China Overseas Heshan Daguan

Submitted By: China Academy of Building Research



Organization Profile

Organization Name: China Academy of Building Research (CABR-中国建筑科学研究院有限公司)

Organization Type: National government; University and research institution

Website:
https://www.cabr.com.cn/zgjyy/index.html

Practice Details

Country(ies): China

City(ies): Hohhot

Start Year: 2019

Ongoing: No

End Year: 2023

Main Adequate Housing Components:



Housing Thematic Areas:

Housing & Climate Mitigation

Technology & Digital Solutions in Housing

Relevant SDGs:



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Problem & Context

The building sector accounts for nearly 40% of global energy use and carbon emissions, with challenges especially acute in cold-climate countries like China. In northern regions, where winter temperatures drop below –20 °C, heating makes up over half of household energy demand. Hohhot, capital of Inner Mongolia, faces a six-month heating season with lows near –28 °C. Residents long relied on coal or electricity, but conventional housing suffers from poor insulation, thermal bridges, and low airtightness—leading to discomfort, high costs, and severe emissions. Although China has pledged carbon peaking by 2030 and neutrality by 2060, current green building codes remain difficult to implement in severe cold regions. The critical gap is replicable models proving comfort, affordability, and deep emission cuts. The China Overseas Heshan Daguan project was conceived to fill this gap in Hohhot's extreme climate.

Solution Developed

The Heshan Daguan project addresses energy inefficiency, high carbon emissions, and poor housing quality in northern China's severe cold regions. In Hohhot, where winter temperatures fall below –28 °C and heating lasts half the year, conventional buildings are leaky, coal-dependent, and costly. The project delivered 820 near-zero energy units for ordinary households in Xincheng District, cutting heating bills by 47%, ensuring stable indoor comfort (above 20 °C, 30–40% humidity), and reducing indoor PM2.5 to 18% of outdoor levels.

Its objectives were to drastically lower heating demand (over 90% savings), ensure affordability through efficiency and renewables, improve indoor health, support China's dual carbon targets and SDGs (11, 13, 7, 3), and create a replicable model for cold-climate housing.

- Technological: high-performance envelope, efficient air-source heat pumps with 70% heat recovery, rooftop PV for shared spaces, and smart monitoring.
- Social: heating cost halved, healthy air, resident feedback confirming high satisfaction.
- Institutional: cross-sector collaboration, alignment with national policy, and dissemination via journals and reports.

Implementation

The Heshan Daguan Project in Hohhot was jointly developed through a multi-actor framework integrating planning, design, construction, and operation.

The project applied ultra-low energy technologies suited to severe cold regions, including airtight envelopes, enhanced insulation, renewable energy integration, and performance-based low-carbon optimization. At the community scale, it advanced residential planning with solar access, functional diversity, and a people-centered environment.

- Developer: Hohhot Haiwei Real Estate Co., Ltd. (China Overseas Property), overall coordination.

- Consultant: Shenzhen Zhonghong Low Carbon Building Technology Co., Ltd., expertise in energy efficiency and carbon reduction.
- Construction: Zhongtian Construction Group Co., Ltd., site execution and quality control.
- Design: Shanghai Hongsi Architectural Design Studio, initial scheme.
- Design development: China Academy of Building Research, low-carbon optimization, technical drawings, and construction support.
- Operation: Hohhot China Overseas Property Services Co., Ltd., property management and performance monitoring.

Timeline of implementation:

- May 2020: Construction start
- Aug 2021: Foundation & substructure acceptance
- Oct 2021: Structural acceptance
- Sep 2022: Energy efficiency acceptance
- Jan 2023: Final project completion
- Aug 2023: Fire safety filing

Enablers & Obstacles

Heshan Daguan succeeded through a mix of policy, technology, institutions, and social demand. Alignment with China's "dual carbon" goals and municipal green policies created strong political backing. China near-zero energy standards (GB/T 51350–2019) and CABR's expertise ensured credible benchmarks. Mature passive house principles, advanced heat pumps, and airtight construction materials enabled reliable performance, while prior pilots reduced risks. Cross-sector collaboration among developer, CABR, contractors, and local authorities provided integrated governance. Rising resident demand for healthier, cost-saving housing enhanced social legitimacy. Challenges included higher initial investment, technical complexity in severe cold climates, resident skepticism and multi-actor coordination. Solutions involved cost balancing and incentives, quality control, early utility engagement, transparent monitoring data and formal governance mechanisms with performance validation.

Results & Impact

The Heshan Daguan project delivered verified outcomes in energy efficiency, comfort, affordability, and social impact. Buildings achieved a 92% energy-saving rate, airtightness 40× better than typical housing, and rooftop PV generating 2.91 kWh/m² annually, powering shared facilities. Indoor temperatures stayed above 20 °C (avg. 23.9 °C) with humidity 30–40%. Indoor PM2.5 averaged 7.9 μg/m³ (18% of outdoor levels), and CO_2 remained below 0.1%. Heating costs were 47% lower than municipal fees (¥11.69/m² vs. ¥22/m²), easing energy poverty. Surveys showed 90%+ resident satisfaction with comfort, air quality, and costs.

- Community: Raised expectations of housing quality, reframing comfort and affordability as complementary. Media coverage built awareness of sustainable living and health.
- Economic: Trained builders and engineers in airtightness and insulation, lowering future costs and boosting developer confidence in green housing.
- Environmental: Cut annual CO_2 emissions by 1,752.9 tons (42.3% reduction), displacing coal use and reducing pollution; lifecycle savings are substantial.
- Policy: Cited in reports and studies, the project informs refinement of China's green building standards, bridging policy ambition with practice and encouraging replication at scale.

Replication & Scale Up

This project demonstrates strong replicability potential. Its core approach—integrating passive house standards with optimized orientation, airtight envelopes, renewable systems, and cost-effective construction—can be adapted to diverse climates. While developed in a severe cold region, the principles of energy efficiency, affordability, and health-centered design are universally relevant. Replication requires supportive policy frameworks, skilled technical teams, and collaboration among developers, researchers, and government bodies to ensure quality and scalability.

The China Overseas Heshan Daguan project has not yet been directly replicated elsewhere, but it is highly replicable. Its passive design and advanced technologies—insulation, airtight construction, thermal bridge elimination, high-performance windows, and heat-recovery ventilation—are adaptable to varied climates. Replication requires supportive policies, financial incentives, and integration into urban strategies. Economies of scale and long-term savings make it affordable, while public demand for comfort and health drives acceptance.

Policy Uptake

This housing practice has informed or been partially integrated into policy discussions, strategies, or pilot-level policy instruments.

The Heshan Daguan project aligns with China's "dual carbon" goals and the national Technical Standard for Near-Zero Energy Buildings, serving as the first large-scale near-zero energy housing in severe cold regions. It provides credible monitoring data on savings, air quality, affordability, and carbon reduction, proving feasibility under –28 °C. Recognized locally as a benchmark, it informs policy and planning. However, it remains a pilot; scaling requires stronger institutional support, incentives, and regulation to embed near-zero housing into mainstream policy.

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Lessons & Takeaways

The Heshan Daguan project proved near-zero housing is feasible in severe cold regions but several areas could improve. Earlier adoption of green finance tools could ease upfront costs and enable uptake in social housing. Stronger resident participation during design would enhance satisfaction and foster low-energy lifestyles. Expanding PV and storage would improve resilience. Long-term monitoring and open data would strengthen policy impact. Systematic training for builders and closer policy integration would ensure scalability and mainstream adoption.