



CHINA's 21ST CENTURY TRAJECTORY:

**A COMPREHENSIVE ANALYSIS
OF SUPPLY CHAINS, SCIENCE &
TECHNOLOGY, GREEN ENERGY,
DECARBONIZATION, AND FOOD &
WATER SECURITY**

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AUTHOR'S BACKGROUND

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Prof. WONG (Eric) has served on more than 3,000 top-tier International Conference Chairs, Scientific/Publicity Chairs & Program/Technical Committees. Since 2005, he has actively participated in 55 International Journals as Editor-in-Chief, Associate Editor, & Member of the Journal Editorial Board Committee. He is currently a Fellow, Professional & Individual member of 12 Internationally renowned Professional Organizations (IEEE, ACM, AAAI, IIBA, ISACA, AIP, BCS, IOA, ACL, CAIAC, AAIA & ICAIL).

During his career, he has held the titles of Honorary Professor, Distinguished Professor, Adjunct Professor, Visiting Professor & Honorary Research Fellow at 15 different universities & institutions. From 1996 to present, he has published more than 310 e-book titles (e-Print [PDF], self-authored^{+Ai}) and over 190 peer-reviewed articles & research papers in top-tier academic journals, conference proceedings, and online R&D outlets. Many of his research papers have appeared in world-renowned journals such as Scientific Reports, Springer Nature & IEEE. Additionally, he has served as a UNICEF (UN) Volunteer since 2018. He has supervised/co-supervised over 100 PhD/Master students.



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PREFACE AND INTRODUCTION

Detailed Information

This book examines China's multifaceted transformation trajectory across five interconnected domains: supply chain repositioning, science and technology innovation, green energy transition, decarbonization pathways, and food-water security. The analysis spans from the reform era through projected trajectories to 2030 and beyond.

China's evolution from the "World Factory" to what analysts now term a "global innovation hub" represents one of the most significant economic transformations of the 21st century. The "next new three" sectors—artificial intelligence, robotics, and innovative medicines—are emerging as new drivers of China's foreign trade, following the earlier "new three" of electric vehicles, lithium batteries, and solar cells. This progression reflects a systemic leap in indigenous innovation capacity, with China's foreign trade reaching historic highs propelled by these emerging sectors.

The conceptual framework guiding this analysis incorporates three pillars: supply chain resilience, technological sovereignty, and ecological security. These frameworks are examined through the lens of the "Dual Circulation" paradigm, which emphasizes domestic economic circulation as the foundation while maintaining international integration as a complementary force.

Table 0.1: China's Export Evolution Timeline

Era	Representative Products	Strategic Focus	Global Position
1990s-2000s	Clothing, Furniture, Appliances ("Old Three")	Labor-intensive manufacturing	World's Factory
2010s-2020s	EVs, Lithium Batteries, Solar Cells ("New Three")	Technology-intensive manufacturing	Manufacturing Powerhouse
2020s-2030s	AI, Robotics, Innovative Drugs ("New New Three")	Innovation-driven systems	Global Innovation Source

CHAPTER 1: CHINA'S STRATEGIC POSITIONING IN THE 21ST CENTURY

Detailed Information

1.1 From "World Factory" to Global Innovation Hub: The Arc of Transformation

China's transformation trajectory has followed a distinctive pattern of industrial upgrading. The "old three" exports of clothing, furniture, and home appliances established China's reputation as the world's factory. The subsequent "new three"—electric vehicles, lithium-ion batteries, and solar cells—reshaped global perceptions of Chinese manufacturing from cost-competitive production to technology-enabled solutions.

The current phase, characterized by the "new new three" of AI, robotics, and innovative medicines, represents China's transition from a global manufacturing hub to a global source of innovation. This evolution reflects structural advantages including the fusion of innovation with manufacturing, what analysts term "process knowledge"—the tacit, experiential know-how that accumulates on factory floors and in supply chain coordination.

1.2 The "Dual Circulation" Paradigm

The Dual Circulation development paradigm represents China's strategic response to changing global economic conditions. Research utilizing inter-country input-output models demonstrates that China has become an economy dominated by domestic economic circulation, with international circulation via foreign direct investment requiring further improvement.

Domestic circulation serves as the primary contributor to employment, with the contribution of international circulation to employment showing variation across different value chain routes—traditional trade value chains, trade-related, FDI-related, and mixed GVCs. The symbiotic interaction between domestic and international circulations operates through multiple mechanisms including international trade, international investment, and technological exchange.

Table 1.1: Dual Circulation Framework Components

Circulation Type	Primary Functions	Key Mechanisms	Policy Priorities
Domestic	Foundation and stabilizer	Production-distribution-circulation-consumption cycle	Demand expansion, supply-side reform
International	Momentum and support	Trade, investment, technology exchange	High-level opening, GVC upgrading
Interaction	Synergistic development	Resource allocation optimization	Institutional coordination

1.3 Key Conceptual Frameworks

Three interconnected frameworks guide this analysis:

- **Supply Chain Resilience:** Moving beyond cost-efficiency optimization to incorporate security-first logic, emphasizing diversification, redundancy, and strategic autonomy in critical sectors.
- **Technological Sovereignty:** The capacity for independent innovation in foundational technologies, supported by the new national system for mobilizing resources and achieving breakthroughs in core technologies.
- **Ecological Security:** Integrating environmental sustainability with economic development through the "Lucid Waters and Lush Mountains" philosophy, recognizing that ecological protection and economic prosperity are mutually reinforcing.

1.4 Methodology and Data Sources

This analysis draws upon multiple data sources including:

- National Bureau of Statistics of China
- Ministry of Industry and Information Technology
- National Energy Administration
- Ministry of Agriculture and Rural Affairs
- Ministry of Water Resources
- International organizations (World Bank, IEA, FAO)
- Peer-reviewed academic research

1.5 Structure and Scope

The book is organized into six parts spanning 28 chapters, with five appendices providing supplementary data and analysis.

PART I: SUPPLY CHAIN TRANSFORMATION AND GLOBAL VALUE CHAIN REPOSITIONING

CHAPTER 2: THE EVOLUTION OF CHINA'S SUPPLY CHAIN ARCHITECTURE

Detailed Information

2.1 Historical Phases

China's supply chain development has progressed through distinct phases:

- Reform Era (1978-2001): Gradual opening, initial industrialization
- WTO Accession Period (2001-2008): Rapid integration into global value chains
- Post-2008 Rebalancing (2008-2020): Moving up value chains, domestic market development
- Strategic Autonomy Era (2020-present): Security-first logic, technological self-reliance

2.2 The "World's Factory" Model

China's manufacturing dominance rests on several structural foundations. The country has maintained its position as the world's largest manufacturing nation for 15 consecutive years, with an annual contribution to global economic growth averaging around 30%. This position is supported by what researchers term "process knowledge"—the accumulated tacit expertise that enables rapid translation of design into production.

2.3 Post-2008 Rebalancing

The rebalancing strategy has emphasized moving from low-value-added assembly to higher-value activities including design, branding, and technology development. This shift is evidenced by the evolution of export composition from labor-intensive to technology-intensive products.

2.4 The Complete Industrial System

China possesses a unique advantage as the only nation with all industrial classifications in the UN system. This comprehensive industrial ecosystem creates compounding effects, where advances in one domain generate spillover benefits in others.

Table 2.1: China's Industrial System Classification

Category	Number of Sub-categories	Key Sectors	Global Position
Mining	7	Coal, Metals, Non-metals	Top 3
Manufacturing	31	Electronics, Machinery, Chemicals	#1
Utilities	3	Electricity, Gas, Water	Top 2

CHAPTER 3: GLOBAL VALUE CHAIN PARTICIPATION AND UPGRADING

Detailed Information

3.1 Theoretical Framework

GVC participation is measured through multiple metrics including:

- GVC Position Index: Ratio of indirect value-added exports to foreign value-added in exports
- Value Chain Participation Rate: Sum of forward and backward participation
- Domestic Value-Added Ratio: Share of domestic content in gross exports

Research demonstrates that international trade facilitates symbiotic interaction between domestic and international circulations by integrating commodity and factor markets. A sound domestic economic circulation nurtures comparative advantages in exports, thereby optimizing international economic circulation.

3.2 Sectoral Analysis

Key sectors demonstrating significant GVC upgrading include:

- **Equipment Manufacturing:** Transition from importing core components to developing indigenous capabilities in high-end equipment.
- **Electronics:** Evolution from assembly to design and manufacturing of advanced semiconductors, displays, and communication equipment.
- **Transportation:** Development of complete electric vehicle supply chains, from battery cells to finished vehicles.

3.3 The "Low-End Lock-In" Challenge

Despite significant progress, challenges persist in:

- Core components (advanced semiconductors, precision instruments)
- Critical materials (rare earth processing, specialty chemicals)
- Standard-setting and brand development

3.4 Production Network Embeddedness

China's embeddedness in global production networks creates nonlinear effects. While deep integration provides access to knowledge and markets, it also creates dependencies that can be weaponized during geopolitical tensions.

3.5 Digital Empowerment

Digitalization is reshaping manufacturing value chains through:

- Industrial internet platforms
- Smart manufacturing systems
- Digital twin technology
- AI-enabled supply chain optimization

Table 3.1: GVC Participation Metrics by Sector (2020-2024)

Sector	Forward Participation	Backward Participation	Position Index	Trend
Electronics	18.5%	22.3%	0.83	Upgrading
Machinery	15.2%	12.8%	1.19	Upgrading
Textiles	8.5%	15.6%	0.54	Stable
Automotive	12.3%	18.9%	0.65	Upgrading

CHAPTER 4: SUPPLY CHAIN RESILIENCE AND SECURITY

Detailed Information

4.1 Conceptualizing Resilience

The shift from cost-efficiency to security-first logic represents a fundamental reorientation of supply chain strategy. Key dimensions include:

- Diversification: Reducing single-source dependencies
- Redundancy: Maintaining buffer capacity
- Flexibility: Rapid reconfiguration capability
- Visibility: End-to-end supply chain monitoring

4.2 Critical Mineral Supply Chains

China's position in critical minerals reflects both strengths and vulnerabilities:

- **Rare Earths:** China dominates processing and separation, with significant market share in downstream applications.
- **Lithium:** While Australia leads in mining, China dominates refining and battery production.
- **Other Strategic Materials:** Graphite, cobalt, and specialty metals present varying dependency profiles.

4.3 Semiconductor Supply Chains

The semiconductor sector exemplifies supply chain chokepoints, with China pursuing breakthrough strategies through:

- Domestic design capability development
- Manufacturing process advancement
- Equipment and materials localization
- Alternative technology pathways

4.4 "Belt and Road" Initiative

The BRI serves as a supply chain diversification mechanism through:

- Infrastructure connectivity
- Trade corridor development
- Industrial capacity cooperation
- Resource access enhancement

4.5 The Four-Pillar Strategy

China's supply chain security strategy rests on four pillars:

1. Foundation Strengthening: Enhancing domestic industrial base
2. Technological Self-Reliance: Reducing external technology dependencies
3. Chain Leapfrogging: Moving to higher-value positions
4. Digital-Intelligent Enhancement: Leveraging digital technologies

Table 4.1: Critical Mineral Dependencies and Strategies

Mineral	Import Dependency	Primary Sources	Strategic Response
Lithium	70%	Australia, Chile	Overseas equity, recycling
Cobalt	95%	DRC	Diversification, substitution
Rare Earths	Net exporter	Domestic	Processing dominance
Graphite	60%	Mozambique, Madagascar	Synthetic alternatives

CHAPTER 5: "NEW THREE" EXPORTS AND EMERGING SUPPLY CHAIN DYNAMICS

Detailed Information

5.1 The New Export Trinity

The "new three" exports of electric vehicles, lithium batteries, and solar cells have become emblematic of China's manufacturing upgrading. In the first half of 2026, exports of lithium batteries and wind turbines rose 37.6% and 35.6% respectively, while exports of electric vehicles increased by 31.5%.

5.2 Cross-Border E-Commerce

Digital trade infrastructure has expanded rapidly, with cross-border e-commerce platforms enabling direct access to global consumers. This channel has become particularly important for small and medium-sized enterprises.

5.3 New Quality Productive Forces

The concept of "new quality productive forces" encompasses:

- Innovation-driven development
- Digital-intelligent transformation
- Green and low-carbon transition
- High-end manufacturing

5.4 The "Involution" Problem

Intensified domestic competition ("involution") presents challenges including:

- Price wars eroding profitability
- Resource misallocation
- Innovation crowding out
- International trade tensions

Table 5.1: "New Three" Export Performance (H1 2026)

Product Category	Export Growth	Key Markets	Competitive Position
Lithium Batteries	+37.6%	EU, US, ASEAN	Global Leader
Wind Turbines	+35.6%	Asia, Europe	Top 3
Electric Vehicles	+31.5%	Europe, Southeast Asia	Global Leader
Electric Motorcycles	+68.7%	Southeast Asia, Africa	Dominant

PART II: SCIENCE AND TECHNOLOGY INNOVATION

CHAPTER 6: THE ARCHITECTURE OF CHINA'S INNOVATION SYSTEM

Detailed Information

6.1 National Strategy for Science and Technology Self-Reliance

The 15th Five-Year Plan (2026-2030) represents a critical stage for China's transformation into a leading science and technology nation. Vice Premier Ding Xuexiang emphasized the importance of basic research in generating original and disruptive scientific breakthroughs, calling for leveraging the new national system to mobilize resources for high-level scientific and technological self-reliance.

Key priorities include:

- Basic research enhancement
- Fundamental technology breakthroughs
- Integration of innovation supply with industrial demand
- Coordinated development of education, science, technology, and talent

6.2 Major Scientific Infrastructure

China has developed over 70 large-scale research facilities, including:

- Synchrotron light sources
- Supercomputing centers
- Neutron sources
- Free-electron lasers
- Space-based observatories

6.3 National Laboratories and Strategic Forces

The national laboratory system has been restructured to focus on:

- Strategic emerging technologies
- National security applications
- Breakthrough innovations
- Talent cultivation

6.4 Enterprise Innovation

Chinese enterprises have evolved from technology followers to leaders in several domains. The innovation ecosystem is characterized by overlapping, cross-pollinating sectors where advances in one domain generate spillover benefits in others.

Table 6.1: China's R&D Investment Trends

Year	R&D Expenditure (billion yuan)	% of GDP	Basic Research Share
2020	2,439	2.40%	6.0%
2022	3,079	2.54%	6.3%
2024	3,600+	2.68%	6.5%
2026 (est.)	4,100+	2.80%	7.0%

CHAPTER 7: BREAKTHROUGH TECHNOLOGIES AND FRONTIER DOMAINS

Detailed Information

7.1 Nuclear Fusion

The "Kuaifu" project and "Artificial Sun" research represent China's ambitious fusion energy program. The EAST tokamak has achieved significant milestones in plasma confinement and duration.

7.2 Quantum Computing

China's quantum program includes:

- Jiuzhang photonic quantum computer prototypes
- Quantum communication networks
- Quantum key distribution systems
- Quantum sensing applications

7.3 Deep Space Exploration

Major programs include:

- Chang'e Lunar Missions: Sample return, far-side exploration
- Tianwen Mars Program: Orbiter, lander, rover missions
- Future asteroid and Jupiter exploration

7.4 Brain-Computer Interfaces

Neural technology research encompasses:

- Invasive and non-invasive BCIs
- Neural signal processing
- Prosthetic control systems
- Cognitive enhancement research

7.5 6G and Advanced Communications

China is pursuing leadership in:

- 6G standardization
- Terahertz communications
- Satellite internet constellations
- Integrated space-terrestrial networks

Table 7.1: Frontier Technology Development Status

Domain	Key Achievement	Global Position	Timeline
Nuclear Fusion	403-second H-mode	Top 3	2030s demo
Quantum Computing	76-photon Jiuzhang	Top 2	Ongoing
Lunar Exploration	Sample return	Top 2	Completed
6G	Standard proposals	Leading	2030 deployment

CHAPTER 8: SEMICONDUCTOR AND INTEGRATED CIRCUIT DEVELOPMENT

Detailed Information

8.1 Supply Chain Vulnerabilities

The semiconductor supply chain exhibits multiple chokepoints:

- Advanced lithography equipment
- Electronic design automation tools
- High-purity materials
- Advanced packaging technologies

8.2 Domestic Capabilities

China's semiconductor industry has developed capabilities in:

- Chip design (mobile processors, AI accelerators)
- Mature node manufacturing
- Packaging and testing
- Specialty processes

8.3 Materials and Equipment

Progress in:

- Silicon wafer production
- Photoresist development
- Etching and deposition equipment
- Metrology tools

8.4 Industry-University-Research Collaboration

Collaborative mechanisms include:

- Joint laboratories
- Technology transfer programs
- Talent development pipelines
- Shared infrastructure

CHAPTER 9: ARTIFICIAL INTELLIGENCE AND DIGITAL TECHNOLOGIES

Detailed Information

9.1 Large Language Models

China's AI development has accelerated significantly. From July 13-19, 2026, weekly usage of Chinese large models on the OpenRouter platform reached 36.11 trillion tokens—a 30.93% increase—securing the top global spot for 12 consecutive weeks.

9.2 AI Applications

Key application domains include:

- Manufacturing optimization
- Medical image analysis
- Content creation
- Coding assistance
- Customer service

Chinese AI technologies are helping small and medium-sized enterprises in Southeast Asia achieve intelligent transformation, boosting local e-commerce and logistics efficiency.

9.3 Computing Infrastructure

AI development requires substantial computing resources:

- Data centers
- Intelligent computing networks
- Specialized AI chips
- Optical communication networks

Special optical fibers used for AI intelligent computing centers are currently in short supply due to explosive growth of data centers.

9.4 AI Governance

China has developed governance frameworks addressing:

- Algorithm transparency
- Data privacy
- AI safety
- Ethical guidelines

Table 9.1: AI Development Indicators

Indicator	2024	2026	Trend
AI Enterprises	4,500+	5,000+	Growing
Large Model Parameters	100B+	1T+	Scaling
AI Patent Applications	Global #1	Global #1	Leading
Industry Applications	50+	100+	Expanding

CHAPTER 10: FUTURE INDUSTRIES AND NEW QUALITY PRODUCTIVE FORCES

Detailed Information

10.1 Defining Future Industries

Future industries encompass:

- Biotechnology and synthetic biology
- Hydrogen energy and fuel cells
- Humanoid robots and embodied intelligence
- Quantum technologies
- Advanced materials

10.2 Biotechnology

Synthetic biology applications include:

- Pharmaceutical production
- Biomaterials
- Agricultural enhancement
- Environmental remediation

10.3 Hydrogen Energy

Development focuses on:

- Green hydrogen production
- Fuel cell technology
- Storage and transport
- Industrial applications

10.4 Humanoid Robots

China's robotics industry has become a global front-runner. In the first half of 2026, cumulative exports of various robots reached 12.947 million units, with total export value of 24.85 billion yuan, reaching more than 160 countries and regions.

Chinese robots are deployed in over 40,000 hotels, more than 200 medical institutions, and numerous factories across over 20 countries.

10.5 "Six Directions" Framework

The industrial system construction framework includes:

1. Intelligent manufacturing
2. Green manufacturing
3. Service-oriented manufacturing
4. Quality manufacturing
5. Digital manufacturing
6. Innovative manufacturing

PART III: GREEN ENERGY TRANSITION AND DECARBONIZATION

CHAPTER 11: THE RENEWABLE ENERGY REVOLUTION

Detailed Information

11.1 Trajectory: From Follower to Leader

China's renewable energy development has undergone remarkable transformation. By the end of 2024, China's cumulative installed capacity reached approximately 3.35 billion kilowatts, with solar and wind power exceeding 1.4 billion kilowatts combined.

11.2 Wind Power

Wind power development has accelerated dramatically:

- 2014: 0.96 GW
- 2024: 520 GW (cumulative grid-connected capacity)
- Annual additions in 2024: 79.82 GW

11.3 Solar PV

Solar PV has experienced explosive growth:

- 2024 new installations: 278 GW
- Cumulative capacity: 890 GW
- Year-over-year growth: 45.2%

11.4 Complete Industrial Chain

China dominates global clean energy manufacturing:

- Over 90% of global solar manufacturing capacity
- 83% of battery production capacity
- Nearly three-quarters of wind technology manufacturing

11.5 Grid Integration Challenges

Despite manufacturing dominance, challenges include:

- Grid integration and consumption
- Storage requirements
- Transmission infrastructure
- Market mechanisms

Table 11.1: Renewable Energy Capacity Growth

Year	Wind (GW)	Solar (GW)	Total Renewable (GW)
2020	281	253	934
2022	395	393	1,213
2024	521	887	1,889

CHAPTER 12: THE NEW POWER SYSTEM

Detailed Information

12.1 Planning Framework

The "Fifteen-Five" Plan for New Power System Construction provides a comprehensive framework for transforming China's electricity system. The plan addresses the need for new energy sources to transition from "following grid operation" to "actively supporting the grid".

12.2 Non-Fossil Generation Targets

Target: 50% non-fossil electricity generation by 2030

12.3 Grid Modernization

Key initiatives include:

- Ultra-high voltage transmission
- Smart grid technologies
- Distributed energy resources integration
- Digital-intelligent infrastructure

12.4 Energy Storage

Storage development encompasses:

- Pumped hydro storage
- Battery storage systems
- Virtual power plants
- Hydrogen storage

12.5 Demand-Side Management

Load flexibility mechanisms include:

- Time-of-use pricing
- Demand response programs
- Industrial load management
- Electric vehicle smart charging

Table 12.1: Power System Transformation Indicators

Indicator	2024	2030 Target
Non-Fossil Share	~35%	50%
UHV Lines (km)	40,000+	60,000+
Storage Capacity	50 GW	200 GW
Smart Meters	500M+	600M+

CHAPTER 13: COAL TRANSITION AND CLEAN UTILIZATION

Detailed Information

13.1 The "Pillar" Role of Coal

Coal continues to play a stabilizing role in China's energy security, providing baseload power while renewable capacity expands.

13.2 Ultra-Low Emission Retrofits

China leads globally in clean coal technology:

- Ultra-low emission retrofits completed at most coal plants
- Significant reductions in SO₂, NO_x, and particulate emissions
- Efficiency improvements through supercritical and ultra-supercritical technologies

13.3 Retirements and Stranded Assets

Coal plant retirement planning must balance:

- Energy security requirements
- Just transition considerations
- Stranded asset management
- Regional economic impacts

13.4 CCUS Development

Carbon capture, utilization, and storage projects include:

- Power sector demonstrations
- Industrial applications
- Enhanced oil recovery
- Storage site characterization

13.5 Just Transition

Considerations for coal-dependent regions:

- Employment transition programs
- Economic diversification
- Social safety nets
- Community development

CHAPTER 14: CARBON PEAKING AND CARBON NEUTRALITY

Detailed Information

14.1 Policy Framework

China has established the "1+N" policy framework for carbon peaking and neutrality—the most systematic and comprehensive carbon reduction policy framework globally. The framework includes:

"1": Guiding principles and top-level design

- Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality
- Action Plan for Carbon Dioxide Peaking Before 2030

"N": Action plans for key sectors and industries

- Energy, industry, transport, urban-rural development
- Coal, oil, natural gas, steel, non-ferrous metals
- Petrochemical, chemical, building materials

14.2 Carbon Intensity Targets

Target: 17% reduction in carbon intensity by 2030 (from 2020 levels)

14.3 Emissions Trading System

The national ETS has expanded to cover:

- Power generation
- Industrial sectors
- Emissions monitoring and reporting
- Allowance allocation mechanisms

14.4 Industrial Decarbonization

Key sectors:

- Steel: Electric arc furnace transition, hydrogen-based reduction
- Cement: Alternative materials, carbon capture
- Chemicals: Process optimization, feedstock transition

14.5 The 2025 Turning Point

2025 is projected as the year of structural fossil fuel replacement, marking a significant milestone in China's energy transition.

Table 14.1: Carbon Peaking Action Plan - Ten Key Actions

Action Area	Key Measures	Target Year
Energy Transition	Renewable expansion, coal reduction	2030
Energy Efficiency	Industrial upgrading, building codes	Continuous
Industrial Peaking	Sector-specific plans	2025-2030
Urban-Rural	Green building, district heating	2030
Transport	EV adoption, public transit	2030
Circular Economy	Recycling, remanufacturing	Continuous
Technology Innovation	Green tech R&D	Continuous
Carbon Sinks	Afforestation, ecosystem restoration	Continuous
Green Lifestyle	Consumer awareness, behavior change	Continuous
Regional Pathways	Differentiated targets	2030

CHAPTER 15: GREEN TECHNOLOGY EXPORTS AND GLOBAL IMPACT

Detailed Information

15.1 Clean Technology Exports

China's green technology exports have surged significantly. In the first half of 2026, exports of lithium batteries and wind turbines rose 37.6% and 35.6% respectively, while exports of electric vehicles, electric locomotives, and electric motorcycles increased between 31.5% and 68.7%.

15.2 Southeast Asia as Strategic Market

Chinese companies' AI models are being used by overseas users for content creation, coding, and medical image analysis, while China's AI technologies are helping small and medium-sized enterprises in Southeast Asia achieve intelligent transformation.

15.3 Building Global Supply Chains

China's photovoltaic industry has dramatically lowered global clean energy costs, while its new energy vehicles transformed green mobility from a high-priced option for the few into a consumer product for the masses.

15.4 Climate Diplomacy

China's climate diplomacy emphasizes:

- South-South cooperation
- Technology transfer
- Capacity building
- Multilateral engagement

Table 15.1: Green Technology Export Performance (H1 2026)

Category	Export Growth	Key Destinations
Lithium Batteries	+37.6%	EU, US, ASEAN
Wind Turbines	+35.6%	Asia, Europe
Electric Vehicles	+31.5%	Europe, Southeast Asia
Electric Motorcycles	+68.7%	Southeast Asia, Africa
Industrial Robots	+45%+	Global

PART IV: FOOD SECURITY

CHAPTER 16: THE FOUNDATION OF CHINA'S FOOD SECURITY

Detailed Information

16.1 Historical Evolution

China has achieved a remarkable transformation in food security. The country now feeds nearly one-fifth of the world's population with only 9% of the world's arable land and 6% of its freshwater resources.

16.2 Grain Production

China's annual grain output has steadily remained above 650 million tonnes over the past five years. In 2024, grain output exceeded 700 million tonnes for the first time, with per capita grain possession reaching 500 kilograms.

16.3 Per Capita Availability

China's per capita grain availability of 500 kg exceeds the internationally recognized food security line of 400 kg per capita.

16.4 Structural Analysis

Production structure:

- Rice: Self-sufficient, major producing regions in South and Central China
- Wheat: Self-sufficient, primary production in North China Plain
- Corn: Increasingly important for feed, production in Northeast and North China
- Soybean: Significant import dependency, diversification strategies

Table 16.1: Grain Production by Crop (2024)

Crop	Production (million tonnes)	Self-Sufficiency	Import Dependency
Rice	210+	~100%	Minimal
Wheat	135+	~100%	Minimal
Corn	290+	~95%	Low
Soybean	20+	~15%	High

CHAPTER 17: THE "STORE GRAIN IN LAND, STORE GRAIN IN TECHNOLOGY" STRATEGY

Detailed Information

17.1 Arable Land Protection

China maintains a rigid policy of ensuring the total area of farmland does not fall below the red line of 1.8 billion mu (120 million hectares).

17.2 High-Standard Farmland

Over 66.7 million hectares of high-standard farmland have been built. Machinery penetration rate in agricultural production has surpassed 75%, 13 percentage points higher than 10 years ago.

17.3 Agricultural Science and Technology

The contribution rate of agricultural science and technology has steadily increased through:

- Improved seed varieties
- Precision agriculture
- Smart farming systems
- Integrated pest management

17.4 Seed Industry Self-Reliance

Germplasm resource development includes:

- National seed banks
- Breeding programs
- Biotechnology applications
- International cooperation

CHAPTER 18: BUILDING RESILIENCE IN FOOD SYSTEMS

Detailed Information

18.1 Climate Adaptation

Strategies include:

- Drought-resistant varieties
- Irrigation modernization
- Weather monitoring systems
- Early warning networks

18.2 Agricultural Insurance

Risk management mechanisms:

- Crop insurance programs
- Weather index insurance
- Disaster relief systems
- Income stabilization

18.3 Food Reserves

China maintains comprehensive reserves:

- Central grain reserves
- Local government reserves
- Enterprise reserves
- Emergency response protocols

China now ranks among nations with the most advanced grain storage technologies.

18.4 Reducing Loss and Waste

Initiatives across the supply chain:

- Improved harvesting techniques
- Better storage facilities
- Cold chain development
- Consumer awareness campaigns

CHAPTER 19: THE "BIG FOOD CONCEPT" AND DIVERSIFIED FOOD SUPPLY

Detailed Information

19.1 Beyond Grain

The "Big Food Concept" expands food security beyond traditional grains to include:

- Meat and poultry
- Aquatic products
- Dairy
- Fruits and vegetables
- Alternative proteins

19.2 Vertical Farming

Controlled environment agriculture includes:

- Hydroponic systems
- Vertical farms
- Greenhouse technology
- Precision environmental control

19.3 Synthetic Biology for Food

Emerging technologies:

- Artificial starch synthesis
- Cultured meat
- Fermentation-derived proteins
- Precision fermentation

19.4 International Trade

Import diversification strategies:

- Multiple sourcing regions
- Long-term contracts
- Overseas agricultural investment
- Trade agreement negotiations

Table 19.1: Food Supply Diversification Indicators

Category	Self-Sufficiency	Import Sources	Trend
Grains	>95%	Minimal	Stable
Soybeans	~15%	Brazil, US, Argentina	Diversifying
Meat	>90%	Limited	Stable
Aquatic	>90%	Limited	Growing

PART V: WATER SECURITY AND RIVER GOVERNANCE

CHAPTER 20: CHINA'S WATER RESOURCES CHALLENGE

Detailed Information

20.1 Fundamental Constraints

China possesses only 6% of global freshwater resources while supporting 20% of the world's population. This fundamental constraint shapes water policy and management approaches.

20.2 Spatial and Temporal Distribution

Water resources exhibit significant imbalance:

- Spatial: North China has limited water relative to population and economic activity
- Temporal: Monsoon patterns create seasonal variability
- Quality: Regional variations in water quality

20.3 Water-Energy-Food Nexus

Interconnected security challenges:

- Water for energy production
- Energy for water treatment and distribution
- Water for food production
- Competing demands

20.4 Climate Change Impacts

Climate change affects water availability through:

- Altered precipitation patterns
- Glacial retreat
- Extreme weather events
- Groundwater depletion

CHAPTER 21: THE SOUTH-NORTH WATER TRANSFER PROJECT

Detailed Information

21.1 National Strategic Infrastructure

The South-North Water Transfer Project represents the world's largest inter-basin water transfer scheme, designed to address China's fundamental north-south water imbalance.

21.2 Eastern and Central Routes

Water transfer achievements:

- 83 billion cubic meters transferred
- Eastern route: Yangtze to Shandong, Hebei, Tianjin
- Central route: Danjiangkou Reservoir to Beijing, Tianjin

21.3 Beneficiary Regions

The project benefits:

- 48 cities
- 195 million people
- Industrial, agricultural, and domestic water users

21.4 Ecological Restoration

Environmental benefits include:

- River replenishment
- Groundwater recovery
- Wetland restoration
- Ecosystem rehabilitation

Table 21.1: South-North Water Transfer Project Overview

Route	Length (km)	Annual Capacity (billion m ³)	Beneficiary Population
Eastern	1,467	14.8	100+ million
Central	1,432	13.0	95+ million
Total	2,899	27.8	195 million

CHAPTER 22: WATER CONSERVATION AND EFFICIENCY

Detailed Information

22.1 Water Conservation Priority

The "Water Conservation Priority" strategy emphasizes:

- Demand management
- Efficiency improvements
- Recycling and reuse
- Behavioral change

22.2 Agricultural Water Efficiency

Improvements in irrigation efficiency:

- Irrigation coefficient improved from 0.50 to 0.58
- Drip and sprinkler irrigation expansion
- Canal lining and modernization
- Water-saving varieties

22.3 Industrial Water Use

Decoupling water use from economic growth:

- Industrial water recycling
- Process optimization
- Cooling system improvements
- Water footprint management

22.4 Urban Water Management

Municipal water efficiency:

- Non-revenue water reduction
- Smart metering
- Leak detection
- Demand management

CHAPTER 23: RIVER BASIN GOVERNANCE AND ECOLOGICAL PROTECTION

Detailed Information

23.1 River Chief System

The "River Chief" system establishes accountability mechanisms:

- Multi-level governance structure
- Clear responsibility assignment
- Performance evaluation
- Public participation

23.2 Yangtze River Protection

Achievements include:

- Class II water quality for five consecutive years
- Pollution source control
- Ecological restoration
- Biodiversity protection

23.3 Yellow River Governance

The Yellow River has achieved:

- Three years of Class II water quality
- Soil and water conservation
- Flood control improvements
- Ecological water allocation

23.4 Urban Water Remediation

Over 3,000 urban black and odorous water bodies have been cleaned through:

- Source control
- Sewer network improvements
- Treatment plant upgrades
- Ecological restoration

23.5 "Lucid Waters and Lush Mountains" Philosophy

The philosophy that ecological protection and economic development are mutually reinforcing has been applied through:

- Eco-compensation mechanisms
- Green development pathways
- Environmental industry development
- Sustainable tourism

Table 23.1: Major River Basin Water Quality

River Basin	Water Quality	Trend	Key Achievements
Yangtze	Class II	Stable	5 consecutive years
Yellow	Class II	Improving	3 consecutive years
Pearl	Class II-III	Stable	Industrial upgrading
Huai	Class III-IV	Improving	Pollution control

CHAPTER 24: CHINA'S CONTRIBUTION TO GLOBAL WATER GOVERNANCE

Detailed Information

24.1 International Cooperation

China actively shares water management expertise through:

- Bilateral agreements
- Multilateral platforms
- Technical assistance
- Knowledge products

24.2 Training Programs

China has trained:

- 4,000 water professionals from 112 countries
- Capacity building in water management
- Technology transfer programs
- Academic exchange initiatives

24.3 Overseas Technology Transfer

Technology transfer centers established in:

- Pakistan
- Ethiopia
- Indonesia
- Serbia
- Senegal

24.4 "Systematic Governance" Approach

China promotes a systematic approach to water governance for Global South countries, emphasizing:

- Integrated water resources management
- Basin-level planning
- Stakeholder participation
- Technology adaptation

PART VI: SYNTHESIS AND FUTURE TRAJECTORIES

CHAPTER 25: INTERCONNECTIONS AND TRADE-OFFS

Detailed Information

25.1 The Water-Energy-Food-Environment Nexus

Interconnections among security domains:

- Energy production requires water
- Food production requires water and energy
- Environmental protection constrains all sectors
- Trade-offs require integrated planning

25.2 Supply Chain Security and Green Transition

Tensions between:

- Security-first logic and efficiency optimization
- Domestic production and international cooperation
- Short-term costs and long-term benefits

25.3 Technology Sovereignty vs. International Cooperation

Balancing:

- Indigenous innovation and global engagement
- Technology protection and knowledge sharing
- Competitive advantage and collaborative benefit

25.4 Urbanization, Industrialization, and Resources

Managing:

- Resource demands of urban growth
- Industrial transformation requirements
- Environmental constraints
- Social equity considerations

CHAPTER 26: SCENARIO ANALYSIS FOR 2030 AND BEYOND

Detailed Information

26.1 Optimistic Scenario

Successful structural transformation characterized by:

- Sustained innovation momentum
- Smooth green transition
- Resilient supply chains
- Enhanced food-water security

26.2 Baseline Scenario

Incremental progress with persistent challenges:

- Moderate growth in key sectors
- Gradual transition progress
- Manageable supply chain adjustments
- Stable security indicators

26.3 Stress Scenario

Geopolitical fragmentation and climate shocks:

- Supply chain disruptions
- Technology decoupling
- Climate-induced stresses
- Resource security pressures

26.4 Key Indicators and Early Warning Signals

Monitoring framework includes:

- Innovation metrics
- Trade indicators
- Energy transition progress
- Food and water security indices

Table 26.1: Scenario Comparison Matrix

Indicator	Optimistic	Baseline	Stress
GDP Growth	5%+	4-5%	3-4%
Non-Fossil Share	55%+	50%	45%
Food Self-Sufficiency	>95%	90-95%	85-90%
Tech Self-Reliance	High	Moderate	Constrained

CHAPTER 27: POLICY RECOMMENDATIONS AND STRATEGIC PRIORITIES

Detailed Information

27.1 Institutional Coordination

Recommendations for:

- Cross-sectoral coordination mechanisms
- Integrated planning processes
- Data sharing platforms
- Performance evaluation systems

27.2 International Cooperation

Strategies for:

- Multilateral engagement
- Bilateral partnerships
- Regional cooperation frameworks
- Global governance participation

27.3 Technology Commercialization

Approaches to:

- Accelerating deployment
- Scaling proven technologies
- Fostering innovation ecosystems
- Supporting entrepreneurship

27.4 Human Capital Development

Priorities for:

- STEM education
- Vocational training
- Talent attraction and retention
- Lifelong learning systems

27.5 Risk Assessment

Framework for:

- Systematic risk identification
- Scenario planning
- Adaptive management
- Early warning systems

CONCLUSION

CHAPTER 28: CHINA'S TRAJECTORY AND GLOBAL IMPLICATIONS

Detailed Information

28.1 Comprehensiveness of Transformation

China's transformation encompasses multiple dimensions:

- Economic: From low to high value-added
- Technological: From follower to leader
- Environmental: From pollution to protection
- Social: From poverty to moderate prosperity

28.2 Lessons for Developing Countries

Key lessons include:

- Importance of long-term planning
- Value of manufacturing capability
- Role of technology in development
- Balance of security and openness

28.3 Implications for Global Governance

China's trajectory affects:

- Global supply chains
- Technology standards
- Climate action
- Development cooperation

28.4 The Road Ahead

Challenges and opportunities:

- Managing great power competition
- Achieving carbon neutrality
- Ensuring resource security
- Maintaining growth momentum

APPENDICES

Appendix A: Key Statistical Indicators and Time Series Data

Table A.1: China's Economic Indicators (2000-2026)

Year	GDP (trillion yuan)	GDP Growth (%)	Per Capita GDP (USD)	Manufacturing Share (%)
2000	10.0	8.5	959	32.0
2005	18.7	11.3	1,753	32.4
2010	41.2	10.6	4,550	31.5
2015	68.9	6.9	8,016	29.3
2020	101.6	2.2	10,408	26.2
2024	134.9	5.0	12,600+	25.5
2026 (est.)	148+	4.5-5.0	13,500+	25.0

Table A.2: Trade Indicators

Year	Total Trade (trillion USD)	Exports	Imports	Trade Balance
2020	4.65	2.59	2.06	+0.53
2022	6.31	3.59	2.72	+0.87
2024	6.90	3.90	3.00	+0.90
2026 H1	3.72	2.10	1.62	+0.48

Table A.3: Energy Indicators

Year	Total Capacity (GW)	Renewable (GW)	Renewable Share (%)	Non-Fossil Share (%)
2020	2,200	934	42.5	33.0
2022	2,560	1,213	47.4	35.0
2024	3,350	1,889	56.4	38.0
2030 Target	-	-	-	50.0

Table A.4: Food Security Indicators

Year	Grain Output (million tonnes)	Per Capita (kg)	Self-Sufficiency (%)
2020	669	478	>95
2022	686	486	>95
2024	700+	500	>95

Appendix B: Policy Documents and Regulatory Frameworks

Table B.1: Key Policy Documents

Document	Issuing Body	Year	Focus
Made in China 2025	State Council	2015	Manufacturing upgrading
Working Guidance for Carbon Peaking	CPC Central Committee	2021	Carbon neutrality
Action Plan for Carbon Peaking Before 2030	State Council	2021	Carbon reduction
14th Five-Year Plan	NPC	2021	Comprehensive development
15th Five-Year Plan Recommendations	CPC Central Committee	2025	Strategic priorities

Table B.2: Regulatory Framework by Sector

Sector	Key Regulations	Implementing Agency
Supply Chains	Foreign Investment Law, Export Control Law	MOFCOM, NDRC
Technology	Science and Technology Progress Law	MOST
Energy	Renewable Energy Law, Energy Conservation Law	NEA
Environment	Environmental Protection Law	MEE
Food	Food Security Law	MARA
Water	Water Law, Yangtze Protection Law	MWR

Appendix C: Glossary of Terms and Concepts

Term	Definition
Dual Circulation	Development paradigm emphasizing domestic economic circulation as foundation with international circulation as complement
New Quality Productive Forces	Innovation-driven productivity encompassing digital-intelligent and green development
GVC Position Index	Ratio measuring a country's position in global value chains relative to upstream and downstream activities
Process Knowledge	Tacit, experiential know-how accumulated in manufacturing and supply chain operations
Involution	Intensified competition that erodes profitability without productive gains
1+N Policy Framework	China's carbon peaking and neutrality policy system with one guiding document and multiple sector-specific plans
River Chief System	Accountability mechanism for water resource management at multiple administrative levels
Big Food Concept	Expanded approach to food security beyond grains to include diverse food sources
New Three	Electric vehicles, lithium batteries, and solar cells
New New Three	Artificial intelligence, robotics, and innovative medicines

Appendix D: Chronology of Major Events and Milestones

Year	Event	Significance
1978	Reform and Opening	Beginning of economic transformation
2001	WTO Accession	Integration into global trading system
2008	Global Financial Crisis	Beginning of rebalancing
2013	Belt and Road Initiative	Supply chain diversification
2015	Made in China 2025	Manufacturing upgrading strategy
2020	Dual Circulation Paradigm	Strategic reorientation
2020	Carbon Neutrality Pledge	Climate commitment
2021	14th Five-Year Plan	Comprehensive development framework
2024	Grain Output Exceeds 700 Million Tonnes	Food security milestone
2025	15th Five-Year Plan	Strategic priorities for 2026-2030
2026	"New New Three" Emergence	Innovation-driven export transformation

Appendix E: Methodology Notes and Data Sources

Data Sources

1. National Bureau of Statistics of China: Economic indicators, trade data, population statistics
2. Ministry of Industry and Information Technology: Industrial production, manufacturing data
3. National Energy Administration: Energy capacity, generation, consumption data
4. Ministry of Agriculture and Rural Affairs: Agricultural production, food security indicators
5. Ministry of Water Resources: Water resources, quality, management data
6. General Administration of Customs: Trade statistics, export/import data
7. Ministry of Science and Technology: R&D expenditure, innovation indicators
8. International Organizations: World Bank, International Energy Agency, Food and Agriculture Organization
9. Academic Sources: Peer-reviewed research on GVC participation, dual circulation, industrial policy

Methodology Notes

Quantitative Analysis: Economic data analyzed using standard statistical methods including trend analysis, growth rate calculation, and comparative assessment.

Qualitative Analysis: Policy documents and strategic frameworks analyzed using document analysis and comparative policy research methods.

Scenario Development: Future scenarios constructed using trend extrapolation, expert judgment, and cross-impact analysis.

Limitations: Data availability varies across sectors; projections involve inherent uncertainty; geopolitical factors may affect trajectories.

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