



# The PRC's Innovation and Successful Experiences on Building Energy Conservation and Carbon Reduction

Lanlan Lin, Standards and Quotas Department,

Ministry of Housing and Urban-Rural Development of the PRC











Learning from the PRC's Clean Energy Innovations







# PRC Building Energy Efficiency Policies and Regulations

Learning from the PRC's Clean Energy Innovations



# 1.1 Current status of global energy demand and carbon emissions

- According to data from the International Energy Agency (IEA), global energy consumption increased by 2% in 2023, of which 2/3 came from fossil fuel.
- □ Global greenhouse gas emissions increased by 1.9%, of which energy-related carbon dioxide (CO 2) emissions accounted for about 71%, both reaching record highs
- As the world's main source of carbon emissions, energy conservation and carbon reduction in buildings are key to the global response to climate change.





**Global energy supply and its annual changes 2010-2023** 

**Global energy-related greenhouse gas emissions from 1950 to 2023** 

(Data source: IEA2024 World Energy Outlook)

Learning from the PRC's Clean Energy Innovations



## **1.2 China's building energy efficiency policy system**



#### June 30, 2022 September 22, 2021 The Ministry of Housing and The Central Committee of the Urban-Rural Development and the CPC and the State Council issued May 23, 2024 October 24, 2021 National Development and Reform the "Opinions on Completely, The State Council issued the "2024-Commission issued the " Accurately and Comprehensively The State Council issued 2025 Energy Conservation and Implementing the New Implementation Plan for Carbon the "Carbon Peak Action Carbon Reduction Action Plan " Peaking in Urban and Rural **Development Concept and Doing** Plan before 2030 " Construction " a Good Job in Carbon Peaking and Carbon Neutrality " March 1, 2022 July 31, 2024 October 21, 2021 The Ministry of Housing and March 12, 2024 **CPC** Central Committee and The General Office of the CPC **Urban-Rural Development** " Work Plan for Accelerating Energy State Council issued "Opinions Central Committee and the issued the "14th Five-Year Plan Conservation and Carbon Reduction in on Accelerating the General Office of the State for Building Energy Conservation the Construction Sector " **Comprehensive Green** Council issued the " Opinions and Green Building Transformation of Economic and on Promoting Green Development " Social Development" Development of Urban and **Rural Construction** " Learning from the PRC's Clean Energy Innovations

# **1.2 China's building energy efficiency policy system**

#### □ Requirements for urban and rural construction and building sector

"Opinions on fully and accurately implementing the new development concept and doing a good job in carbon peak and carbon neutrality"

Action Plan for Reaching Carbon Peak Before 2030 Opinions on Accelerating the Comprehensive Green Transformation of Economic and Social Development



Energy Conservation and Carbon Reduction Action Plan 2024-2025



VII. Improving the quality of green and low-carbon development in urban and rural construction

(17) Promote low-carbon transformation of urban and rural construction and management models.

(18) Vigorously develop energysaving and low-carbon buildings. (19) Accelerate the optimization of building energy structure.

|--|

Key tasks: (4) Carbon peak action in urban and rural construction.

 Promote green and lowcarbon transformation of urban and rural construction.
 Accelerate the improvement of building energy efficiency. 3.
 Accelerate the optimization of building energy structure.



VI. Promote green transformation of urban and rural construction and development

(XII) Promote green planning and construction methods.
(13) Vigorously develop green and low-carbon buildings.
(14) Promote green development of agriculture and rural areas.



Key tasks: (7). Building Energy Saving and Carbon Reduction Action

 Accelerate the transformation of construction methods.
 Promote the renovation of existing buildings.
 Strengthen building operation management.



Learning from the PRC's Clean Energy Innovations

# **1.3 China's building energy conservation regulations system**

Energy Conservation Law of the PRC

Renewable Energy Law of the PRC

١Ō٢

Regulations on Energy Conservation in Civil Buildings



People's governments at all levels should strengthen leadership over energy conservation in civil buildings, actively cultivate the civil building energy conservation service market, improve the civil building energy conservation service system, promote the development and application of civil building energy conservation technologies, and do a good job in publicity and education on civil building energy conservation knowledge.



Regulations on Energy Conservation Management of Civil Buildings



Encourage scientific research and technological development in energy conservation in civil buildings, promote the application of energy-saving buildings, structures, materials, energyconsuming equipment and ancillary facilities and corresponding construction processes, application technologies and management technologies, and promote the development and utilization of renewable energy.



The construction, design, construction and supervision units of construction projects shall comply with the building energy conservation standards. The state encourages the use of new wall materials and other energy-saving building materials and energy-saving equipment in new buildings and energy-saving renovation of existing buildings, and the installation and use of renewable energy utilization systems such as solar energy.

In the design and construction of buildings, necessary conditions are provided for the utilization of solar energy. For existing buildings, residents can install solar energy utilization systems that meet technical specifications and product standards without affecting their quality and safety.

Learning from the PRC's Clean Energy Innovations





# Green and Low-Carbon Buildings Technology and Standards

Learning from the PRC's Clean Energy Innovations



# 2.1 China's building energy efficiency standard system

#### PRC has established a standard system covering all types, processes and regions in the field of building energy conservation.



# 2.1 China's building energy efficiency standard system

- □ After 40 years and four rounds of systematic improvement, China's building energy efficiency standard system is aligned with the international advanced level.
- □ The future aim is to develop towards the "30-30-30" direction
- STATIC BENCHMARK TYPICAL BUILDING ENERGY CONSUMPTION LEVEL IN



# 2.2 Green Building Technology Path

- □ Green Building Evaluation Standard GB/T 50378
- Five types of evaluation indicators



#### Score

Control items ( 400 points) + Scoring items ( 600 points) + Bonus items ( 100 points)

Total score = ( control items + scoring items + bonus

items ) / 10. The full score is 110 points .

#### Administrative Rules of Green Building Label

**Star Rating** 







Three-star ≥85 points

Two-star ≥70 points



#### Authorities in Charge

**Three-star** green building to be certified by Ministry of Housing and Urban-Rural Development **Two- star** green building to be certified by Provincial housing and urban-rural development departments **One-star** green building to be certified by Municipal and prefecture-level housing and urban-rural development departments

# 2.3 Technology Paths for Building Energy Saving and Carbon Reduction

1. Energy Efficient	2. Energy - saving	3. Highly Efficient equipment system	4. Renewable	5. Energy
Building Design	measures for building		energy	transition
<ul> <li>✓ Optimize building spacial layout;</li> <li>✓ Optimize building shape design;</li> <li>✓ Enhance natural ventilation in summer;</li> <li>✓ Increased sunlight in winter;</li> <li>✓ Use shape to create sunshade;</li> <li>✓ Avoid the influence of cold wind;</li> <li>✓ Reduce heat island effect;</li> <li>✓</li> </ul>	<ul> <li>✓ High performance insulation system;</li> <li>✓ High-performance door and window systems;</li> <li>✓ Effective sunshade design;</li> <li>✓ Building airtightness design;</li> <li>✓ Thermal bridge-free structural design;</li> <li>✓</li> </ul>	<ul> <li>✓ High-efficiency air conditioning system;</li> <li>✓ Highly efficient heat recovery ventilation system;</li> <li>✓ Highly efficient machinery room;</li> <li>✓ Smart lighting system;</li> <li>✓ Energy-efficient elevators;</li> <li>✓</li> </ul>	<ul> <li>✓ Optoelectronic systems;</li> <li>✓ Photothermal system;</li> <li>✓ Air source;</li> <li>✓ Shallow soil sources;</li> <li>✓ Deep soil sources;</li> <li>✓ Deep soil sources;</li> <li>✓ Wind energy;</li> <li>✓ Biomass energy;</li> <li>✓ Waste incineration;</li> <li>✓ Residual heat / waste heat;</li> <li>✓</li> </ul>	<ul> <li>✓ Building electrification;</li> <li>✓ Multi-energy complementary system;</li> <li>✓ Energy storage technology;</li> <li>✓ Light storage direct and flexible technology;</li> <li>✓ RV coupling technology ;</li> <li>✓ Green electricity + carbon trading;</li> <li>✓</li> </ul>

Learning from the PRC's Clean Energy Innovations

# 2.4 Low-carbon / zero-carbon building technology path



# 2.5 Technical measures for energy conservation and carbon reduction in buildings in different climate zones

Project		Severely cold areas	Cold Regions	Hot summer and cold winter areas	Hot summer and warm winter areas	Temperate areas
Design principles		Winter insulation requirements must be fully met, and summer heat protection generally need not be considered.	It should meet winter insulation requirements, and in some areas, it should also take summer heat protection into consideration.	Summer heat protection requirements must be met, while winter insulation must be appropriately considered.	Summer heat protection requirements must be fully met, and winter insulation generally need not be considered.	Some areas should consider winter insulation, but generally do not need to consider summer heat protection.
Design Standards		Energy-saving design standard for residential buildings in severe cold and cold regions		Energy-saving design standard for residential buildings in hot summer and cold winter areas	Energy-saving design standard for residential buildings in hot summer and warm winter areas	Energy-saving design standards for residential buildings in temperate regions
Heat transfer coefficient W/(m <sup>2</sup> ·K)	Extern al Wall	0.25-0.6	0.45-0.7	0.8-1.5	0.7-2.5	0.8-2.0
	Roofin g	0.2-0.4	0.35-0.45	0.5-1.0	0.4-0.9	0.5-1.0
	Extern al windo ws	1.5-2.5	1.8-3.1	2.3-4.7	2.5-6	2.5-3.8
External window shading coefficient			≤0.45	Summer ≤ 0.45 Winter ≥ 0.6	≤0.9	Summer ≤ 0.4 Winter ≥ 0.5

The climate in China's hot-summer and warm-winter regions is similar to that in parts of Southeast Asia (high temperature, heavy rainfall, and monsoon-dominated). Therefore, China's experience in energy-saving design of residential buildings in these regions can be replicated to ADB DMCs in East Asia and South Asia.

By the end of 2023,

The total floor area of green building in cities and towns across the country is about 11.463 billion square meters ;

The number of projects that have obtained green building labels has reached more than 25,000 ;

The cumulative floor area of energy-saving buildings has reached approximately 32.68 billion square meters, accounting for 64.5% of the existing urban building area.

In 2023

230 million square meters of existing public and residential buildings have undergone energy efficiency renovation.

Approximately 8.4131 million square meters of ultra-low energy consumption and nearzero energy consumption new buildings started construction



Learning from the PRC's Clean Energy Innovations





Learning from the PRC's Clean Energy Innovations



#### **Shenzhen Xiangrui Jinmao Mansion**

#### Technology Highlight 1: Energy Saving and Carbon Reduction

High-performance building envelope, efficient air conditioning system, efficient lighting and other measures are adopted to comprehensively reduce the building's carbon emissions. The average annual carbon emission is 39.30 kgCO  $_2/(m^2 \cdot a)$ .

#### Technology Highlight 2 - Landscape Microclimate

By making full use of landscape microclimate technology and optimizing the design of ventilation, shade and plants, the actual summer perceived temperature is 1~3 °C lower than that of surrounding venues, which is conducive to expanding outdoor leisure time.

#### Highlight Technology 3 - Intelligent Operation

The entrances and garages of the residential area are equipped with facial recognition systems, which allow automatic entry into the residential area and buildings, and the intelligent elevator call system allows users to directly reserve the home floor. Lighting, curtains, fresh air, background music, security, door locks, WiFi , etc. can all be remotely monitored and controlled through the mobile phone APP.

The total investment of the project is 300 million yuan, the initial investment cost increased by 12.8444 million yuan to achieve green building, the incremental cost per unit area is 90.66 yuan. The green building can save 6.0876 million yuan in operating expenses per year.



**Project picture** 



**Basement lighting well** 



Fall protection buffer zone with landscape



Sunken Courtyard

#### Nearly Zero Energy Demonstration Building of China Academy of Building Research

- 4 floors above ground and a construction area of 4025 <sup>m2</sup>. It was put into use on July 11, 2014 and is mainly used for office and meeting.
- Adhering to the principle of " passive priority, active optimization, economy and practicality ", we focus on taking measures in terms of building design, envelope structure, energy system, renewable energy utilization, efficient lighting, energy management and building automation, indoor air quality, and mechanical and electrical system debugging.

#### 2015~2021

- Average annual power consumption 143,773.1 kWh
- Electricity consumption per unit building area 35.7 kWh/(m<sup>2</sup>·a)
- The HVAC system consumes 16.8 kWh/(m<sup>2</sup>·a), accounting for 48% of the total energy consumption.
- □ The lighting system consumes 5.9 kWh/( $m^2 \cdot a$ ), accounting for 17% of the total energy consumption.
- □ The socket system consumes 10.79 kWh/(m<sup>2</sup>·a), accounting for 30% of the total energy consumption
- Other power systems consume 2.26 kWh/(m<sup>2</sup>⋅a) , accounting for 5% of the total energy consumption
- Annual energy saving: approx. 330,100 kWh





Historical data of electricity consumption

#### Xiong'an High-speed Railway Station

- **C**onstruction in 2020
- Design Institute: China Architecture Design & Research Group Co., Ltd.
- Total construction area: 475,000 m<sup>2</sup> Green building star rating: three stars
- Photovoltaic area: 35,000 m<sup>2</sup>
- 35,000m<sup>2</sup> photovoltaic system installed on the roof
- 5.8 million kWh of clean electricity provided to Xiongan High-speed Railway Station every year, accounting for 12.7% of total annual electricity consumption
- Reduce coal consumption by 1,800 tons and reduce carbon dioxide emissions by 4,500 tons



#### **Bo'ao Near-Zero Carbon Demonstration Zone**

"Region of near-zero carbon, resource recycling, natural environment, and smart operation"

4 major construction concepts,

8 types of low-carbon technology integration



Concept	Eight categories	18 implementation projects		
environment nature	1. Garden landscape Ecological transformation	Project 01 : Dongyu Island Ecological Coastline Reconstruction and Restoration Project		
		Project 02 : Ecological restoration and function improvement project of forest land on the island		
		Project 03 : Yuanyang Avenue Landscape Improvement and Function Improvement Project		
area Zero Carbon	2. Green transformation of buildings	Project 04 : Boao Forum for Asia Conference Center and Hotel Renovation Project		
		Project 05 : Dongyu Island Hotel Renovation Project		
		Project 06 : News Center Renovation Project		
	3. Utilization of renewable energy	Project 07 : Integrated construction project of distributed photovoltaic systems for buildings and structures		
		Project 08 : Agricultural and photovoltaic complementary organic fruit and vegetable supply base project		
	4. New power system	Project 18 : Dongyu Island Zero-Carbon New Power System Demonstration Project		
	5. Greening of transportation	Project 09 : Green transportation site construction project on the island		
		Project 10 : Off-island green transportation transfer station construction project		
		Project 11 : Transportation supporting facilities and equipment construction project		
	6. Solid waste resource treatment	Project 12 : Waste collection and transportation facility renovation project		
resource cycle		Project 13 : Material recycling and processing facility construction project		
	7. Water recycling	Project 14 : High-quality water supply improvement project		
		Project 15 : Outdoor rainwater utilization and sponge transformation project		
wisdom		Project 16 : CIM+ Visualized Zero Carbon Management System		
operations	8. Intelligent operation	Project 17 : Carbon Monitoring Terminal Equipment Construction Project		

#### Building Renovation Projects

#### Two Five-star conference hotels, one media center

#### Project Features

- ✓ Demonstration of Zero-Carbon/Low-Carbon Retrofit Technologies for Existing Buildings in Hot Summer and Warm Winter Areas
- Application Scheme for High-Efficiency Chiller Room Retrofit in Buildings within an Extremely Short Construction Period (3 Months)
- Demonstration of Full Electrification Application in Five-Star Hotel Buildings

#### Main technical measures

- Natural ventilation and natural lighting
- Improved thermal insulation performance of roofs and curtain walls
- ✓ Sunshade, green plant system shading
- High-efficiency refrigeration room

#### End result after renovation

- Air source heat pump for domestic hot water
- Efficient lighting + intelligent lighting control
- Roof, ground, sunshade
- Fully electric cooking
- ✓ After the renovation, the carbon emissions of the two hotels decreased by 28%, and those of the news center dropped by 100%.
- ✓ The hotel buildings have reached the low-carbon building standard, while the media center has achieved the zero-carbon building level.
- ✓ The entire island has achieved 100% electrification of building energy use.





On March 18, 2024, the Bo'ao Near-Zero Carbon Demonstration Zone officially entered its operational phase.

	Electricity ( excluding PV ) 10,000 kWh	Gas 10,000 m <sup>3</sup>	Diesel fuel ton	PV power generation ( on the island + outside the island ) 10,000 kWh	Net carbon emissions tCO <sub>2</sub>
2019	1910	65	39	0	11350
2024	1653	0	0	3154	0
Decline	Down 13%	100% decrease	100% decrease	-	100% decrease

31.54 million kWh of PV power, of which 16.54 million kWh was supplied to the island and 15 million kWh was transmitted to the municipal power grid.



INTERNAL. This information is accessible to ADB Management and Staff. It may be shared outside ADB with appropriate permission.



After over 40 years of development in building energy conservation in the PRC, we have gained a wealth of experience and lessons. We are willing to share them with the world and work together to promote global ecological civilization.

Learning from the PRC's Clean Energy Innovations







# Thank you!



