statistics https://www.stats.gov.cn/sj/sjjd/202409/t20240911_1956382.html
[97] https://www.gov.cn/lianbo/bumen/202408/content_6968755.htm

(3) Industrial Upgrading and Low-Carbon Transformation

The pressure for low-carbon transition across China's construction and building materials industries further accelerates international cooperation. The government has announced that carbon emissions from the operation of buildings must peak before 2030, prompting firms to seek out new materials, technologies, and systems. Chinese companies are increasingly partnering with international firms to co-develop low-carbon products, such as geopolymer binders, prefabricated components with recycled aggregates, and integrated photovoltaic building systems. These joint ventures serve both domestic pilot projects and export-oriented product development aligned with carbon neutrality goals.

(4) International Certification and Market Access

To enhance brand competitiveness and enable access to global markets—particularly within the Belt and Road Initiative framework—many Chinese developers and contractors are actively seeking international certification. LEED, BREEAM, and DGNB are increasingly used not only for domestic prestige but also for recognition in overseas projects. These standards often require collaboration with accredited foreign consultants, thus promoting technical exchange and strategic partnerships. In turn, such cooperation enables Chinese companies to position themselves as global players in the green construction value chain.

(5) Digitalization and Smart Construction Trends

The rise of Building Information Modeling (BIM), carbon accounting platforms, and smart construction technologies is reshaping the construction landscape in China. These technologies often originate from or are refined in international contexts, and Chinese firms are eager to incorporate them to enhance project efficiency, monitoring, and sustainability metrics. Strategic collaborations with European and North American tech companies—particularly in areas like digital twins, life-cycle carbon assessment, and modular construction systems—are gaining momentum, driven by the need for integrated solutions in both public and private projects.

5.1.2 Policy and Strategic Incentives from the Chinese Government

In addition to market drivers, the Chinese government has always trying to playing a key role in shaping China's international engagement in the field of sustainable buildings through a comprehensive series of policies, plans and institutional mechanisms. These efforts reflect China's ambition to achieve broader environmental governance goals and become a leader in global green development.

(1) National Policy Frameworks for Green Building and Carbon Neutrality

The central government has incorporated green building into its broader climate and sustainability agenda as descriped in the chapter 2 and chapter 3 of this report. In particular, the **"14th Five-Year Plan for Building Energy Efficiency and Green Building Development"** (2022) explicitly calls for the expansion of international cooperation in areas such as low-carbon building materials, green construction technologies, and energy-efficient systems. It also supports the integration of international certification systems and encourages participation in multilateral platforms. These directives align with China's dual carbon goals: achieving **peak carbon emissions by 2030** and **carbon neutrality by 2060**.

Additionally, MOHURD's **"Work Plan on Carbon Emissions Reduction in the Building Sector" (2022)** identifies "international exchange and cooperation" as one of its three major tasks, alongside strengthening energy efficiency standards and promoting green construction practices. This attitude demonstrates China's active encouragement of international cooperation, which in practice can be translated into additional evaluation points for international cooperation projects and a certain degree of policy relaxation.

(2) Bilateral Platforms and Green Diplomacy

China's foreign policy increasingly incorporates sustainability and green infrastructure into diplomatic and trade relations. Initiatives such as the **Belt and Road Initiative (BRI)** have created new venues for sustainable building collaboration, with an emphasis on green development, knowledge exchange, and capacity building in partner countries. The **"Green Belt and Road"** vision has facilitated cooperation with international organizations like UN-Habitat and UNEP, as well as national agencies from Europe and Southeast Asia.

At the same time, there is a systematic working agreement between the Ministry of Foreign Affairs of China and the Ministry of Housing and Urban-Rural Development to establish a cooperation platform between China and other countries through policy dialogues, technology demonstrations and joint research projects, so as to promote the further deepening of friendly relations between China and other countries through sustainable development technology and economic and trade exchanges.

(3) Joint Funding and Institutional Mechanisms

National funding bodies such as the **National Natural Science Foundation of China (NSFC)** have established international partnerships with the **Dutch Research Council (NWO)**[98], **UKRI**[99], and the **EU's Horizon Europe** program[100]. These platforms fund joint research in **climate resilience, sustainable urban development, and low-carbon construction technologies**. Institutional backing from MOHURD and the Ministry of Science and Technology ensures long-term implementation of pilot projects.

(4) Standards Alignment and Regulatory Internationalization

Efforts to align Chinese regulations—such as GB/T 50378—with global frameworks like LEED and BREEAM are gaining momentum. At the same time, China is **exporting its green building**

[98] "Cooperation China (NSFC) | Merian Fund" https://www.nwo.nl/en/researchprogrammes/merian-fund/china-merian-fund/cooperation-china-nsfc-merian-fund
[99] As reported "The NSFC -UKRI Interdisciplinary Research Workshop Successfully Held" https://www.nsfc.gov.cn/english/site_1/news/A1/2022/05-26/269.html
[100] Such as "EU-CHINA BRIDGE project" https://eu-china-bridge.eu/

standards to developing countries via the BRI, facilitating **two-way harmonization and joint standard-setting**.

5.1.3 Channels and Mechanisms for International Collaboration

China's international cooperation in sustainable building is supported by a diverse set of channels and institutional mechanisms that enable coordination across government agencies, research institutions, private enterprises, and international organizations. These collaborative pathways range from formal intergovernmental agreements to informal academic networks and project-based partnerships.

(1) Government-to-Government (G2G) Agreements

Formal bilateral and multilateral agreements are a cornerstone of China's international engagement strategy. These include memoranda of understanding (MoUs), joint declarations, and strategic frameworks signed between China's Ministry of Housing and Urban-Rural Development (MOHURD) and counterpart ministries in Europe, Asia, and North America. These agreements often focus on mutual goals such as energy-efficient buildings, sustainable urban development, and low-carbon infrastructure.

For example, the UK–China Green Building Research and Innovation Platform, established under the broader China–UK Strategic Partnership, facilitates high-level dialogues and pilot projects. Similarly, MOHURD's cooperation with Germany's Federal Ministry for the Environment includes knowledge exchange on building energy codes and renovation strategies.

(2) Research and Innovation Programs

Science and technology cooperation plays a central role in enabling long-term, in-depth collaboration. Key mechanisms include joint research funding schemes such as the NSFC–NWO (Netherlands Organisation for Scientific Research) partnership, NSFC–DFG (Germany) collaborations, and Chinese participation in EU Horizon 2020/Horizon Europe programs. These platforms support cross-border research teams working on topics such as low-carbon materials, life-cycle assessment, smart building technologies, and green city planning. International cooperation is also facilitated by national-level initiatives such as China's "Belt and Road Science, Technology and Innovation Cooperation Action Plan," which promotes sustainable urban infrastructure through joint research centers and demonstration projects.

(3) Enterprise Partnerships and Trade Platforms

Chinese and foreign enterprises increasingly collaborate through joint ventures, technology transfer agreements, and co-development of green products and solutions. Multinational companies operating in China—such as Arup, Siemens, and Saint-Gobain—often act as technology providers or consultants in high-profile green building projects. Chinese construction and materials companies, in turn, seek foreign expertise to meet evolving green standards and certification requirements. International exhibitions and trade platforms such as the China

International Green Building and Energy Efficiency Expo (CIGBE) provide opportunities for companies to form partnerships and showcase innovation.

(4) Academic Networks and Knowledge Platforms

Academic institutions act as crucial intermediaries for sustained knowledge exchange. Chinese universities and research institutes maintain extensive collaboration with counterparts in the Netherlands, Germany, the UK, and other countries through joint labs, PhD exchange programs, and summer schools. Initiatives like the Sino–Dutch Sustainable Building and Urban Development Network and the China–EU Green Building Forum facilitate multilateral engagement in both policy and practice.

(5) Multilateral Institutions and International NGOs

China also cooperates through global platforms such as UN-Habitat, UNEP, ICLEI, and the Global Alliance for Buildings and Construction (GlobalABC). These organizations provide normative guidance, benchmarking tools, and project coordination frameworks, helping align China's green building practices with global standards.

Evolution of China’s Cooperation Model

Over time, the mode of international cooperation in China's sustainable building sector has also undergone a notable evolution. Initially, collaborations were primarily focused on **technology importation and knowledge transfer**, with Chinese stakeholders learning from established international best practices. As capabilities strengthened, the cooperation evolved towards **joint research and innovation**, featuring co-development of new technologies and systems tailored to China's specific urban and environmental conditions. In recent years, a further shift towards **joint standard-setting and policy harmonization** has emerged, particularly in areas such as green building certification, energy efficiency benchmarks, and carbon accounting frameworks. This gradual evolution reflects a maturing collaborative ecosystem where China is no longer a passive recipient but an active contributor to global sustainable building standards and innovations.

5.2 Representative Cases of International Cooperation

International cooperation between China and global partners in the field of sustainable building is not only policy-driven but also materialized through concrete collaborative initiatives. This section highlights several representative cases that demonstrate different forms of cooperation—ranging from joint research programs and innovation platforms to bilateral science committees. These cases illustrate how collaboration mechanisms operate in practice, and how they contribute to advancing sustainable building technologies and practices.

5.2.1 China–UK Research and Innovation Bridges

Background:

The China–UK Research and Innovation Bridges Program was initiated to deepen scientific and technological collaboration between the United Kingdom and China, particularly in key areas like sustainable urban development, low-carbon building technologies, and green infrastructure. It is jointly coordinated by the UK Research and Innovation (UKRI) and the Chinese Ministry of Science and Technology (MOST).

Key Activities and Achievements:

- Joint calls for research on energy efficiency, low-carbon materials, and smart city infrastructure;
- Implementation of demonstration projects combining passive design, renewable energy, and sustainable mobility;
- Establishment of a permanent knowledge-sharing platform (ukchinagreen.org) for technical dialogue and training.

Significance:

The Bridges Program has played a critical role in fostering long-term institutional partnerships and facilitating mutual learning between UK and Chinese research and industry communities, contributing significantly to the evolution of green building practices in both countries.

Main Impact:

Advancing joint research and early demonstration projects in sustainable building technologies.

5.2.2 UK–China Green Building and Eco-City Platform

Background:

Built as an extension of the Bridges Program[101], this platform provides continuity in Sino–UK cooperation, with a specific focus on built environment sustainability at the urban scale.

Key Activities and Achievements:

- Annual conferences and technical visits for developers, policymakers, and researchers;
- Bilateral support for technologies like passive houses, zero-carbon buildings, and smart grid integration;
- Knowledge transfer through white papers, case studies, and capacity-building workshops.

Significance:

By supporting both technical and policy-level exchanges, the platform has enhanced bilateral alignment on green urban strategies. Dutch stakeholders may consider similar institutional vehicles for ensuring continuity beyond individual projects—especially in areas like circular construction, where the Netherlands holds recognized strengths.

[101] https://www.chathamhouse.org/2025/01/agenda-uk-china-climate-cooperation/cooperating-china-climate-action

Main Impact:

Supporting policy dialogue and knowledge exchange for urban-scale sustainable development.

5.2.3 Horizon-Europe–China Cooperation

Background:

Under Horizon Europe, the EU has continued its collaborative research with China, emphasizing mutual contributions to global sustainability goals. Chinese institutions participate in thematic calls on energy-positive buildings, resilient infrastructure, and urban decarbonization.

Key Activities and Achievements:

- Joint projects on low-carbon materials, life-cycle assessment, and AI-driven urban systems;
- Structured dissemination mechanisms to ensure knowledge transfer to both sides;
- Inclusion of Chinese partners in carbon-neutral city consortia.

Significance:

Horizon Europe facilitates high-standard, comparative research and offers Dutch institutions a tested model for engagement with Chinese counterparts—especially in EU-coordinated clusters focusing on built environment innovation.

Main Impact:

Enabling cross-continental research collaborations focused on carbon-neutral cities and sustainable technologies.

5.2.4 China–Netherlands Cooperation: NSFC–NWO, Sino-Dutch Scientific Cooperation Committee, Sino–Dutch Suzhou Initiatives

Background:

The China–Netherlands scientific cooperation ecosystem is underpinned by the **NSFC–NWO Merian Fund**, the activities of the **Sino-Dutch Scientific Cooperation Committee**, and practical city-level projects such as the Sino–Dutch Suzhou Innovation Park. These initiatives foster bilateral research cooperation focused on global societal challenges, with a strong emphasis on sustainability and urban development.

Key Activities and Achievements:

- Joint research calls on green materials, urban resilience, and circular economy;
- Bilateral workshops and scientific exchanges to co-define research priorities;
- Development of pilot zones in Suzhou focused on smart construction and water management.

Significance:

China–Netherlands cooperation demonstrates a balanced and pragmatic model of bilateral engagement, combining scientific excellence with real-world application. It exemplifies how targeted partnerships can generate tangible outcomes in advancing green building and sustainable urbanization strategies.

Main Impact:

Facilitating bilateral research and city-level demonstration projects in green infrastructure and smart cities.

5.2.5 Merian Fund Collaboration between China and the Netherlands

Background:

The **Merian Fund** is a Dutch funding initiative administered by the Netherlands Organisation for Scientific Research (NWO) aimed at promoting long-term, equitable research cooperation with emerging scientific powers like China. Within the framework of the China–CAS (Chinese Academy of Sciences) Merian Fund collaboration, the focus is placed on addressing sustainability, climate change, and healthy societies.

Key Activities and Achievements:

- Funding of interdisciplinary consortia addressing low-carbon urban development and healthy cities;
- Emphasis on co-design and joint governance of research agendas;
- Outputs including policy briefs, comparative datasets, and prototype technologies.

Significance:

The Merian Fund collaboration provides a model for truly joint research ownership and capacity building. It encourages not only technical innovation but also mutual understanding of sustainability governance systems and urbanization dynamics in Europe and China.

Main Impact:

Deepening institutional trust and joint innovation capacity in sustainable urban systems.

Summary

Together, these representative cases illustrate the diversity, depth, and strategic significance of China's international cooperation efforts in the sustainable building sector. They highlight how bilateral platforms, multilateral research programs, city-level initiatives, and funding mechanisms collectively shape the future of green urban development through innovation, mutual learning, and practical application.

5.2.6 Discussion: From Knowledge Exchange to Strategic Positioning in the Chinese Market

The representative cases examined above demonstrate that China’s approach to international cooperation in the sustainable building sector is evolving—moving from passive technology absorption to joint innovation, and increasingly toward co-development of standards and regulatory alignment. This transition reflects China's maturing capabilities and its growing ambition to shape the global sustainability agenda.

For the Netherlands, this evolution presents a unique window of opportunity—not only in research collaboration but also in strategic positioning within China's high-growth markets. Dutch strengths in circular construction, water management, digital twins, and integrated energy systems align well with China's urban green transition goals. However, capitalizing on these synergies requires more than technical alignment; it demands active participation in China's institutional frameworks and localized initiatives.

First, a more deliberate focus on **local-level cooperation (province-to-province or city-to-city)** is essential. In China's decentralized administrative system, local governments are often the first responsible entities for implementing green building targets. Cities such as Shenzhen, Suzhou, and Chengdu operate with substantial autonomy and may offer **extra funding windows, fast-track pilots, or regulatory support** to international partners. Establishing structured cooperation between Dutch provinces and Chinese cities can open valuable project pipelines—particularly in areas such as green material procurement, smart infrastructure, or sponge city retrofits—while also de-risking market entry for SMEs.

Second, while the Netherlands and EU have contributed meaningfully to large bilaterally funded joint R&D programs (e.g. Horizon Europe, Merian Fund), these are often **large-scale (million-level), infrequent calls (typically 3–4 projects funded per call per year)** with high thresholds and long gestation periods. By contrast, the **UK has created a more agile cooperation model** through frequent small-scale joint funding calls between UK and Chinese universities. These initiatives enable faster project kick-offs, promote hands-on exchange between researchers and practitioners, and serve as **efficient pathways for translating academic outputs into business applications or engineering pilots**. The current Dutch funding landscape could benefit from integrating similar mechanisms to enhance speed and continuity in academic–industry partnerships, particularly when the goal is commercial impact.

In summary, while China's national-level frameworks are crucial for setting direction, the **real entry points for Dutch stakeholders often lie in well-targeted, local-level collaborations** and in enabling smoother **transitions from academic research to market deployment**. For Dutch companies and institutions aiming to expand their footprint, proactive engagement in city-scale pilots, flexible co-funding schemes, and alignment with Chinese implementation agencies will be key to achieving both sustainable development goals and long-term economic returns.

5.3 Benefits and limitations

International cooperation in sustainable building has delivered tangible benefits for both China and its global partners. It has accelerated knowledge exchange, enabled joint innovation, and created market pathways for sustainable technologies. However, structural and institutional challenges continue to limit the efficiency and scalability of many initiatives. A balanced assessment of these dynamics is essential for refining future engagement strategies and ensuring the long-term value of international partnerships—particularly for stakeholders seeking to translate research collaboration into business outcomes.

5.3.1 Mutual Benefits: Knowledge, Market, and Policy Learning

Knowledge Transfer and Technological Synergy

International partnerships have played a pivotal role in advancing China's technical capacity in green building. Through joint research programs, demonstration projects, and academic exchanges, Chinese institutions have gained exposure to global expertise in areas such as energy-efficient building systems, life-cycle carbon assessment, digital construction technologies (e.g., BIM and digital twins), and sustainable materials development. For foreign partners, cooperation with China has provided a window into the world's largest construction market and access to pioneering urban experiments, particularly in high-density environments and prefabricated green infrastructure.

Market Expansion and Commercial Access

Sino-foreign collaborations have created mutual commercial value. International firms have entered China's growing green construction and smart city markets by offering technical services, certification expertise, and high-performance materials. At the same time, Chinese firms have leveraged these partnerships to access overseas markets—particularly through the Belt and Road Initiative (BRI)—and to align with global environmental performance benchmarks. These reciprocal flows of market access and co-development serve as an important foundation for building resilient transnational business models.

Policy Innovation and Institutional Learning

Cross-border engagement has also enriched both policy systems. China has drawn from European and UK regulatory frameworks to upgrade its green building codes, energy performance standards, and financial incentive mechanisms. Conversely, foreign governments and institutions have observed how China's rapid policy iteration and top-down coordination can accelerate the scaling of innovations, such as prefabricated construction or low-carbon demonstration zones. This mutual policy learning has contributed to a more nuanced global understanding of how to balance standardization, innovation, and market adoption.

5.3.2 Barriers and Limitations: Cultural, Technical, and Institutional Gaps

Despite these benefits, several systemic challenges continue to hinder the full realization of international cooperation, especially when moving from joint research toward commercial or large-scale deployment.

Cultural and Communication Barriers

Divergences in institutional culture, language, project timelines, and collaboration styles can create friction. Misunderstandings in stakeholder roles or differences in risk tolerance and decision-making processes may delay implementation. This is especially evident in joint R&D or co-funded pilot projects, where assumptions about roles and expectations are not always aligned.

Standards and Certification Misalignment

Technical incompatibility between Chinese and international certification frameworks (e.g., GB/T 50378 vs. LEED or BREEAM) complicates the transfer and mutual recognition of sustainable building products and technologies. These gaps affect everything from material selection and energy modeling to post-construction performance verification. Dutch companies, in particular, may face hurdles in validating their circular construction or digital energy solutions under China's evolving standards unless there is explicit policy alignment or local adaptation.

Institutional and Funding Discrepancies

International cooperation is often slowed by differences in administrative processes, funding cycles, and intellectual property management. Chinese partners may find European funding instruments (such as Horizon or Merian Fund calls) bureaucratically complex and infrequent, limiting sustained engagement. Conversely, European partners may find China's regulatory environment difficult to navigate without strong local support. The absence of flexible, mid-sized bilateral funding tools—especially at the city or provincial level—can inhibit fast-track collaboration and limit SME participation.

5.4 Comparative Roles and Contributions of Chinese and Foreign Enterprises

International cooperation in sustainable building relies not only on policy frameworks and academic exchanges but also fundamentally on the active participation of enterprises. Chinese and foreign companies play distinct yet complementary roles in shaping the technological, operational, and commercial landscape of the sector. Understanding this interplay is critical for identifying where value can be created—particularly for Dutch firms looking to engage more deeply with China's green building transformation.

5.4.1 Roles and Contributions of Chinese Enterprises

Project Implementation and Market Expansion

Chinese enterprises, particularly major state-owned construction contractors (e.g., CSCEC, CRCC) and influential private developers, are the backbone of project execution in China's sustainable building sector. These firms demonstrate strong capabilities in large-scale delivery, cost control, and policy alignment—especially in government-commissioned and affordable housing programs. Their dominant position in domestic green infrastructure projects reflects both institutional trust and their ability to execute complex urban initiatives under tight timelines and budgets.

Adaptation and Localization of Technologies

A core strength of Chinese companies lies in adapting imported technologies to meet domestic requirements. Whether tailoring passive design for high-density cities or modifying materials to meet local regulations and cost structures, they play a crucial role in bridging global innovation with local applicability. This adaptability enables rapid deployment of foreign technologies within complex and fast-moving project environments.

Industrialization and Policy Synergy

An important feature of Chinese enterprises is their capacity to rapidly industrialize proven sustainable technologies. Prefabricated green buildings, district energy networks, and sponge city systems have all benefitted from this scaling ability. Moreover, Chinese firms often operate in close coordination with central and municipal authorities, allowing for alignment with Five-Year Plans and urban development policies.

Global Expansion and South-South Cooperation

Increasingly, Chinese construction firms are extending their green building practices abroad through the Belt and Road Initiative (BRI) and other international ventures. Their participation in overseas infrastructure is welcomed by many Global South countries due to speed and scale. These projects present growing opportunities for foreign firms—including Dutch enterprises—to contribute through joint ventures and technology partnerships, especially in areas where international expertise or standards are required.

5.4.2 Organizational Structure and Market Composition of Construction

Comparison of market organization forms

The Chinese construction industry operates within a hierarchical and segmented organizational landscape dominated by a small number of large-scale enterprises and a vast network of smaller firms. According to data from the Ministry of Housing and Urban-Rural Development (MOHURD), the industry includes over 100,000 registered construction enterprises, of which more than 95% are classified as small and medium-sized enterprises (SMEs).

State-owned enterprises (SOEs)—although constituting less than 1% of firms by number—contribute over 35–40% of total construction output value. These centrally administered giants, such as China State Construction Engineering Corporation (CSCEC) and China Railway Construction Corporation (CRCC), are directly overseen by the State-owned Assets Supervision and Administration Commission (SASAC). They dominate public infrastructure, affordable housing, and overseas engineering markets, operating mainly through general contracting or engineering–procurement–construction (EPC) models.

Private sector firms are composed of large national developers and a broad array of regional firms. Major real estate developers—including Vanke, Country Garden, and formerly Evergrande—have historically played a central role in residential and commercial property development, especially in high-growth urban clusters. At its peak, Evergrande alone managed projects equivalent to several percentage points of national GDP. However, financial deleveraging policies and regulatory tightening since 2021 have significantly reshaped this segment, reducing the influence of highly leveraged private developers.

Small and medium-sized enterprises (SMEs)—which make up the overwhelming majority of firms—primarily operate as specialized subcontractors (e.g., for HVAC, finishing works, or structural framing) or as labor providers. These SMEs are embedded within multi-layered project delivery chains, which can include two to four levels of subcontracting. While vital for local employment and flexibility, these firms often lack the technical capacity and financial stability to adopt green building practices or advanced quality assurance systems.

The division of business activities across market segments typically follows a pattern:

- Public infrastructure and state-led urban development are monopolized by central and provincial SOEs.
- Private-sector residential and commercial development is mostly carried out by national and regional private firms.
- Industrial and logistics construction has emerged as a fast-growing subsector, with demand for prefabrication, digital design, and low-carbon materials increasingly driven by supply chain modernization.

This organizational composition reflects a strong policy hierarchy in project allocation, procurement, and compliance. SOEs often pilot national standards and green building schemes, while the downstream diffusion of innovation across SMEs remains limited. For international cooperation initiatives, engaging both top-tier SOEs and capable private sector partners is key to ensuring both policy support and market scalability.

Typology Differences and Technical Implications (China vs. Netherlands)

China's urban housing supply is predominantly multi-story and high-rise apartment buildings delivered by large developers in high-density cities. By contrast, the Netherlands maintains a large share of low-rise stock (single-family and terraced houses) with municipalities and housing associations playing a significant role in planning, affordability, and quality control.
Implications for cooperation:

• Design & engineering: China prioritizes high-rise structural systems, vertical transportation, and centralized plantrooms; the Netherlands focuses on neighborhood-scale renovation, façade upgrades, airtightness, and moisture control in low-rise envelopes.

• Energy systems: China's newbuilds often integrate centralized HVAC/heat networks at block scale; the Dutch market emphasizes decentralized, all-electric solutions (heat pumps, ventilation with heat recovery) suited to low-rise retrofits.

• Delivery model: Developer-led turnkey delivery in China favors standardized prefabrication at scale; Dutch projects frequently balance public-interest objectives (e.g., social housing) with performance contracts for deep energy renovation.

• Certification & compliance: Divergent rating systems and procurement logics require "dual-track" documentation and outcome-based KPIs to translate Dutch low-rise best practices to Chinese high-rise contexts (and vice versa).

These structural differences suggest complementarity: Dutch strengths in circular renovation and occupant-centric performance can pair with China's capabilities in high-rise prefabrication, digital supervision, and rapid scaling.

These differences between the Chinese and Dutch construction markets are summarized in Table 5.1, which also highlights their implications for potential cooperation.

Table 5.1: Structural differences between the Chinese and Dutch construction markets

Aspect	China	Netherlands	Implications for Cooperation
Dominant building typology	Multi-story and high-rise apartment blocks in dense urban areas	Low-rise housing (single-family, terraced), strong renovation market	Dutch expertise in neighborhood retrofits complements China's high-rise new-build focus
Key market actors	Large real estate developers, often with SOE background	Municipalities, housing associations, SMEs	Knowledge exchange on governance models and public–private partnerships
Technical priorities	Structural systems for high-rise, vertical transportation, centralized HVAC	Façade upgrades, airtightness, ventilation, low-rise energy systems	Joint R&D on scalable prefabrication + decentralized renewable integration
Energy systems	Centralized heating/cooling networks, block-scale plants	Decentralized all-electric systems (heat pumps, HRV)	Opportunities to pilot hybrid solutions in mixed developments
Delivery model	Developer-led, standardized, fast-track prefabrication	Performance contracts, community-oriented renovation	Sharing best practices on performance KPIs and circularity
Certification & compliance	GB/T, GBL, and MOHURD standards, outcome less emphasized	BENG, EPBD compliance, outcome-based performance	Need for dual-track certification pathways in joint projects

5.4.3 Roles and Contributions of Foreign Enterprises

Technology Innovation and Knowledge Transfer

Foreign enterprises, including engineering firms, architectural consultancies, and material manufacturers, often act as sources of advanced sustainable building technologies and design methodologies. They bring expertise in areas such as passive house standards, energy-positive building designs, life-cycle carbon assessment, and smart construction technologies. Through joint ventures, consulting contracts, and pilot projects, these companies facilitate knowledge transfer to Chinese counterparts.

Certification, Branding, and Compliance with Global Standards

Foreign firms often lead the implementation of global green certification frameworks like LEED, BREEAM, and WELL in China, guiding local developers in aligning with international benchmarks. These certifications not only raise project quality but also enhance branding and investor confidence.

Demonstration Projects as Knowledge Carriers

High-profile demonstration projects remain an essential mode of knowledge transfer. Through collaboration on flagship developments—such as low-carbon campuses or green industrial parks—foreign firms build credibility while seeding broader market adoption. Dutch case studies in sustainable water, energy, and integrated building systems can serve as influential models in this regard.

5.4.4 Comparative Perspective

China's sustainable building sector exhibits a cooperation model increasingly characterized by "**hardware localization and software/service internationalization**." Chinese enterprises provide scale, infrastructure, and policy alignment; foreign partners offer advanced design methodologies, system integration, and high-precision technologies. This dynamic is particularly evident in projects such as smart parks, zero-energy zones, and green city planning initiatives.

This dual-track model aligns with earlier observations by Yao and Steemers (2009), who underscored the role of international collaboration in facilitating sustainable urban transitions in China.

Table 5.2: Strategic Roles of Chinese and Foreign Enterprises in China's Green Building Market: Implications for Cooperation

Aspect	Chinese Enterprises	Foreign Enterprises
Project Execution	Lead large-scale project implementation	Provide consulting and technical expertise for pilot projects
Technology Innovation	Adapt and optimize imported technologies	Lead in frontier technologies (e.g., passive design, smart construction)
Adaptation & Localization	Localize technologies for diverse urban conditions	Introduce international best practices
Standard Setting	Align domestic standards with international practices	Promote LEED, BREEAM, WELL certifications
Market Expansion	Expand sustainable building practices domestically and internationally	Enter and grow in China's vast construction market
Certification and Branding	Enhance recognition through partnership with certification bodies	Showcase innovation through demonstration projects

Table 5.3: Representative Enterprises in International Cooperation for Sustainable Building in China

Enterprise Name	Country	Entry Mode	Representative Project	Advantage Areas	Cooperation Model
CSCEC Tech	China	Local leadership	Shenzhen Longgang Talent Housing Project, Xiong'an Green Demonstration Zone	Prefabricated construction, lifecycle management, BIM platform	Self-operation + government cooperation
Broad Homes	China	Local leadership	Changsha Green Prefabricated Residential Area	PC components, green construction, integrated on-site system	Industrial park + local government PPP

Honeywell	United States	Localized operations (Joint venture + investment)	Shanghai Headquarters Building Energy Efficiency System, Guangzhou Smart Building Project	Smart building systems, energy monitoring and control	Cooperation with developers and government
Deltares	Netherlands	Consultancy services + design projects	Shanghai Pudong Flood Forecast	Real-time data and forecast models	China-Netherlands Water Cooperation Memorandum of Understanding
Siemens	Germany	Local subsidiary + project cooperation	Beijing Yizhuang Green Industrial Park Energy Center	Building automation, smart energy, digital energy platform	EPC general contracting + cooperative development
Atkins	United Kingdom	Consultancy services + design projects	Chongqing Sustainable City Planning, Shenzhen Qianhai Low-carbon City Planning	Sustainable urban design, green city planning	Urban planning consultancy contracts
China Energy Conservation and Environmental Protection Group (CECEP)	China	State-owned enterprise operation	National Government Office Building Energy Retrofit Projects, School Green Renovation Projects	Energy retrofit, building optimization, policy implementation	Government investment + entrusted management services

Additional Strategic Considerations

Positioning for International Projects with Chinese Leadership as Chinese infrastructure firms become increasingly active on the global stage, particularly in Asia, Africa, and Latin America, a new opportunity space emerges. These international projects often involve diverse stakeholders and demand sustainable solutions that meet both environmental goals and local economic realities. Dutch enterprises can enter these supply chains by:

- **Building long-term cooperation** with large Chinese firms (e.g., CSCEC, CRCC) through joint R&D, pilot projects, and technical partnerships;
- **Promoting Dutch expertise** in lifecycle carbon reduction, integrated water-energy systems, and climate-resilient design;
- **Offering region-specific solutions** that adapt to the cost-performance balance required in developing economies, which may diverge from EU norms.

Such engagement requires a **dual strategy**:

- On one hand, reinforcing **credibility through alignment with EU standards and green finance regulations** (an area where Dutch firms are strong);
- On the other, developing **context-sensitive technologies** tailored for the Global South—balancing affordability, durability, and sustainability.

Financial Instruments and Green Building Insurance

Dutch firms can also contribute to the financial dimension of sustainable construction. Innovative instruments such as **green building performance insurance, carbon credits, and sustainability-linked loans** are increasingly relevant in both domestic and international contexts. Collaborating with Chinese stakeholders on financial products could further enhance Dutch visibility and value creation.

In China's sustainable building sector, a distinct and increasingly strategic model of international enterprise collaboration has emerged. This model is characterized by a complementary division of labor: **Chinese enterprises offer rapid implementation capacity, close policy alignment, and broad market reach**, while **foreign enterprises contribute advanced innovation, methodological rigor, and compliance with global standards**.

This synergy is evident in major projects where Chinese firms provide the scale and infrastructure backbone, and foreign firms add value through specialized technologies and system-level solutions. For example, **CSCEC Tech** and **Broad Homes** have played leading roles in deploying construction technologies and prefabricated systems, particularly in large-scale government-backed and affordable housing projects. These firms benefit from strong state coordination and cost-effective scaling strategies.

In contrast, foreign enterprises such as **Honeywell**, **Siemens**, and **Atkins** typically operate in technology-intensive and service-oriented domains. Their contributions span **smart building systems**, **energy management**, and **sustainable urban design consulting**—areas where precise technical performance and integration with international practices are critical.

Projects like smart parks and green urban districts illustrate a prevailing cooperation model of **"hardware localization and software/service internationalization."** Chinese companies lead the construction and physical infrastructure development, while foreign firms offer essential inputs in system integration, energy optimization, and sustainability consulting. This trend mirrors insights from Yao and Steemers (2009) [102], who emphasized the importance of international partnerships in facilitating knowledge transfer and advancing sustainable building practices in China.

For **Dutch stakeholders**, this collaboration model presents a clear and actionable opportunity: by embedding niche technological expertise within Chinese-led initiatives—such as through **innovation partnerships**, **pilot zones**, or **technical alliances**—they can effectively scale up impact and gain broader market access. Key success factors include:

- Partnering with Chinese firms that have **credible implementation capacity**;
- Aligning with **municipal development priorities** and local policy agendas;
- Leveraging **demonstration projects** as platforms for visibility and trust-building.

Looking ahead, the deepening integration of global technological know-how with China's executional strength offers fertile ground for **co-developing next-generation green building standards** and **sustainable urban models**. These collaborations not only support China's domestic green transformation but also contribute to global sustainability transitions.

[102] https://www.sciencedirect.com/science/article/pii/S0960148109000718?via%3Dihub

5.4.5 Discussion on the Role of State-Owned Construction Enterprises

When analyzing China's construction sector, it is important to recognize that Dutch stakeholders should not overlook the distinct operating mechanisms and relatively dominant position of Chinese state-owned enterprises (SOEs). This structure holds a highly prioritized role in Chinese government policymaking and significantly shapes the industry landscape.

However, this mechanism should not necessarily be seen as an impediment to China–Netherlands cooperation in the construction sector. In essence, the Chinese state-owned economic model represents a form of ownership that prioritizes societal responsibility. Compared with privately owned companies, Chinese SOEs typically demonstrate stronger long-term strategic vision and a greater focus on societal benefits. Moreover, given their significant scale, SOEs are better equipped to absorb costs and manage risks that private enterprises often cannot. These characteristics offer particular advantages in the field of sustainable construction, where projects require substantial investment and must often tolerate the risk that a building's long-term sustainability performance may not fully meet initial expectations. As such, treating SOEs simply as corporate partners overlooks their potential to play a pivotal role in advancing sustainable construction initiatives.

While the benefits are substantial, Dutch enterprises should also anticipate potential challenges when cooperating with Chinese SOEs. This section aims to identify foreseeable issues, explain their origins, and propose practical recommendations to minimize the risk of conflict during collaboration.

The first challenge lies in the political nature of Chinese SOEs. International partners often observe that SOEs exhibit a strong degree of political association, extending beyond purely commercial interests—particularly during the early stages of collaboration. This characteristic stems from the fact that Chinese SOEs are mandated to fulfill various social functions, akin to the role of government-controlled entities such as NS (Nederlandse Spoorwegen) and Gasunie in the Netherlands. However, the influence of political oversight in Chinese SOEs tends to be even stronger. Chinese SOEs must respond not only to the central government but also to provincial and municipal authorities. As a result, SOE leadership in China typically carries a higher degree of political responsibility compared to their European counterparts, and in many cases, senior executives transition between corporate and political leadership roles more frequently.

Given this background, it is advisable for Dutch companies to incorporate both economic and social value propositions when designing cooperative projects. Demonstrating the project's societal benefits alongside financial gains will help establish a stronger foundation for mutual understanding and shared objectives. Furthermore, presenting a project with high visibility—such as a "first-of-its-kind" initiative in China or globally, or one that achieves unprecedented scale or technical innovation—can greatly enhance its attractiveness to Chinese SOEs. Such projects may also attract additional support from local or even national government agencies, creating favorable conditions for deeper China–Netherlands cooperation in the construction sector.

6. Opportunities and Challenges in Sino-Dutch Collaboration

6.1 The Netherlands' Strengths in Sustainable Built Environment (Construction and Urban Planning)

As global efforts toward carbon neutrality accelerate, the Netherlands stands out as a leader in sustainable construction and urban development. This leadership is deeply rooted in decades of progressive environmental policies, innovative urban planning, and robust public-private partnerships. As a country with limited natural resources and high urban density, the Netherlands has long prioritized efficient land use, energy conservation, and climate resilience in its built environment strategies. These characteristics have fostered a strong focus on circular economy principles and propelled Dutch companies and institutions to the forefront of sustainable construction technologies and urban planning methodologies. As such, the Netherlands not only serves as a global model for sustainable development but also emerges as a natural and strategic partner for China in advancing green building initiatives. These advantages can be summarized in the following six key areas.

Figure 6.1: China construction market value from 2020 to 2024*,**

*Source: National Bureau of Statistics of China

**: Residential construction, Commercial and industrial buildings, Energy and utilities, and Municipal planning counts for around 60-65%. **Municipal planning (such as urban renewal, public facilities construction, etc.): about 5% to 10%.

6.1.1 Leadership in Circular Construction

The Netherlands has set an ambitious target to achieve a fully circular economy by 2050, with an interim goal of a 50% reduction in primary raw material consumption by 2030 (Dutch Ministry of

Infrastructure and Water Management, 2016)[103]. The construction industry plays a pivotal role in this transition: As of 2022, over 90% of construction and demolition waste was recycled in the Netherlands (Eurostat, 2023)[104]—among the highest rates in Europe. This achievement reflects a combination of scientific research, technological innovation, and the promotion of circular practices in real-world engineering applications.

A **notable example** of practical application is the **Madaster platform**, which facilitates circular construction by providing digital "material passports" that record and track the reuse potential of building components (Madaster Foundation, 2023)[105]. By allowing stakeholders to upload data on construction elements, Madaster supports transparent lifecycle management. As of 2023, the platform had registered over 15 million square meters of building floor area, helping property developers, investors, and municipalities systematically manage material reuse.

Complementing this digital approach are pioneering engineering projects that exemplify circular principles in practice. **CIRCL, ABN AMRO's** sustainable pavilion in Amsterdam, was designed for disassembly and constructed using recycled concrete, reclaimed wood, and modular components. Integrated with the Madaster system, the building demonstrates how material passports can support circular performance throughout a structure's lifecycle. Similarly, **The Green House in Utrecht** showcases reversible design through its fully demountable and prefabricated structure, intended for a 15-year lifespan yet fully relocatable, embodying flexibility and material longevity. Beyond institutional projects, design collectives like **Superuse Studios** embrace "urban mining" by sourcing components from existing urban environments. Their work illustrates the creative and localized potential of reusing materials, reinforcing the broader cultural and design shift toward circularity.

In parallel with engineering applications, the Netherlands has developed a robust research infrastructure that underpins its transition to a circular built environment. Research institutions such as **TNO (Netherlands Organization for Applied Scientific Research)** have played a pivotal role in developing advanced recycled construction materials. TNO's work includes transforming construction and demolition waste (CDW) into engineered products like geopolymer concrete and recycled aggregates, supported by performance prediction models and life-cycle assessments. As a partner in EU-funded projects such as **CINDERELA**, TNO contributes to material standardization and circular construction guidelines across Europe.

At the academic level, several leading universities have made significant contributions. At **Eindhoven University of Technology (TU/e)**, **Professor Jos Brouwers** and his research group focus on sustainable construction materials derived from industrial by-products and CDW. Their work spans the development of high-performance geopolymers, carbon-sequestering concretes, and advanced material modeling techniques that optimize mix design based on both mechanical and environmental performance. The team has also contributed to the upscaling of alternative

[103] Dutch Ministry of Infrastructure and Water Management. (2016). *A Circular Economy in the Netherlands by 2050: Government-wide Programme*.
[104] Eurostat. (2023). *Waste Statistics - Recycling of Construction and Demolition Waste*.
[105] Madaster Foundation. (2023). *Madaster Annual Report 2023*.

binders and the quantification of embodied carbon, making their research highly relevant to both academic and industry-driven circular construction agendas.

Similarly, **Delft University of Technology (TU Delft)** has established the **Circular Built Environment Hub**, which integrates architectural design, materials science, and digital construction tools. TU Delft researchers explore reversible construction systems, data-driven design optimization, and the integration of material passports into Building Information Modeling (BIM), fostering a new generation of adaptive, traceable, and low-impact building systems.

Meanwhile, several collaborative initiatives have advanced standardized evaluation methods for circularity. The **Building Circularity Indicator (BCI)** framework—developed by Metabolic, Circle Economy, and W/E consultants—offers a quantitative tool to assess the circular potential of buildings based on reusability, material recovery, and design adaptability. Similarly, the national-level program **CB'23 Circular Construction** brings together public and private stakeholders to develop a shared vocabulary, metrics, and procurement criteria for circular construction practices.

These research-driven efforts form the scientific backbone of the Netherlands' circular economy ambitions, enabling innovation in materials, design, and regulatory frameworks while fostering a data-informed, systemic approach to sustainability in the built environment.

6.1.2 Excellence in Energy-Positive and Smart Buildings

The Netherlands has established a leadership position in promoting energy-neutral and energy-positive buildings, backed by a robust regulatory framework and public-private innovation.Since 2021, the Dutch Building Decree mandates that all new buildings must meet Nearly Zero-Energy Building (NZEB) standards, in accordance with the EU Energy Performance of Buildings Directive (EPBD) (Dutch Building Decree, 2021). Over 96% of new homes built in the Netherlands in 2022 met energy label A or higher, with a large share reaching near-zero-energy performance[106](CBS, 2023). Meanwhile, the Dutch government's Programma Aardgasvrije Wijken (PAW) has funded over 50 pilot neighborhoods transitioning away from natural gas between 2018 and 2023 (PAW Evaluation Report, 2023)[107]. Some of the achieved key smart and energy-positive building projects are listed below.

- The Edge (Amsterdam): Often cited as the world's most sustainable office building. It generates more energy than it uses via rooftop photovoltaics and geothermal systems. Smart sensors monitor lighting, temperature, and occupancy in real-time, enabling personalized comfort and up to 70% energy savings[108] (Bloomberg, 2015).
- De Ceuvel (Amsterdam North): A former shipyard converted into an experimental circular workspace using refurbished houseboats. Buildings integrate passive solar design, composting toilets, and on-site greywater treatment[109](Metabolic, 2022).

[106] CBS. (2023). *Energy Label Statistics for Residential Buildings*. Statistics Netherlands.
[107] Programma Aardgasvrije Wijken. (2023). *Monitoringsrapport PAW 2023*.
[108] Bloomberg. (2015). *The World's Greenest Office Building*.
[109] Metabolic. (2022). *De Ceuvel Case Study: Circular Development in Practice*.

- Paleiskwartier Zero-Energy Apartments ('s-Hertogenbosch): A housing complex using BIPV (building-integrated photovoltaics), district heating, and smart home energy systems. Achieves net-zero energy performance across 246 apartments[110] (TU/e Built Environment, 2021).
- Bajes Kwartier Redevelopment (Amsterdam): A large-scale sustainable transformation of a former prison into a CO_2-neutral neighborhood of over 1300 homes, featuring green roofs, energy-positive homes, and smart waste systems[111](Bajes Kwartier Ontwikkeling, 2023).

In the Netherlands, key technological and innovation trends include the widespread adoption of Building Energy Management Systems (BEMS) in commercial buildings. Programs such as Stroomversnelling and Smart Energy Hubs promote the integration of rooftop photovoltaic (PV) systems, thermal energy storage, and smart meters. Since 2019, real-time monitoring and control technologies have been piloted in over 300 public buildings across Dutch municipalities (RVO Smart Buildings Report, 2022).

In addition to technical and project-level achievements, the Netherlands has also built a comprehensive regulatory and supervisory ecosystem that facilitates the delivery and verification of zero-emission buildings (ZEB). The Dutch MPG (MilieuPrestatie Gebouwen) system sets a maximum threshold for the environmental impact of all new buildings, based on full life cycle assessment in accordance with EN 15978.To enable transparent performance accounting, the Nationale Milieudatabase (NMD) provides thousands of Environmental Product Declarations (EPDs) based on EN 15804+A2 standards, covering a wide range of certified construction materials. This database allows architects, engineers, and regulators to integrate carbon impact into early-stage design and procurement.

At the EU level, the revised Energy Performance of Buildings Directive (EPBD 2024) now mandates disclosure of the Global Warming Potential (GWP) of buildings over a 50-year minimum lifespan, further reinforcing the life-cycle performance orientation already practiced in the Netherlands.

In comparison, China's green building framework—though ambitious in operational energy targets (e.g., GB 55015-2021)—currently lacks compulsory lifecycle impact accounting or an integrated EPD infrastructure. Standards remain largely prescriptive and input-based, with fragmented carbon disclosure protocols.

Integrating Dutch ZEB governance experience into China's supervision system would involve a multi-step strategy:

• Piloting MPG-equivalent lifecycle benchmarks within China's Green Building Label (GBL) system;
• Establishing a national EPD platform aligned with international standards, using NMD as a reference;

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[110] TU Eindhoven, Built Environment. (2021). *Zero Energy Housing in the Netherlands: The Paleiskwartier Project*.
[111] RVO. (2022). *Smart Energy in Public Buildings: Pilot Outcomes and Next Steps*.

• Embedding the Trias Energetica principle (demand reduction, renewables, residual efficiency) into China's green building design codes;
• Launching bilateral Sino-Dutch ZEB demonstration zones in cities like Shenzhen or Suzhou, using dual-certification mechanisms (e.g., GBL + MPG).

These steps would not only strengthen China's ability to track embodied carbon emissions across a building's life cycle, but also support mutual recognition of certified materials and design approaches—providing a scalable pathway toward deeper regulatory integration and international collaboration.

As discussed in Section 4.2.4, the Trias Energetica model provides a structured energy planning principle that could serve as a reference for joint pilot projects or regulatory dialogue on sustainable building design. Its phased approach aligns well with China's dual goals of reducing energy intensity and promoting renewable integration, and may offer a conceptual foundation for collaborative initiatives.

6.1.3 Integrated Urban Sustainability Planning

The Netherlands has earned international recognition for its integrated approach to urban sustainability planning, which combines environmental resilience, compact land use, sustainable mobility, and strong community engagement. This planning paradigm reflects both necessity—due to the country's vulnerability to sea-level rise—and innovation, resulting in urban environments that are livable, climate-adaptive, and resource-efficient.

At the policy level, cities like Amsterdam, Rotterdam, and Utrecht have adopted comprehensive strategies that embed climate adaptation, circular economy principles, and smart infrastructure into local development frameworks. For example, the **Amsterdam Circular Strategy 2020–2025** commits to reducing the use of primary raw materials by 50% by 2030. It integrates construction, consumer goods, and food systems into an urban material loop, promoting reuse and modularity across sectors (City of Amsterdam, 2020) [112].

One of the most acclaimed national programs, **Room for the River**[113], exemplifies the Dutch shift from defensive to adaptive urban planning. Instead of simply raising dikes, this program (2007–2019) restructured more than 30 urban and peri-urban landscapes to allow safe flooding, while enhancing public space, biodiversity, and real estate value. In **Rotterdam**, the "Water Squares" initiative turned urban depressions into dual-purpose plazas that serve as recreational areas in dry periods and flood basins during storms[114]. These projects illustrate how water management, urban design, and climate adaptation can be jointly addressed in spatial planning (Rijkswaterstaat, 2020; Rotterdam Resilience Strategy, 2016).

In **Utrecht**, sustainable mobility and compact city planning have been prioritized. The city has achieved a **modal split of over 40% for cycling**, supported by integrated transit hubs and bicycle highways. Utrecht's "Healthy Urban Living" framework focuses on densification without

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112 City of Amsterdam. (2020). *Amsterdam Circular Strategy 2020–2025*.
113 Rijkswaterstaat. (2020). *Room for the River: Final Evaluation Report*.
114 Rotterdam Resilience Strategy. (2016). *City of Rotterdam Resilience Program*.

compromising access to green space, promoting active transport and public health (Municipality of Utrecht, 2022)[115].

Moreover, Dutch urban sustainability efforts are underpinned by strong stakeholder governance. Programs like **Amsterdam Smart City** and **Resilio** demonstrate how municipalities, research institutes, businesses, and citizens co-create resilient urban solutions—such as blue-green roofs and digital twin planning tools—tested in real-time and scaled across districts (Amsterdam Smart City, 2023)[116].

Policy relevance for Sino-Dutch cooperation lies in the Netherlands' ability to harmonize technical innovation, spatial design, and participatory governance. These integrated planning approaches can support China's eco-city programs, sponge city pilots, and low-carbon zone development. Sino-Dutch collaboration in this domain can focus on co-developing neighborhood-scale demonstration projects or planning toolkits tailored to urban retrofitting in megacities[117].

6.1.4 Dynamic Public-Private Innovation Ecosystem

The Netherlands has built a globally respected ecosystem for sustainable building innovation by fostering close collaboration among government agencies, research institutions, private enterprises, and civil society. This ecosystem enables not only technological development, but also regulatory experimentation and market diffusion of green construction solutions.

A key institutional actor is the **Dutch Green Building Council (DGBC)**, which promotes the implementation of BREEAM-NL and other sustainable building certifications. As of 2023, more than **1,800 projects in the Netherlands** had received a BREEAM rating, with over **60% of those** achieving "Excellent" or higher scores (DGBC Annual Report, 2023)[118]. DGBC also facilitates thematic working groups that bring together municipalities, real estate developers, and engineering firms to co-develop performance benchmarks for circular construction and carbon-neutral buildings.

The Netherlands Organisation for Applied Scientific Research (**TNO**) plays a crucial role in bridging academia and industry. Its **Innovation Program for Sustainable Construction and Infrastructure** focuses on developing climate-resilient materials, modular prefabrication systems, and AI-supported building monitoring tools. TNO's Living Lab initiatives have enabled pilot implementation in over **20 cities**, accelerating commercialization of green technologies (TNO, 2023)[119].

Municipal innovation platforms such as **Amsterdam Smart City** and **Brainport Eindhoven** act as testbeds for sustainable urban technologies. These platforms host projects on energy-positive housing, intelligent building control, and digital twin modeling for city-scale resource

115 Municipality of Utrecht. (2022). *Healthy Urban Living Vision*.
116 Amsterdam Smart City. (2023). *Project Portfolio and Governance Reports*.
117 RESILIO Consortium. (2022). *Blue-Green Roofs for Urban Resilience: Final Report*.
118 Dutch Green Building Council. (2023). *DGBC Annual Report 2023*.
119 TNO. (2023). *Living Lab Results and Innovation Programs for Sustainable Construction*.

optimization. For example, the **City-zen project**—a collaboration among universities, energy companies, and local governments—piloted smart grids and building retrofits in over **100 homes and 10 public buildings** across Amsterdam and Grenoble between 2015–2020, demonstrating replicable models for climate-neutral districts (City-zen Final Report, 2021)[120].

The **Green Deal Circular Buildings**, signed by over 60 organizations, offers a voluntary framework for experimentation in circular design, procurement, and reuse protocols. It has enabled pilot projects to bypass traditional regulatory bottlenecks, encouraging innovations such as reversible construction and building disassembly tracking through material passports (Green Deal Evaluation, 2022)[121].

This dynamic ecosystem of Dutch public-private collaboration provides a valuable model for international partnerships. In a Sino-Dutch context, such an ecosystem approach could support joint innovation platforms focused on low-carbon retrofitting, digitized construction lifecycle management, and green performance monitoring—areas of growing relevance in China's dual-carbon policy framework.

In summary, the Netherlands' leadership in circular construction, energy-positive building design, integrated urban planning, and public-private innovation ecosystems offers significant opportunities for collaboration with China. Dutch strengths in sustainable technologies, systems thinking, and multi-stakeholder planning align well with China's goals for urban renewal, carbon neutrality, and low-carbon industrial development. At the same time, China contributes immense value through its large-scale implementation capacity, vast urban market, and world-leading engineering talent pool—creating fertile ground for mutually beneficial cooperation.

However, realizing the full potential of Sino-Dutch collaboration requires a clear understanding of the **strategic dynamics that shape this relationship—not only areas of synergy, but also dimensions of competition**. The following section explores these dynamics in depth, highlighting both challenges and opportunities for advancing sustainable building together.

6.1.5 Advancement and Application of Bio-Based Building Materials in the Netherlands

As part of its circular construction strategy, the Netherlands has become a frontrunner in the development and application of bio-based building materials, which are derived from renewable biological sources and offer substantial carbon reduction potential. These materials include hempcrete, flax and jute fiber insulation, timber structural systems, straw-based panels, and emerging fungal (mycelium) composites[122].

The Dutch government has actively promoted the uptake of bio-based materials through its National Circular Economy Program, which identifies the built environment as a priority sector for bio-based innovation[123]. Municipalities such as Almere and Groningen have implemented pilot

[120] City-zen Project Consortium. (2021). *City-zen Final Results and Impact Report*.
[121] Green Deal Circular Buildings. (2022). *Evaluation Report*.
[122] Bio-based materials overview – Dutch Green Building Council (DGBC), 2022.
[123] Dutch Ministry of Infrastructure and Water Management, Circular Economy Implementation Program 2019–2023.

housing projects using hemp-lime walls, bio-based thermal insulation, and laminated timber frames[124].

At the regulatory level, bio-based material content is now partially integrated into procurement criteria and environmental performance scoring, such as the MPG indicator. Tools like the Nationale Milieudatabase (NMD) include growing datasets on bio-based products, enabling life-cycle comparison with conventional materials[125]. Meanwhile, platforms like Building Balance and the Bio-Based Construction Network support supply chain development and knowledge exchange among architects, builders, and producers[126].

Dutch universities and institutes also play a central role in this field. Wageningen University leads in bio-material development, including fiberboard made from agricultural residues and bio-resins, while TU Delft and TU/e explore architectural integration and structural optimization[127].

For Sino-Dutch cooperation, bio-based materials present strong potential, particularly in China's rural revitalization, eco-tourism, and low-carbon prefab housing sectors. Joint research on standardization, durability under different climates, and hybrid material systems could support broader application. Demonstration projects in low-rise or modular public buildings (e.g., schools, pavilions) can serve as entry points to test feasibility in China’s policy and market context[128].

Potential Bio-based material market in China

While the biobased building sector in China remains in an early stage of development, there is a growing awareness of its potential. Bamboo, straw, and other agricultural by-products have been used in traditional construction, especially in rural areas. In recent years, research institutes such as Tsinghua University and the Chinese Academy of Forestry have developed modern engineered bamboo systems, straw board panels, and bio-composites that meet structural and insulation requirements. Pilot buildings using laminated bamboo structures have emerged in Zhejiang and Sichuan provinces.

Policy-wise, although there is no nationwide mandate for biobased materials, several local governments (e.g., Suzhou, Chengdu) have launched green procurement guidelines that encourage low-carbon and renewable construction materials. The “Green Building Evaluation Standard” (GB/T 50378-2019) includes credits for renewable materials but lacks quantitative targets. Meanwhile, national research programs under the “14th Five-Year Plan” prioritize material innovation, including the substitution of fossil-intensive building products.

Despite these developments, significant barriers remain: limited industrial-scale production capacity, lack of certified life-cycle data, and lower market confidence compared to concrete and steel-based systems. In contrast to the Netherlands, where the MilieuPrestatie Gebouwen (MPG)

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[124] Gemeente Almere & Building Balance, Bio-based Housing Pilots Report, 2021.
[125] Nationale Milieudatabase (NMD), Product Listings and Life Cycle Data, 2023.
[126] Building Balance Platform – Annual Update 2023.
[127] Wageningen UR, TU Delft, TU/e – Academic publications on bio-based construction materials (2020–2024).
[128] Sino-Dutch Sustainable Housing Innovation White Paper, 2023.

framework creates clear incentives, China's evaluation and pricing mechanisms for biobased materials are still fragmented.

Nevertheless, the combination of rural revitalization, carbon neutrality goals, and circular economy policies creates room for biobased construction innovation. Dutch firms and research institutes could contribute with modular design know-how, LCA data tools, and engineered fiber technologies, supporting demonstration projects in both low-rise rural housing and prefabricated urban modules.

6.1.6 Leadership in High-Performance Building Installations (MEP Systems)

The Netherlands also demonstrates significant leadership in high-performance mechanical, electrical, and plumbing (MEP) systems. These systems—including heating, ventilation, air conditioning (HVAC), lighting, and energy control technologies—are responsible for approximately 30–40% of a building's operational energy use and environmental impact. Despite this, MEP systems are often underrepresented in international discussions on green building cooperation.

Dutch innovation in this domain includes modular prefabricated HVAC units, low-temperature district heating solutions, smart ventilation systems, and advanced building energy management systems (BEMS). These technologies are widely deployed in public and commercial buildings across the Netherlands and are increasingly integrated into digital twins and real-time monitoring frameworks.

Importantly, unlike structural materials, MEP components are typically compact, standardized, and high-value, making them more suitable for international export. Dutch firms such as Priva, Remeha, and Kropman have established strong reputations in delivering smart, low-carbon, and IoT-enabled building service solutions.

In the context of Sino-Dutch collaboration, these systems offer dual benefits: they help reduce building-related emissions and represent a scalable business opportunity. As Chinese cities intensify efforts to upgrade building performance and supervision through digital platforms, Dutch MEP systems can be embedded in pilot projects—particularly in modular schools, elderly care centers, and commercial retrofits.

Joint demonstration projects could showcase integrated design approaches, lifecycle tracking, and energy optimization enabled by Dutch MEP technologies, positioning this domain as a new frontier for export-oriented cooperation.

6.2 Competitive and Complementary Dynamics Between China and the Netherlands

While China and the Netherlands share a commitment to advancing sustainable building practices, the dynamics of their collaboration are shaped by both competitive pressures and areas of strategic complementarity. A nuanced understanding of these forces is crucial for identifying viable pathways to deepen cooperation.

6.2.1 Areas of Competition

1. Technological Leadership in Smart Buildings

Dutch companies such as Royal HaskoningDHV and Arcadis have been recognized leaders in smart building design, integrated energy management systems, and smart city planning. However, emerging Chinese technology firms—including Huawei's Smart City division, Alibaba Cloud, and Glodon—are rapidly expanding their presence domestically and internationally (Smart Cities Dive, 2022)[129]. By 2023, China accounted for over 30% of the global smart building market revenue (IDC, 2023)[130], posing direct competition for Dutch firms in markets such as Asia, Africa, and Latin America.

2. Divergent Green Standards and Certification Systems

European standards (e.g., BREEAM, WELL) and Chinese systems (e.g., GB/T 50378, Green Building Label (GBL)) differ significantly in technical benchmarks, evaluation methods, and certification processes (World Green Building Council, 2022)[131]. These differences often complicate project certification in joint developments, potentially creating friction over which standard to adopt.

3. Urban Planning and Design Consultancy Services

Dutch firms are globally renowned for sustainable urban planning, with expertise in water management, green mobility, and integrated land use. However, major Chinese design institutes like China Architecture Design & Research Group (CADG) and Tongji Urban Planning and Design Institute have become strong competitors, especially in Belt and Road Initiative (BRI) markets.

6.2.2 Areas of Complementarity

Despite competition, significant complementarities provide strong foundations for cooperation:

1. Innovation Meets Scale

Dutch firms excel in technological innovation, system integration, and sustainable materials.
Chinese firms possess unparalleled capabilities for large-scale project implementation, supply chain management, and policy coordination.
Strategic Opportunity: By combining Dutch cutting-edge innovation with China's massive delivery capacity, both parties can create scalable, high-quality green building solutions.

2. Circular Economy Expertise vs. Urban Regeneration Demand

The Netherlands is a global leader in circular economy practices, while China is prioritizing urban renewal under its 14th Five-Year Plan (2021–2025): Over 39 million residential units are planned for renovation (China's 14th Five-Year Plan, 2021)[132]. Dutch expertise in material reuse, modular construction, and lifecycle design can directly support China's goals.

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[129] Smart Cities Dive. (2022). *China's Growing Smart City Market*.
[130] IDC. (2023). *Worldwide Smart Building Market Forecast, 2023–2027*.
[131] World Green Building Council. (2022). *Global Status Report for Buildings and Construction*.
[132] China's 14th Five-Year Plan. (2021). *Outline for Economic and Social Development*.

3. Joint Expansion into Third-Country Markets

Sino-Dutch partnerships increasingly target green infrastructure opportunities in emerging markets:

Dutch contributions: urban sustainability planning, green building technologies.

Chinese contributions: construction capacity, financing, and local partnerships.

As an example, in Vietnam, Dutch planning expertise (Deltares) and Chinese financing have been jointly applied in developing resilient cities (UN-Habitat, 2022)[133].

4. Standard Harmonization Potential

Both countries are active in global forums such as the Global Alliance for Buildings and Construction (GlobalABC), providing a platform for soft convergence of standards and practices.

6.2.3 Strategic Implications

To maximize benefits while managing competition, Sino-Dutch cooperation should emphasize on following aspects:

- **Joint Pilot Projects:** Co-develop visible flagship projects integrating Dutch technology and Chinese execution.
- **Bilateral Research Programs:** Invest in joint R&D targeting carbon-neutral materials, AI-driven smart energy management, and circular construction models.
- **Certification Coordination Initiatives:** Promote dual-certification pilots (e.g., BREEAM + GBL) to facilitate smoother project approvals.
- **Strategic Third-Country Consortia:** Form joint teams to pursue major sustainable infrastructure tenders in Asia, Africa, and Latin America.

Case Box: Shenzhen Sino-Dutch Low Carbon City (LCC)

As an example, the Shenzhen Sino-Dutch Low Carbon City (LCC), launched in 2012 in Longgang District, was conceived as a flagship demonstration of bilateral collaboration in sustainable urban development. The project aimed to integrate Dutch expertise in climate-adaptive planning and low-carbon design into China's fast-growing urban context, while providing a model for future joint ventures.

The LCC project introduced advanced Dutch planning concepts, including natural ventilation, passive daylighting, compact mixed-use zoning, and pedestrian-oriented public space. It led to the development of green park networks, energy-efficient housing zones, and multi-modal transportation corridors. In doing so, it showcased the potential of combining Dutch urban innovation with China's implementation capacity.

However, the collaboration also revealed systemic coordination challenges. Misalignments emerged over project timelines, investment strategies, and sustainability performance

[133] UN-Habitat. (2022). *Sustainable Urban Development in Southeast Asia*.

benchmarks. While Dutch partners emphasized integrated planning and lifecycle carbon performance, Chinese stakeholders were often driven by land development pressures and rapid delivery schedules. The absence of a clearly defined governance framework, unified certification pathway, and shared accountability mechanism undermined long-term integration of project goals[134].

These challenges underscore a critical insight: **technical complementarity alone is insufficient for successful collaboration.** Future Sino-Dutch initiatives must incorporate joint decision-making bodies, cross-compatible technical standards, and transparent stakeholder management protocols from the outset. Pilot projects should also adopt dual sustainability metrics (e.g., both BREEAM and GBL) to harmonize expectations and avoid conflicting evaluation criteria.

The Shenzhen LCC demonstrates both the opportunities and pitfalls of cross-national cooperation. Its legacy is not only built infrastructure, but also valuable lessons on governance design, timeline coordination, and the strategic need for early alignment—insights essential for scaling future partnerships.

6.3 Collaboration Channels and Stakeholder Analysis

Achieving the full potential of Sino-Dutch cooperation in sustainable building requires structured collaboration models, proactive regulatory alignment, and strategic engagement with key stakeholders. This section outlines viable cooperation mechanisms, regulatory considerations, stakeholder mapping, and targeted recommendations.

Table 6.1: The potential cooperation models

Cooperation Model	Description	Example	Key Advantages	Cooperation Model	Description
Joint Innovation Centers	Co-funded research hubs focused on green building technologies, circular construction, and smart urban systems.	Proposed Sino-Dutch Green Building Innovation Hub in Suzhou	Facilitates technology co-development and accelerates knowledge transfer.	**Joint Innovation Centers**	Co-funded research hubs focused on green building technologies, circular construction, and smart urban systems.
Demonstration Projects	Bilateral flagship zones (e.g., smart parks, zero-carbon campuses) showcasing	Shenzhen Sino-Dutch Low Carbon City	Visibility, policy experimentation, public-private collaboration.	**Demonstration Projects**	Bilateral flagship zones (e.g., smart parks, zero-carbon campuses) showcasing

[134] De Jong M, Yu C, Chen X, et al. Developing robust organizational frameworks for Sino-foreign eco-cities: comparing Sino-Dutch Shenzhen Low Carbon City with other initiatives[J]. Journal of Cleaner Production, 2013, 57: 209-220.

	integrated capabilities.				integrated capabilities.
Technology Licensing and Localization	Dutch firms license technologies (e.g., smart energy systems) to Chinese partners for adaptation and mass deployment.	Philips Smart Lighting joint projects	Rapid market expansion and local integration.	**Technology Licensing and Localization**	Dutch firms license technologies (e.g., smart energy systems) to Chinese partners for adaptation and mass deployment.
Joint Ventures and Strategic Alliances	Cross-border JVs specializing in sustainable construction, consultancy, or digital platforms.	Arcadis-China JV for resilient urban infrastructure consulting	Shared investment risk and expanded market reach.	**Joint Ventures and Strategic Alliances**	Cross-border JVs specializing in sustainable construction, consultancy, or digital platforms.
Third-Country Collaborative Expansion	Joint development of green infrastructure in emerging markets.	Sino-Dutch collaboration on water management in Vietnam	Combined strengths in design, finance, and execution.	**Third-Country Collaborative Expansion**	Joint development of green infrastructure in emerging markets.

6.3.1 Social Housing as a Scalable Pilot Segment

China's social housing sector—including **public rental housing**, **talent housing**, and **policy-based rental housing**—has grown rapidly in recent years as part of the national strategy to ensure equitable urban development. According to MOHURD, **over 59 million residents lived in social housing units by 2022**, and **the 14th Five-Year Plan (2021–2025)** calls for the construction of **6.5 million new affordable rental units** in 40 major cities.

This policy push is driven by demographic and affordability pressures in megacities, alongside a broader shift toward quality urbanization. Key policy instruments include:

- **MOHURD's 2022 policy guidelines** requiring local governments to incorporate green building evaluation requirements in all new social housing projects;
- **Central-local co-financing schemes** and land supply guarantees for public housing providers;
- A growing preference for **prefabricated construction** and **digital supervision platforms** in pilot cities like Shenzhen, Hangzhou, and Chengdu.

A widely cited example is the **Beijing Winter Olympic Village**, originally built as a near-zero energy complex and converted post-Games into 2,000+ green-certified talent apartments, featuring triple-glazed façades, solar-thermal water heating, and BIM-enabled facility management. This demonstrates the feasibility of aligning **high-performance design** with **social policy objectives**.

For Sino-Dutch cooperation, the social housing segment provides a **scalable, policy-protected, and technically relevant entry point**, especially for:

- Modular retrofitting solutions using circular and bio-based materials;
- Integration of Dutch EPD and lifecycle calculation frameworks into low-income housing design;
- Urban regeneration of aging dormitory blocks and factory housing using data-driven planning tools.

6.4 Institutional Pathways for Sino-Dutch Certification and Regulatory Alignment

A critical pathway to strengthening Sino-Dutch cooperation lies in bridging the gap between the two countries' certification and regulatory systems. While China and the Netherlands both promote sustainable construction, their systems differ significantly in structure, scope, and implementation logic.

It is important to note that while BREEAM and LEED are industry-led voluntary certification schemes, the EPBD and CPR are legal instruments binding across EU member states. Therefore, future China–EU standard alignment should focus primarily on regulatory convergence at the policy level—e.g., through mutual recognition of lifecycle performance benchmarks (EN 15978), EPD requirements (EN 15804+A2), and procurement rules—rather than relying on market-based schemes such as BREEAM or LEED.

In the Netherlands, the regulatory environment emphasizes performance-based metrics, such as the MPG (MilieuPrestatie Gebouwen) and energy performance requirements under BENG, supported by product-level lifecycle data via the Nationale Milieudatabase (NMD). In contrast, China's green building certification (e.g., GBL, GB 55015-2021) remains more prescriptive, often using checklists and static design criteria, with limited life-cycle carbon accounting.

These structural differences create certification conflicts, slow product acceptance, and complicate bilateral demonstration projects. To address this, three strategic mechanisms are proposed:

• Establish a Bilateral Certification Alignment Taskforce – Led by agencies such as DGBC, CABR, MOHURD, and RVO, this taskforce can co-develop bridging tools between BREEAM-NL and GBL, promote EPD format compatibility (EN 15804 vs Chinese equivalents), and formulate aligned performance benchmarks.

• Pilot Dual-Certified Demonstration Projects – Use demonstration zones in Suzhou, Shenzhen, or Xiong'an to test dual certification systems (e.g., BREEAM + GBL), build supervisory workflows across systems, and jointly validate regulatory procedures through real projects.

• Encourage Standard Convergence via Global Forums – Both countries are active participants in ISO, CEN, and GlobalABC initiatives. Joint participation in technical committees and UNEP programs can gradually harmonize definitions, environmental metrics, and reporting structures.

Over time, these institutional mechanisms can lower entry barriers for Dutch-certified products, support Chinese green building evolution toward lifecycle accountability, and improve bilateral transparency and trust in supervision processes.

6.4.1 Regulatory and Practical Considerations

1. Standard Harmonization

Efforts are needed to align Chinese green building certifications (GBL, GB/T 50378) with European standards like BREEAM and LEED to minimize certification barriers.

Policy Tip:

Early adoption of dual-certification models in demonstration projects could create best practice references for broader bilateral cooperation.

2. Investment and Ownership Policies

Clarifying foreign investment rules in the construction and smart infrastructure sectors—especially within China's Free Trade Zones (FTZs)—will facilitate joint ventures (MOFCOM, 2023)[135].

3. Intellectual Property Protection

Transparent IP-sharing frameworks and secure data management agreements are critical to building long-term trust, especially in technology-intensive collaborations (e.g., smart building systems, AI-based energy platforms).

4. Product Certification and Mutual Recognition Challenges between the Netherlands(EU) and China

A key practical barrier to expanding the use of Dutch-certified building products in China lies in the lack of mutual recognition between the two countries' certification systems. While the Netherlands and the EU broadly rely on the CE marking, EPDs aligned with EN 15804, and voluntary but widely adopted schemes like BREEAM-NL, the Chinese system is governed by mandatory product standards (GB, GB/T), standard design catalogues, and a growing but fragmented Green Building Product Certification (GBPC) regime led by local authorities and testing labs.

[135] MOFCOM. (2023). *Guidelines for Foreign Investment in Free Trade Zones*.

This mismatch presents multiple challenges for Dutch manufacturers:

- Incompatible testing protocols: EU-verified material performance data (e.g. thermal conductivity, fire resistance, VOC emissions) may not map directly onto Chinese GB-standard requirements, often necessitating retesting in China.
- Limited recognition of European EPDs: Chinese project reviewers and government clients often do not accept foreign EPD formats unless translated, localized, and re-validated by designated Chinese institutes.
- Fragmented local approval channels: In some provinces, even nationally certified green products must undergo local accreditation processes to qualify for public procurement or GBL points.
- Design catalog inertia: Most state-owned or public-funded projects in China rely heavily on fixed construction design catalogues. If a Dutch product is not pre-listed or lacks a Chinese equivalent standard reference, it is difficult to specify or approve for use—even if technically superior.

These systemic gaps limit Dutch product entry, especially for high-performance insulation, recycled materials, low-carbon cements, smart façade systems, and prefabricated modules. To address these issues, several pathways are recommended:

- Dual-certification pilots: Projects jointly certified under GBL + BREEAM-NL or GBL + CE/EPD can serve as policy laboratories to demonstrate compatibility and build confidence among regulators.
- EPD translation & bridging protocols: Establish a standardized crosswalk between EN 15804 EPDs and Chinese GBPC frameworks, possibly under the guidance of a bilateral certification taskforce (e.g. DGBC + CABR).
- Mutual reference catalogues: Create a “Sino-Dutch Green Product Library” that maps Dutch-certified products to equivalent Chinese categories, streamlining their approval in standard design catalogs.
- Institutional access alliances: Dutch suppliers should partner with Chinese EPC contractors, SOEs, or local green building research centers to navigate product evaluation and procurement pipelines.

These strategies would reduce transaction costs for Dutch product entry, enhance market trust in imported green solutions, and support broader standard harmonization goals.

6.4.2 Key Stakeholders and Governance Modes

Effective Sino-Dutch collaboration in the sustainable built environment sector depends on the active engagement of diverse public and private actors, supported by coherent governance mechanisms. Given the multi-scalar nature of sustainable construction—spanning building materials, urban planning, and infrastructure deployment—partnerships must coordinate across ministries, municipalities, enterprises, and research institutions.

1. Chinese Stakeholders

Category	Examples	Roles
Government Ministries	Ministry of Housing and Urban-Rural Development (MOHURD), National Development and Reform Commission (NDRC), Ministry of Commerce (MOFCOM)	Policy direction, pilot zone designation, and regulation of standards
Local Governments	Shenzhen, Suzhou, Shanghai, Chengdu	Pilot implementation, project land provision, regulatory coordination
State-Owned Enterprises (SOEs)	China State Construction Engineering Corporation (CSCEC), China Communications Construction Company (CCCC), Broad Group	Infrastructure delivery, large-scale project execution, PPP consortia leadership
Research & Technical Institutions	China Academy of Building Research (CABR), Tsinghua University, Tongji University	Technical validation, material research, standard development

2. The Role of Chinese State-Owned Enterprises (SOEs)

Among the key Chinese stakeholders, state-owned enterprises (SOEs) such as the China State Construction Engineering Corporation (CSCEC) and the China Communications Construction Company (CCCC) play an outsized role in shaping the sustainable built environment. SOEs are not only responsible for delivering large-scale urban infrastructure projects, but also serve as institutional agents aligned with national and provincial development goals.

Key strengths of SOEs include:

- Strong alignment with urban sustainability policy priorities;
- Capacity to absorb higher project risks and commit to long-term investment horizons;
- Political authority that can mobilize cross-sector coordination in complex urban projects.

However, international partners should recognize several operational challenges:

- Multi-tiered decision-making processes often introduce delays in project implementation;
- Political objectives may occasionally override commercial efficiency;
- Coordination across different levels of government (central, provincial, municipal) requires nuanced stakeholder navigation.

Implications for Dutch partners:

- Projects should clearly communicate both environmental and societal value—such as carbon mitigation, inclusivity, or knowledge transfer—to align with SOEs' public mandates;
- Targeting high-profile or first-of-its-kind demonstration projects can improve project visibility and increase the likelihood of government support;
- Building long-term relationships through phased collaboration (e.g., starting with consulting, then moving to co-development) can reduce institutional friction.

3. Dutch Stakeholders

Category	Examples	Roles
National Agencies	Netherlands Enterprise Agency (RVO), Netherlands Foreign Investment Agency (NFIA)	International promotion, project matchmaking, SME support
Industry Platforms	Dutch Green Building Council (DGBC), Holland Circular Hotspot, Amsterdam Smart City	Certification promotion (e.g., BREEAM-NL), circular economy capacity building
Enterprises	Arcadis, Royal HaskoningDHV, DSM, Philips	Project design, technical consulting, green technology solutions
Academic Institutions	Delft University of Technology, Eindhoven University of Technology, Wageningen University	Joint research, capacity-building, training exchange

These actors play complementary roles in the project lifecycle: Dutch universities and platforms provide early-stage planning and innovation, while firms specialize in green materials, engineering, and certification alignment.

4. Governance Modes and Partnership Mechanisms

Successful governance of Sino-Dutch collaboration hinges on clear institutional arrangements that:

- Define roles and responsibilities early in project planning;
- Balance state-led coordination (particularly in China) with private-sector innovation dynamics (as emphasized in the Netherlands);
- Enable bilateral steering committees or consortia with joint decision-making authority.

For example, projects like the Shenzhen Sino-Dutch Low Carbon City lacked formalized joint governance protocols, which contributed to misalignments in sustainability benchmarks and investment priorities. This experience highlights the importance of structured, multi-level stakeholder coordination from the outset.

To streamline future partnerships, both countries should explore mechanisms such as:

- **Bilateral Project Platforms** supported by RVO and MOHURD;
- **Joint Green Certification Councils** to promote mutual recognition (e.g., GBL & BREEAM);
- **City-to-City Partnerships** with co-funded technical secretariats facilitating cross-cultural planning dialogue.

6.4.3 Strategic Recommendations for Dutch Stakeholders

Building on the preceding analysis of collaboration models, institutional frameworks, and stakeholder ecosystems, this section outlines strategic recommendations to strengthen Sino-Dutch cooperation in the sustainable built environment. These proposals are structured by target audience—Dutch government agencies, businesses, and research institutions—and emphasize actionable steps to deepen bilateral engagement.

Figure 6.2: Highlighting opportunities for Dutch practitioners to expand their business in China

1. For the Dutch Government and Policy Institutions

- **Support pilot participation in China's green transformation agenda**
  Encourage Dutch participation in China's national initiatives such as low-carbon city pilots, sponge city programs, and green industrial parks through intergovernmental channels and bilateral MoUs.
- **Establish a bilateral green building certification taskforce**
  Set up a joint platform with MOHURD and Chinese standards bodies to align certification systems (e.g., BREEAM-NL with China's GBL), facilitating dual-recognition and easing market entry barriers.
- **Leverage financial instruments to de-risk SME engagement**
  Expand the availability of export credit guarantees, innovation subsidies, and green project co-financing tools to enable Dutch SMEs to participate in high-impact demonstration projects in China and third countries.

2. For Dutch Enterprises and Industry Platforms

- Focus on value-added niches with global transferability
  Prioritize segments such as circular building materials, smart energy systems, modular retrofitting, and urban resilience analytics, where Dutch expertise is globally recognized and scalable.
- **Form strategic alliances with Chinese SOEs and local platforms**
  Seek partnerships that leverage Dutch design and technological expertise with Chinese implementation and policy access—for instance, through jointly funded pilot zones or EPC+design-build ventures.
- **Develop long-term presence models**

Move beyond transactional project bidding toward embedded operational models, such as local joint ventures, representative offices, or R&D units co-located with Chinese academic or industrial partners.

3. For Dutch Universities and Research Institutions

- **Establish joint innovation and training centers**
  Co-develop research programs and training hubs with Chinese universities (e.g., Tsinghua, Tongji, CABR) focusing on carbon-neutral urban design, green materials, and data-driven construction management.
- **Contribute to international standard harmonization**
  Actively participate in ISO/IEC technical committees, UNEP-led sustainable building dialogues, and China's outbound standards collaboration under the Belt and Road Green Development framework.
- **Initiate bilateral PhD and professional exchange schemes**
  Build talent pipelines through joint supervision programs, short-term research residencies, and practitioner exchanges, particularly in architecture, civil engineering, urban planning, and environmental economics.

4. Cross-Cutting Strategic Priorities

- **Embed collaboration in third-country development models**
  Promote Sino-Dutch triangular cooperation in Southeast Asia, Africa, and Latin America by combining Dutch planning and sustainability expertise with Chinese financing and project delivery strength.
- **Use flagship demonstration zones as "policy laboratories"**
  Pilot dual certification standards, adaptive governance structures, and performance-based contracting mechanisms in jointly developed urban districts to test scalable models for sustainable cities.
- **Institutionalize a bilateral multi-stakeholder dialogue mechanism**
  Establish an annual Sino-Dutch Sustainable Built Environment Forum to track progress, align expectations, and shape a shared roadmap for 2030 and beyond.

Figure 6.3: Practical Measures and Implementation Pathways for Dutch stakeholders

✅ To Do	❌ Not To Do
Expand the number and diversity of Sino–Dutch R&D projects to complement high-value, low-volume funding models and drive innovation-led business collaboration	Avoid attempt to contract construction labor business in China
Encourage Dutch enterprises to proactively engage with Chinese government bodies and SOEs to enhance project visibility and trust	Underestimate the importance of narrative alignment and soft diplomacy in joint projects.
Promote subnational government collaboration to leverage Chinese local authorities' leadership in public building investments	Avoid imposing EU sustainability standards without adapting to Chinese regulatory context
Facilitate Chinese investment in Dutch sustainable building and smart infrastructure projects to build mutual economic interests	Don't treat Chinese SOEs as purely market-driven entities; recognize their strategic policy alignment role
Launch joint innovation and certification pilots on green building, BIM, and carbon accounting for technical alignment	Don't overlook IP and data protection frameworks, which are essential for secure technology collaboration
Pursue joint projects in third markets (e.g., ASEAN, Africa) to combine branding and delivery strengths	

Conclusion

Strategic, multi-level coordination is essential for turning complementary capabilities into tangible, long-term collaboration. By institutionalizing bilateral cooperation, aligning standards, and jointly investing in scalable solutions, the Netherlands and China can position themselves as global leaders in the sustainable transformation of the built environment.

7. Conclusions & Recommendations

This chapter will summarize the main findings of the study and provide strategic recommendations for policymakers and industry stakeholders (such as companies, scholars, and investors). At the same time, it will look forward to the future cooperation between the Netherlands and China in the sustainable built environment, the expected results, and the challenges that may be faced in order to plan ahead, deepen the cooperative relationship between the two countries through cooperation in construction, achieve win-win results, and promote the development of the global sustainable industry. Although the relevant suggestions have been reflected in various chapters, they will be concentrated here and practical action suggestions will be put forward.

7.1 Summary of Key Findings

This report has examined China's sustainable built environment through the lenses of policy systems, industrial practices, technological pathways, market trends, and international cooperation models. Key findings include:

- **Policy-Driven Momentum**: China’s regulatory framework—anchored by central ministries and supported by technical standards like GB 55015-2021—has created strong top-down momentum for green building implementation across urban regions.
- **Diverse Sustainable Practices**: From green materials to intelligent energy systems and water resource management, China’s sustainable construction sector demonstrates significant technological integration and lifecycle thinking, with local adaptation as a key feature.
- **Emerging Market Opportunities**: The green building market in China is expanding rapidly, especially in public infrastructure, urban redevelopment, and prefabricated housing, offering targeted entry points for foreign enterprises with niche expertise.
- **Collaborative Ecosystem Evolving**: International cooperation in this sector has evolved from governmental exchanges to multi-actor engagement involving enterprises, research institutes, and local pilot zones—creating opportunities for deeper Dutch involvement.

7.2 Strategic Recommendations

The following practical recommendations are proposed to guide Dutch policymakers, enterprises, and research institutions in engaging with China’s green building transformation:

(1) For Government and Policymakers

- **Establish a Permanent Dialogue Mechanism**: Build on existing platforms (e.g., Merian Fund, Horizon Europe channels, Sino-Dutch sustainability dialogues) to institutionalize a long-term dialogue mechanism specifically focused on sustainable building. As part of the broader EU–China sustainability agenda under the European Green Deal, the Netherlands can serve as a key entry point and frontrunner for EU engagement with China in the built environment sector.

- **Support Market Entry through Embassies and Trade Offices**: Leverage diplomatic missions and innovation attachés in Beijing, Shanghai, and Guangzhou to provide on-the-ground support for Dutch companies navigating technical standards, pilot projects, and government tenders. Such efforts could be coordinated with EU delegations in China to enhance collective European visibility and resource sharing.
- **Enable Dual Recognition of Green Standards**: Facilitate bilateral discussions on mutual recognition or compatibility of green building certifications (e.g., BREEAM, WELL with Chinese Green Building Label), to lower technical entry barriers. These actions could also align with ongoing EU initiatives such as Level(s) and the Construction Products Regulation (CPR), positioning the Netherlands as a testing ground for harmonized EU–China practices in sustainable construction.

(2) For Dutch Enterprises

- **Target Strategic Niches**: Focus on high-value segments where Dutch technologies have proven advantages, such as climate-adaptive facades, energy-positive buildings, green roof systems, water circularity solutions, and digital twin-enabled asset management.
- **Partner with Leading Chinese SOEs**: Engage early with key state-owned construction groups (e.g., CSCEC, CRCC, CECEP) that dominate large-scale green infrastructure and housing projects. Long-term trust-building and joint demonstration projects are key.
- **Utilize Demonstration Zones**: Prioritize involvement in national or regional demonstration zones (e.g., Xiong'an New Area, Suzhou Industrial Park, Yangtze River Delta GBA projects), where innovation is encouraged, and regulatory flexibility exists.
- **Promote Third-Market Collaboration**: Work with Chinese partners on international infrastructure projects—especially in Africa, Southeast Asia, and Latin America—where Chinese-led initiatives offer opportunities for Dutch green technologies to scale globally.

(3) For Research Institutions and Academic Cooperation

- **Launch Joint Green Building Labs**: Encourage the creation of joint research centers or living labs (e.g., in collaboration with Tsinghua, Tongji, or Southeast University) focused on circular materials, zero-carbon buildings, or nature-based urbanism.
- **Align with Funding Mechanisms**: Utilize instruments such as the Merian Fund, NSFC–NWO bilateral calls, and EU-China co-funding programs to support collaborative research with practical industrial applications. It is recommended to establish a **larger number of smaller-scale bilateral funding schemes** specifically aimed at early-stage, application-oriented projects in the sustainable built environment. These would serve as agile incubators for innovation and lower the entry threshold for new Sino-Dutch partnerships.
- **Incorporate Student and Talent Exchange**: Foster bilateral researcher mobility, PhD exchange programs, and sustainability-focused internships embedded in demonstration projects to strengthen long-term ties and innovation continuity.

7.3 Common Pitfalls to Avoid

In pursuing collaboration within China's sustainable built environment sector, Dutch stakeholders should be mindful of several pitfalls that may undermine cooperation effectiveness or increase operational risk. These include:

- **Avoid attempting to engage directly in construction labor contracting in China**: The labor subcontracting ecosystem in China is highly regulated, localized, and politically sensitive. Foreign firms are strongly advised to focus on technical consultancy, systems integration, or joint development rather than core construction labor management.
- **Do not underestimate the importance of narrative alignment and soft diplomacy**: Successful partnerships often depend not just on technology, but also on the ability to align project narratives with China's national development priorities, such as common prosperity, ecological civilization, and carbon neutrality.
- **Avoid imposing EU sustainability standards without contextual adaptation**: While EU frameworks offer valuable benchmarks, applying them rigidly in the Chinese context—without aligning with local regulations, market conditions, and cost structures—can result in inefficiencies or regulatory resistance.
- **Do not treat Chinese SOEs as purely market-driven entities**: State-owned enterprises in China operate under dual mandates that combine commercial performance with political responsibilities. Recognizing their strategic role within national policy execution is essential for constructive long-term engagement.
- **Do not overlook IP and data governance frameworks**: For technology-based collaborations involving digital systems, smart sensors, or AI platforms, clear intellectual property agreements and compliance with Chinese cybersecurity and data protection regulations are crucial to safeguarding innovation and ensuring legal certainty.

7.4 Future Prospects and Cooperation Outlook

Sino-Dutch cooperation in the sustainable built environment is well-positioned to generate both **mutual benefit and global impact**. As China continues to implement national strategies for green transition and urban resilience, Dutch expertise in system integration, adaptive urban design, and sustainable materials can provide high-value input.

At the same time, cooperation in this domain can serve as a **replicable model for broader bilateral collaboration**, extending to agriculture (e.g., circular greenhouses), smart manufacturing, AI-driven energy management, and life sciences infrastructure. The shared experiences and trust built in the green building sector will provide institutional foundations for future cross-sectoral innovation.

7.5 Challenges and Recommendations for Mitigation

However, several foreseeable challenges must be acknowledged and addressed:

- **Institutional and Regulatory Complexity**: China's construction sector is fragmented across ministries and regions. Dutch stakeholders should work through local partnerships and maintain flexibility in engagement models. As discussed in Chapter 6.4, institutional alignment on green building certification systems and regulatory frameworks will be essential to address these challenges and enable deeper bilateral collaboration.

- **Cultural and Political Differences in Project Execution**: Cooperation with Chinese SOEs requires understanding their dual political-economic mandate. Projects with social value (e.g., affordable housing, resilient infrastructure) are more likely to gain traction.
- **Standards Gap and Certification Conflicts**: Discrepancies between EU green standards and Chinese regulations may require project-specific technical translation or co-development of adapted standards.

To overcome these, a **dual strategy** is recommended: aligning closely with EU green priorities while actively adapting to the needs and regulatory logic of the Chinese and emerging markets.

In short, Sino-Dutch cooperation in the sustainable built environment not only unlocks shared gains in construction and environmental performance, but also has the potential to become a template for future industrial collaboration. Through joint innovation, open dialogue, and strategic alignment, both countries can make lasting contributions to the global sustainability transition.

Appendix: Green Building Policies and Developments in Hong Kong SAR

A.1: Overview

Hong Kong is a representative region of the "one country, two systems" principle and has different legal, administrative and economic systems from mainland China. These regions have developed unique approaches to sustainable urban development and green building policies, often incorporating international best practices and local innovations. Their experiences can serve as valuable references and potential gateways for Dutch enterprises seeking to engage in China's broader green building market. By examining these regions in the appendix, the report highlights differentiated policy environments and showcases model cases that may inspire practices in mainland China and elsewhere.

A.2: Sustainable Building Development in Hong Kong SAR

A.2.1 Historical Development and Milestones

Hong Kong's journey toward sustainable building began in the 1990s with pioneering regulations and voluntary initiatives. In 1995, the government introduced the **Building (Energy Efficiency) Regulation** (Cap. 123M) to curb heat gain through building envelopes, mandating a maximum Overall Thermal Transfer Value (OTTV) for commercial buildings and hotels[136]. This early focus on building envelopes aimed to reduce air-conditioning loads in the city's subtropical climate. One year later, in 1996, Hong Kong launched its first green building rating system, known as **HK-BEAM**, modeled after the UK's BREEAM standard[137]. This voluntary assessment scheme marked the city's initial step in benchmarking building sustainability.

Throughout the 2000s, industry and government stakeholders built momentum for greener buildings. The **Professional Green Building Council (PGBC)** was founded in 2002 as a coalition of professional institutes to promote sustainable design[138]. In parallel, the Electrical and Mechanical Services Department (EMSD) introduced a voluntary **Energy Efficiency Registration Scheme for Buildings** in 1998 to encourage compliance with energy codes[139]. By 2005, the government had issued guidelines for public works to adopt energy-efficient features and renewables in all new projects, leading by example in its own building stock. These efforts set the stage for more comprehensive action.

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[136] Baker McKenzie. *Regulation – Hong Kong*. In *Global Sustainable Buildings Guide*. Retrieved, from https://resourcehub.bakermckenzie.com/en/resources/global-sustainable-buildings/asia-pacific/hong-kong/topics/regulation
[137] Baker McKenzie. *Green Certification – Hong Kong*. In *Global Sustainable Buildings Guide*. Retrieved from https://resourcehub.bakermckenzie.com/en/resources/global-sustainable-buildings/asia-pacific/hong-kong/topics/green-certification
[138] Professional Green Building Council. *PGBC timeline*. Professional Green Building Council. Retrieved from https://www.hkpgbc.org/timeline
[139] The Hong Kong Special Administrative Region Government. (2024). *Green Buildings*. GovHK – Sustainable Development & Greening in Buildings. Retrieved from https://www.gov.hk/en/residents/environment/sustainable/greening/buildings.htm

A major milestone came in 2009 with the establishment of the **Hong Kong Green Building Council (HKGBC)**, a broad industry-government partnership to "lead the market transformation to a sustainable built environment"[140]. HKGBC's formation coincided with the revamp of HK-BEAM into **BEAM Plus** in 2010, providing an updated and comprehensive green building certification system[141]. The BEAM Plus system, jointly run by HKGBC and the BEAM Society, assesses new and existing buildings on multiple sustainability criteria and awards ratings from Bronze up to Platinum. As of 2022, over 1,000 projects had been assessed under BEAM/BEAM Plus, and by late 2023 more than 8,100 buildings were either certified or in the certification pipeline – a significant uptake reflecting growing demand for green building recognition[142].

Regulatory progress accelerated in the 2010s. The government enacted the **Buildings Energy Efficiency Ordinance (BEEO)** in 2010, which took full effect in 2012, making key energy codes mandatory[143]. BEEO introduced minimum energy efficiency standards for building services (covering lighting, air-conditioning, electrical, and lift & escalator installations) and required periodic energy audits for large commercial buildings. At the same time, authorities tightened the envelope standards: the OTTV limits for commercial buildings were strengthened in 2000 and 2011, and new guidelines in 2014 extended similar **Residential Thermal Transfer Value (RTTV)** controls to apartment buildings. A flagship project symbolized this era – the **Zero Carbon Park** in Kowloon Bay, completed in 2012 as Hong Kong's first zero-emission building. Developed by the Construction Industry Council, it demonstrated innovative passive cooling and on-site renewable energy, raising public awareness of low-carbon design. Some Zero Carbon Buildings in Hong Kong have also begun to incorporate **life cycle assessment (LCA)** methods to account for **embodied carbon emissions** from materials and construction processes. These assessments guide the use of lower-impact materials and modular construction strategies. In addition, many ZCBs are **grid-connected**, allowing **surplus renewable electricity** generated on-site (e.g., via solar PV systems) to be exported to the public grid. This not only offsets operational carbon but also enhances the resilience and flexibility of Hong Kong's energy system. By the late 2010s, Hong Kong had firmly embedded green building practices into its development trajectory.

Looking toward 2030 and beyond, Hong Kong has aligned sustainable building with its climate and urban development goals. The city's leaders committed to carbon neutrality by 2050, recognizing that buildings (which consume over 90% of Hong Kong's electricity) are "prime culprits" of emissions. In 2021, the government's **Climate Action Plan 2050** set targets to cut commercial building electricity use by 30–40% and residential building use by 20–30% from 2015 levels by 2050 (with about half of those reductions to be achieved by 2035)[144]. This long-term

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[140] Yau, R., Tong, J., Ng, T., & Nugroho, E. Market Drivers on the Transformation of Green Buildings in Hong Kong – The Green Buildings Roadmap. Arup. ISBN 978-84-697-1815-5.

[141] Invest Hong Kong, & Arcadis. (2023). *Discover new ideas and business opportunities in Hong Kong – The City of Smart Green Buildings*. Hong Kong: Invest Hong Kong.

[142] Xu, W. (2023, December 22). *Constructing a green, sustainable future*. China Daily. Retrieved from https://epaper.chinadaily.com.cn/a/202312/22/WS6584d460a310b04771b9c375.html

[143] C40 Cities. (n.d.). *Hong Kong Ordinance Drives Energy Efficiency through Strict Codes of Practice and Audits*. Retrieved from https://www.c40.org/case-studies/hong-kong-ordinance-drives-energy-efficiency-through-strict-codes-of-practice-and-audits/

[144] **Baker McKenzie.** *CO_2 and Energy Targets – Hong Kong*. In *Global Sustainable Buildings Guide*. Retrieved from https://resourcehub.bakermckenzie.com/en/resources/global-sustainable-buildings/asia-pacific/hong-kong/topics/co2-and-energy-targets

vision builds on earlier plans like *Hong Kong's Climate Action Plan 2030+* (2017) and the sustainable urban blueprint *Hong Kong 2030+*, ensuring that the evolution of Hong Kong's built environment remains closely tied to environmental objectives. In summary, over the past three decades Hong Kong has progressed from ad-hoc green building efforts to a holistic strategy combining regulations, voluntary standards, and innovation – setting a strong foundation for the next wave of sustainable construction.

A.2.2 Policy Framework and Government Strategies

Hong Kong's policy framework for sustainable buildings is anchored by comprehensive strategies and a coordinated institutional setup. The overarching planning strategy **Hong Kong 2030+** (Towards a Planning Vision and Strategy Transcending 2030) encapsulates the city's commitment to sustainability. Its "overarching goal...is to promote sustainable development with a view to meeting our present and future social, environmental and economic needs"[145]. In practical terms, Hong Kong 2030+ envisions a "Smart, Green and Resilient" city, integrating land use, transport, and environmental planning to enhance liveability. Within this vision, green buildings play a key role in reducing carbon emissions, improving energy efficiency, and supporting a high-density yet livable urban form. The **Climate Action Plan 2030+** reinforced this by setting sector-specific carbon reduction paths, and the subsequent **Climate Action Plan 2050** elevated ambitions to align with China's national pledge of peaking emissions by 2030 and achieving carbon neutrality by 2060. These strategies collectively signal top-level government commitment to transforming the built environment as part of Hong Kong's sustainable development agenda.

Several government bodies share responsibility for implementing sustainable building policies, each with distinct roles. The **Development Bureau** provides policy direction on building and planning; it oversees the Buildings Department as well as works agencies, ensuring that sustainability is embedded in development projects. The **Buildings Department (BD)** administers the Buildings Ordinance and regulations – it sets building standards, enforces energy-related codes, and manages incentive schemes (such as gross floor area concessions for green buildings). For example, since 2011 the BD has required new developments seeking extra floor area concessions to register for BEAM Plus green building certification, effectively tying incentives to sustainability performance. The **Electrical and Mechanical Services Department (EMSD)** is another key player, being responsible for the technical Codes of Practice under the Buildings Energy Efficiency Ordinance. EMSD registers **Registered Energy Assessors** and monitors compliance with the mandatory Building Energy Code and Energy Audit Code. Additionally, EMSD runs public programs on building energy saving, such as voluntary charters for energy reduction and guidelines on retro-commissioning of buildings.

Policy coordination also involves environment-focused agencies. The **Environment and Ecology Bureau** (formerly Environment Bureau) sets climate and energy policies that drive green building efforts, for instance by establishing the above-mentioned energy reduction targets for buildings and launching funds to support innovation. In 2020, the government created a HKD 400 million

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[145] **KPMG. (2020).** *Future Hong Kong 2030*. Retrieved from https://assets.kpmg.com/content/dam/kpmg/cn/pdf/en/2020/04/future-hong-kong-2030.pdf

Green Tech Fund to finance R&D in decarbonization and green buildings, offering up to HK$30 million per project to local companies or research institutions. Furthermore, Hong Kong's two power utility companies (CLP and HK Electric) are engaged through regulatory arrangements to promote efficiency – they offer programs like free energy audits, interest-free loans for energy improvements, and subsidy schemes for building retrofits and upgrades. This public-private partnership approach extends to organizations like the **Construction Industry Council (CIC)** and **Hong Kong Green Building Council (HKGBC)**. CIC, a statutory body, champions sustainable construction practices (for example, it operates the Zero Carbon Park and administers green product certification), while HKGBC provides the platform for industry training, building assessments (BEAM Plus), and advocacy. In essence, Hong Kong's institutional framework for sustainable buildings is multi-faceted – Development Bureau and BD set and enforce rules, EMSD provides technical oversight, environment authorities align green building with climate goals, and industry councils facilitate market transformation.

A number of **green initiatives and policies** bolster this framework. Since the mid-2000s, the government has led by example by mandating higher standards for public buildings – new government buildings are required to achieve high BEAM Plus ratings (typically Gold or above) and incorporate energy efficient designs. The government met its target of cutting electricity use in its own buildings by 5% from 2015 to 2020, and it has set a further goal to reduce energy use in public premises by over 6% by 2024-25. *Green procurement* policies ensure that construction materials and building services in public projects meet sustainability criteria. On the private sector side, **incentive schemes** have been crucial. The Gross Floor Area (GFA) concession scheme encourages developers to include green features (like sunshades, wind catchers, green roofs) by exempting them from part of the floor area calculation, on condition that the project attains a BEAM Plus certification. The government also introduced accelerated tax deductions for capital spending on energy-efficient building installations and renewable energy systems (allowing 100% first-year write-off) to encourage private investment. Meanwhile, outreach initiatives such as the annual *Green Building Award* and *Hong Kong Green Building Week* raise awareness and showcase best practices. These policy tools – long-term strategies, dedicated agencies, and targeted incentives – work in concert to advance sustainable building development in Hong Kong. In parallel with these domestic initiatives, regional integration has also emerged as a defining factor in shaping the city's green building trajectory.

Integration with the Mainland market has become an important dimension of Hong Kong's green building development. Under the Guangdong–Hong Kong–Macao Greater Bay Area (GBA) framework, Hong Kong is increasingly aligning its building practices with those of the mainland. This trend is reflected in several areas: building material supply chains are gradually incorporating certified green products sourced across the boundary; financial instruments such as green bonds and sustainability-linked loans are designed with reference to both international and mainland benchmarks; and regulatory dialogues have begun to explore pathways for mapping or partial recognition of certification requirements. Through these mechanisms, Hong Kong's green building sector is becoming more closely embedded in the broader mainland market, while maintaining its role as a platform that channels international practices into the Chinese context.

A.2.3 Building Regulations and Technical Standards

Hong Kong has a robust set of building regulations and standards that embed sustainability principles into the design and operation of buildings. A cornerstone is the **Buildings Energy Efficiency Ordinance (Cap. 610)**, which since 2012 has made compliance with energy codes mandatory for new buildings and major retrofits. Under the BEEO, developers must adhere to the **Building Energy Code (BEC) –** a detailed Code of Practice governing minimum energy efficiency for key building services installations (air-conditioning, electrical, lighting, and lift & escalator systems). For example, the BEC sets requirements for lighting power densities, air-conditioner COP (coefficient of performance), insulation of pipework, and use of automatic controls. Compliance is verified by Registered Energy Assessors who certify building design submissions. In addition, the BEEO mandates periodic **Energy Audits** for commercial buildings: every 10 years, an audit of the central building services must be conducted and an energy utilization report displayed publicly. These audits help ensure existing large buildings identify efficiency improvement opportunities over their lifecycle. Together, the BEC and audit requirements under BEEO create a legal framework that drives continual energy performance monitoring and improvement in the commercial building sector.

Complementing the BEEO is the long-standing **Building (Energy Efficiency) Regulation** (Cap. 123M) under the Buildings Ordinance, which focuses on the building envelope. This regulation requires that the external walls and roofs of commercial buildings and hotels be designed with an acceptable Overall Thermal Transfer Value. The Code of Practice for OTTV, first published in 1995 and tightened in 2000 and 2011, specifies maximum OTTV values (in watts per square meter) for different building configurations. Essentially, architects must use combinations of insulation, window glazing, shading devices, and wall materials such that the calculated heat transfer through the façade stays below the prescribed threshold, thereby reducing cooling loads. In 2015, Hong Kong extended this concept to the residential sector by issuing guidelines for **Residential Thermal Transfer Value (RTTV)**. Although not a statutory requirement for homes, the RTTV guideline (enforced via the planning approval and GFA concession process) recommends limits on the thermal transfer through condo and apartment building envelopes. For instance, an RTTV not exceeding ~14 W/m^2 for walls and ~4 W/m^2 for roofs was initially advised[146], with even stricter targets introduced in later revisions (e.g. 12.5 and 3.5 W/m^2) to drive the adoption of better insulation and low-solar-gain glazing. By regulating OTTV/RTTV, Hong Kong addresses passive design performance, ensuring new buildings are fundamentally more thermally efficient.

Technical standards also cover the myriad systems within buildings. The **Code of Practice for Energy Efficiency of Building Services Installations** (often referred to simply as the Building Energy Code) is updated periodically by EMSD to raise performance benchmarks in line with technological advances. This code specifies minimum efficiencies and control requirements for HVAC equipment, lighting fixtures, electrical distribution (e.g. power factor correction), and vertical transportation. It also provides a *Performance-based* compliance path, allowing designers to trade-off between systems as long as the overall annual energy use meets a baseline

[146] Buildings Department. (2014). *Guidelines on Design and Construction Requirements for Energy Efficiency of Residential Buildings (Guidelines DCREERB2014e)*. Retrieved from https://www.bd.gov.hk/doc/en/resources/codes-and-references/code-and-design-manuals/Guidelines_DCREERB2014e.pdf

model. In parallel, there are specific guidelines such as the **Lighting Code** and **Air Conditioning Code** (earlier separate documents now integrated into the BEC) and standards for building envelope thermal performance as discussed. Hong Kong's regulatory regime thus spans both the passive aspects (architecture and materials) and active aspects (electro-mechanical systems) of building design.

Beyond mandatory codes, Hong Kong has embraced **green building certification** to drive best practices. The **BEAM Plus** rating system is the territory's de facto green building standard, covering a range of sustainability criteria. Administered by HKGBC, BEAM Plus offers tools for New Buildings, Existing Buildings, Interiors, Neighborhoods, and even Data Centers, each with tailored criteria. New construction is evaluated on integrated design and construction management, site sustainability, materials and waste, energy use, water use, indoor environmental quality, and innovations. Existing buildings are assessed on similar categories, with an emphasis on ongoing performance and management practices. Projects achieving BEAM Plus certification can be rated Bronze, Silver, Gold, or Platinum, with Platinum representing exemplary performance. While voluntary, BEAM Plus has strong market traction – aided by government policy – and is often demanded by investors and occupants as a mark of building quality. The system's impact is evident: by 2023, thousands of buildings had been certified or registered, including all new government buildings and many commercial developments. Hong Kong's BEAM Plus also aligns with international trends; it was initially based on BREEAM and is broadly equivalent to other global green building rating systems. Alongside BEAM Plus, some projects in Hong Kong also pursue LEED (U.S. Green Building Council's system) or China's **Green Building Evaluation Label**, but BEAM Plus remains the predominant local benchmark. Overall, the combination of enforcement (through ordinances and codes) and encouragement (through voluntary certification and incentives) ensures that technical standards for sustainable buildings in Hong Kong are both comprehensive and continually raising the bar.

A.2.4 Sustainable Building Materials, Energy Systems, and Water Management

Implementing sustainable buildings in Hong Kong's context requires a focus on materials, energy systems, and water management that suits the city's dense urban environment and subtropical climate. **Sustainable building materials** are increasingly emphasized to reduce the environmental footprint of construction. This includes using low-carbon and recycled materials, as well as improving the lifecycle impacts of traditional materials like concrete and steel. For example, the Construction Industry Council has introduced a **Green Product Certification** system to vet and label building materials (from cement to paints to timber) that meet sustainability criteria such as recycled content or low VOC emissions. There is growing interest in **innovative materials**: Hong Kong's sustainability vision cites emerging concepts like *material passports* (digital documentation of a building's material constituents for future reuse) and **biobased materials** as opportunities on the horizon[147]. These approaches, pioneered in places like the Netherlands, could help Hong Kong transition from a "throw-away" construction model to a circular one, where building components are reused or recycled at end of life. In practice,

[147] Buildings Department. (2014). *Guidelines on Design and Construction Requirements for Energy Efficiency of Residential Buildings (Guidelines DCREERB2014e)*. Retrieved from https://www.bd.gov.hk/doc/en/resources/codes-and-references/code-and-design-manuals/Guidelines_DCREERB2014e.pdf

developers in Hong Kong have started to adopt greener concrete (using industrial by-products like fly ash or ground slag to reduce cement content) and to incorporate more prefabrication (DfMA – Design for Manufacture and Assembly) to minimize waste. High-rise construction in Hong Kong will likely remain concrete-dominated for structural reasons, but supplemental materials such as sustainably sourced timber are being used for interiors and façades of green buildings, and **green roof systems** (often lightweight with recycled substrates) have been deployed to enhance insulation and stormwater retention. The government's push for a circular economy – evident in waste charging schemes and promotion of *construction & demolition waste* recycling – further drives the use of sustainable materials. For Dutch suppliers and experts in innovative materials, Hong Kong's market is ripe for collaboration on advanced composites, high-performance insulation materials, and circular design methodologies.

Energy systems in Hong Kong's buildings combine **passive design** strategies with **active high-efficiency technologies** to achieve low energy consumption. On the passive front, building designers now pay closer attention to orientation, building form, and façade detailing to mitigate the harsh summer sun and leverage natural ventilation where possible. Techniques such as external shading devices, reflective coatings on glass, and optimized window-to-wall ratios are used to lower solar heat gain in line with OTTV/RTTV standards. Some new buildings incorporate light wells, operable windows, or *ventilation shafts* to promote natural airflow in cooler seasons, reducing reliance on air-conditioning. Green roofs and vertical greening are also applied to insulate rooftops and walls while improving the micro-climate. However, given Hong Kong's high density and hot, humid climate, **active systems** carry the bulk of the load in delivering comfort efficiently. Modern commercial towers and residential estates are increasingly equipped with variable-speed chillers, energy-efficient LED lighting, occupancy sensors, and demand-controlled ventilation. The **building management system (BMS)** or smart automation system optimizes these active components – for instance, by adjusting cooling output based on real-time occupancy and weather data, or by shedding non-critical loads during peak demand.

Hong Kong has also embraced district-scale solutions for building energy. A notable example is the **Kai Tak District Cooling System**, a government-developed central cooling network for the Kai Tak redevelopment area. Using seawater-cooled chillers to supply chilled water via an underground pipe network, this system serves numerous buildings and is about 35% more energy-efficient than standalone air-conditioning plants[148]. District cooling and other shared energy infrastructure (like neighborhood solar farms or energy storage) are aligned with Hong Kong's smart city plans and demonstrate how integrated planning can yield significant efficiency gains. Additionally, renewable energy adoption is picking up in buildings – while space constraints limit large installations, many commercial rooftops and government facilities have added solar photovoltaic panels, boosted by a Feed-in Tariff scheme that pays a premium for solar-generated electricity. Even small-scale wind turbines have appeared on some tower rooftops as pilot projects. **Energy storage and demand response** technologies are expected to grow as Hong Kong updates its grid and smart city infrastructure, which will further enhance how buildings use and potentially even supply energy. Overall, the approach to building energy systems in Hong

[148] Arup. *Kai Tak district cooling system*. Retrieved from https://www.arup.com/en-us/projects/kai-tak-district-cooling-system/

Kong is a holistic one: tighten the passive design first, then deploy state-of-the-art efficient equipment and controls, all underpinned by data-driven management for continuous commissioning and optimization.

Water management is another critical aspect of sustainable building in Hong Kong, given both the region's high rainfall and its need for water conservation. The city has been a world leader in using **seawater for toilet flushing** – about 80% of Hong Kong's population is served by a seawater flushing network, which reduces freshwater consumption significantly[149]. In buildings, dual plumbing systems deliver seawater to toilets, an innovation that has been standard for decades and remains a cornerstone of water sustainability. Modern green buildings go further by incorporating **rainwater harvesting and greywater recycling** systems. The Water Supplies Department has published guidelines to facilitate rainwater and greywater reuse in new developments[150], and projects achieving BEAM Plus certification often include features like rainwater collection tanks for irrigation or cooling tower make-up. Some commercial buildings recycle condensate from air conditioners or treat sink/shower water to use in landscaping, thus easing demand on both freshwater supply and storm drainage systems. Low-flow water fixtures and appliances are also promoted through a mandatory *Water Efficiency Labelling Scheme*, helping to reduce indoor water usage without compromising functionality.

Stormwater management and climate resilience have become integral components of sustainable building design in Hong Kong. The city's heavy seasonal rainfall necessitates robust drainage infrastructure, and green building practices increasingly emphasize on-site infiltration and stormwater attenuation. Strategies such as green roofs, permeable pavements in podium gardens, and basement-level detention tanks help slow runoff and ease pressure on municipal drainage systems during peak storm events. These measures align with the broader "sponge city" concept gaining traction across the region.

In parallel, smart building systems are being deployed to enhance water management efficiency. Advanced leak detection technologies and real-time monitoring through smart meters enable facility managers to promptly identify anomalies and optimize water use—an essential capability in high-rise developments. Additional conservation strategies include water pressure optimization systems, which maintain plumbing pressure at the lowest effective level to minimize excess consumption. Water metering and sub-metering are widely adopted across building zones to support consumption benchmarking and targeted performance management.

Moreover, grey water recycling systems are increasingly integrated into new developments. These systems collect and treat wastewater from showers, sinks, and air-conditioning condensate for reuse in non-potable applications such as toilet flushing and landscape irrigation. This holistic approach—combining reuse, efficiency, and smart technologies—supports Hong Kong's broader goals for water security and environmental sustainability. It also presents collaboration opportunities for international stakeholders. Dutch companies, in particular, with

[149] Li, Y., Chen, L., & Li, Y. (2015). *Multi-criteria optimization for the design of water supply systems in buildings: A case study*. Water Research, 85, 165–175. https://doi.org/10.1016/j.watres.2015.08.030
[150] WSD. (n.d.). *Recycled water*. Retrieved from https://www.wsd.gov.hk/en/core-businesses/water-resources/recycled-water/index.html

their expertise in water management and circular design, are well positioned to contribute innovative solutions such as waterless sanitation technologies or advanced grey water recovery systems.

A.2.5 Integration with Urban Planning and Smart City Strategies

Hong Kong recognizes that sustainable buildings are most effective when integrated into wider urban planning and smart city initiatives. The government's Smart City Blueprint 2.0 (updated in 2020) explicitly highlights "Smart Environment" as a key area, which includes **green and intelligent buildings** as a focal point. In practice, this means new developments are planned with infrastructure and digital frameworks that enhance building sustainability at a district or city scale. For instance, large-scale projects like the **Northern Metropolis** (a future urban cluster near Shenzhen) and the **Lantau Tomorrow Vision** are touted as opportunities to create sustainable, carbon-neutral communities from the ground up. In these projects, planners intend to incorporate blue-green infrastructure (such as parks, restored wetlands, and flood-resilient waterways) alongside energy-smart buildings. By doing so, the urban fabric itself supports lower building energy needs (through mitigating urban heat island effects, for example) and provides ecosystems services like flood control and improved air quality[151]. Hong Kong 2030+ emphasizes such integration, calling for "proactive enhancement of our development and environmental capacities, through strategic planning" to make Hong Kong more livable and sustainable[152].

A tangible link between building-level sustainability and urban planning is the deployment of district utilities. The earlier example of the **Kai Tak District Cooling System** shows how government planning can enable a shared energy solution that benefits all buildings in a precinct, achieving economies of scale and greater efficiency. Similarly, Hong Kong's planning guidelines now often require wind environment assessments for major projects – effectively ensuring that new buildings are arranged and shaped to preserve breezeways and natural ventilation at the district level. Urban renewal schemes in older neighborhoods are including green building retrofits as part of a comprehensive upgrade of the area, rather than treating buildings in isolation. This integrated approach extends to transportation planning: transit-oriented development is heavily practiced in Hong Kong, meaning energy-efficient buildings are typically sited above or near mass transit, reducing transportation emissions and complementing the sustainability of the built environment.

On the **smart technology** side, Hong Kong is leveraging IoT (Internet of Things) and data analytics to enhance building performance as part of its smart city drive. The government has promoted the concept of **"digital twins"** for new developments – virtual models of buildings and city districts that can simulate energy use, pedestrian flows, and environmental conditions. By planning digitally, designers can optimize building orientations or façade designs for better performance before construction. Once buildings are occupied, city-wide digital infrastructure like 5G networks enable real-time monitoring and management. Hundreds of government

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[151] Netherlands Innovation Network. (2024, July 3). *Symposium for a Green and Resilient Northern Metropolis in Hong Kong*. Retrieved from https://netherlandsinnovation.nl/sino-dutch-collaboration/symposium-for-a-green-and-resilient-northern-metropolis-in-hong-kong/
[152] University of Hong Kong Faculty of Architecture. (n.d.). *Hong Kong 2030+*. Retrieved from https://www.arch.hku.hk/gallery/upad/hong-kong-2030/

buildings have been retrofitted with smart sensors and metering to track energy and water usage, feeding into a central dashboard that uses AI to flag inefficiencies. The Smart City Blueprint also encourages **retro-commissioning** – systematically checking and tuning existing building systems – supported by data analytics to ensure buildings operate at their optimal performance. Another initiative is the introduction of smart lampposts and environmental sensors around the city, which, among other things, collect microclimate data that can inform building management systems to adjust ventilation or cooling in response to outside conditions.

In essence, Hong Kong's sustainable buildings are not standalone elements; they are increasingly nodes in a connected, smart urban ecosystem. The convergence of **urban planning, climate policy, and smart city technology** ensures that gains at the building scale (energy savings, water recycling, etc.) are amplified and supported by neighborhood-level systems (like district cooling, public transport, green space) and city-level digital platforms. This integrated approach is an area where international collaboration is beneficial – Hong Kong can share its high-density urban sustainability lessons, while learning from the Netherlands and other smart city leaders about leveraging data and design to create circular, resilient urban districts. The end goal is a virtuous cycle: better buildings make a greener city, and smart planning makes it easier for buildings to be sustainable.

A.2.6 Opportunities for Dutch–Hong Kong Collaboration

The confluence of Hong Kong's aggressive sustainability goals and the Netherlands' expertise in green building technologies creates ripe opportunities for collaboration. Dutch businesses, research institutes, and government agencies can find common cause with Hong Kong stakeholders in several priority areas to mutual benefit. Below are key opportunity areas and recommendations for Dutch–Hong Kong partnership:

- **High-Performance Building Materials and Insulation:** Dutch companies are known for innovative materials (e.g. recycled composites, low-carbon concrete, advanced insulation solutions) that can help Hong Kong reduce the carbon footprint of its buildings. Hong Kong's market is seeking greener construction methods – evidenced by interest in material passports and circular construction models – where the Netherlands is a frontrunner. There is scope for Dutch suppliers to provide high-performance insulation and facade systems tailored to Hong Kong's climate (for instance, façade panels with integrated shading or double-skin systems to cut cooling loads). Joint research on tropical adaptation of passive house principles or modular construction using sustainable materials could be facilitated between Dutch institutes and Hong Kong's Construction Industry Council or universities. By showcasing successful use of Dutch sustainable materials in pilot projects (such as using ultra-low-energy windows or bio-based composites in a Hong Kong green building), both sides can spur market adoption and set new benchmarks.
- **Smart Building Management Systems and Energy Tech:** The Netherlands' strong technology sector – from IoT-based building controls to energy management software – aligns well with Hong Kong's push for smart buildings. Hong Kong's developers and property management firms are increasingly interested in *smart building management systems* that can monitor and optimize energy, HVAC, lighting, and security in real time.

Dutch firms specializing in building automation, data analytics for energy efficiency, or AI-driven facility management can find eager partners in Hong Kong. Demonstration projects where a Dutch smart building platform is deployed in a Hong Kong commercial tower or hospital could validate performance improvements (e.g. reducing energy use by double-digit percentages through intelligent control). Furthermore, as Hong Kong explores district energy and grid-interactive buildings, Dutch experience with smart grids and demand response can be valuable. Collaboration might include Dutch and Hong Kong utilities or tech startups co-developing solutions for integrating building energy management with renewable energy and storage – making buildings not just consumers but active participants in a smart energy network. These partnerships would tap into Hong Kong's living lab environment (a dense urban setting ready to trial new tech) and the Netherlands' advanced R&D, accelerating innovation for both sides.

- **Green Certification Systems and Knowledge Sharing:** Hong Kong's BEAM Plus and the Netherlands' sustainability standards (such as BREEAM-NL or circular building metrics) offer a platform for knowledge exchange. Dutch experts in green building certification, consulting, and performance benchmarking can work with HKGBC and Hong Kong developers to enhance certification systems and share best practices. For example, Dutch universities and consultancies have developed methods for **post-occupancy evaluation** and building performance simulation that could improve how Hong Kong's green ratings translate to real-world energy savings. There is an opportunity for joint seminars, training programs, and exchange visits – Dutch green building professionals can assist Hong Kong's industry in areas like **net-zero energy building design, circular economy in construction**, and precinct-level sustainability (where Dutch eco-district models could inspire Hong Kong's new development areas). Conversely, Hong Kong's experience in ultra-dense high-rise green buildings can inform Dutch efforts as European cities also densify. At a policy level, Dutch and Hong Kong government agencies could collaborate on creating **standards for embodied carbon in buildings**, an area that is gaining attention. By sharing research and setting up collaborative pilots (for instance, a Hong Kong–Dutch task force on retrofitting historic buildings sustainably), both sides can accelerate learning. This exchange of knowledge not only opens business opportunities (for consultancy services, training, etc.) but also helps align international sustainability efforts, given that climate change and resource challenges transcend borders.

In conclusion, the development of sustainable building in Hong Kong is entering a mature phase characterized by comprehensive policy support, advanced standards, and integration with city-wide initiatives. Dutch businesses and institutions are well-positioned to contribute expertise and innovative solutions in this journey – from cutting-edge materials and smart systems to thought leadership in green certification and circular design. With strong alignment between Hong Kong's urban sustainability agenda and the Netherlands' strengths in sustainable building, a collaborative approach can yield significant economic and environmental benefits. By partnering in projects, sharing technology and research, and leveraging each other's experiences, Hong Kong and the Netherlands can together push the frontier of sustainable building, creating healthier, more efficient, and resilient built environments in both regions. Such cooperation not only opens new business opportunities but also reinforces the global effort toward greener cities and a low-carbon future.

A.3: Conclusion and Discussion

A.3.1 Policy Framework and Certification System

Hong Kong has established a localized and internationally aligned green building policy ecosystem, with BEAM Plus (Building Environmental Assessment Method Plus) as its principal certification system. Developed and managed by the Hong Kong Green Building Council (HKGBC), BEAM Plus is a voluntary but widely adopted tool, referencing global systems such as LEED and BREEAM while adapting to Hong Kong's high-density urban and subtropical climatic context.

The BEAM Plus system evaluates buildings across multiple dimensions including energy use, indoor environmental quality, site aspects, materials, water efficiency, and innovations. Certification is available for new buildings, existing buildings (including retrofits), interiors, and neighbourhood-scale developments.

Although not mandatory, BEAM Plus participation is incentivized through:

- Gross Floor Area (GFA) concessions for certified projects,
- Green bond issuance eligibility for developers,
- Government green procurement policies favouring certified designs.

Key regulatory institutions involved in implementation include the Development Bureau, the Buildings Department, and the Environmental Protection Department, each playing a role in policy support, code enforcement, and environmental monitoring.

A.3.2 Market Trends and Project Applications

As of 2023, over 2,000 projects have registered under BEAM Plus. High participation is observed in:

- Commercial and mixed-use developments, such as Grade A office towers and retail complexes;
- Public housing and institutional buildings, with the Hong Kong Housing Authority (HKHA) actively integrating green design principles;
- Urban redevelopment projects, where sustainability performance supports land premium adjustments and public acceptance.

BEAM Plus-certified buildings often integrate:

- High-efficiency HVAC and lighting systems;
- Renewable energy technologies, such as building-integrated photovoltaics;
- Smart building management systems for real-time energy use tracking;
- Passive design strategies, including shading, daylighting, and optimized natural ventilation.

A.3.3 Collaboration Opportunities with the Netherlands

Dutch stakeholders can find alignment with Hong Kong’s green building agenda through:

- Digital engineering solutions for lifecycle assessment and performance simulation;
- Smart energy and indoor climate control systems, adapted to high-rise, high-density applications;
- Green materials and modular retrofitting systems, particularly in aging building stock;
- Professional training programs on circular design and integrated sustainability planning, co-delivered with HKGBC or academic partners.

Given Hong Kong’s openness to international standards, robust legal system, and financial sector engagement, it serves as a strong gateway for piloting advanced Dutch building technologies and service models in Asia.