

## Practice and Innovation of Green, Low-Carbon and High-Quality Development Driven by Circular Economy

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<https://doi.org/10.71659/icsoba2025-kn005>

### Abstract

The aluminium industry is under increasing pressure to balance growth with sustainability. Xinfa Group has developed an integrated circular economy model that addresses this challenge by linking energy, non-ferrous metals, high-end chemicals, and eco-friendly building materials into a closed industrial system. Through cogeneration, aluminium–power integration, waste heat recovery, and by-product utilization, Xinfa has achieved substantial reductions in emissions and energy consumption, while maximizing resource efficiency. Annual solid waste reduction exceeds 14 million tonnes, with significant economic and environmental benefits. Continuous investment in technological upgrading, smart manufacturing, and digital management has enhanced Xinfa’s competitiveness and resilience. Recent initiatives extend the circular model into agriculture, creating synergies between industry and ecological farming. Xinfa’s experience demonstrates how circular economy practices can accelerate the aluminium industry’s green, low-carbon, and high-quality development, offering a practical model for replication in China and globally.

**Keywords:** Circular economy, Aluminium industry, Low-carbon development, Resource efficiency, Green innovation.

*(Note from ICSOBA’s Editor: The following text was prepared from the Chinese Powerpoint file provided by the author, using M365 CoPilot. Please note that the quality of the English may not meet the usual editorial standards, and some concepts may remain vague.)*

### 1. Overview of Xinfa Group

Xinfa Group was founded in 1972. It is a modern large-scale enterprise group integrating industries such as energy, non-ferrous metals, high-end chemicals, environmentally friendly building materials, mineral development, and modern agriculture. The group currently has more than 80 subsidiaries and holding companies, with total assets of 310 billion RMB (42.9 billion USD approx.).

In 2024, it achieved a main operating revenue of 302.9 billion RMB (41.9 GUSD approx.), total profit and tax of 32.8 billion RMB (4.5 GUSD approx.), and paid 12.7 billion RMB (1.8 GUSD approx.) in taxes. From January to August this year, it achieved a main operating revenue of 204.56 billion RMB (28.3 GUSD approx.), an increase of 3 % year-on-year; profit and tax of 24.92 billion RMB (3.45 GUSD approx.), an increase of 9 % year-on-year; and paid 11.14 billion RMB (1.54 GUSD approx.) in taxes, an increase of 30 % year-on-year.

Xinfa Group actively implements the ecological concept of “Lucid waters and lush mountains are invaluable assets”, vigorously develops a circular economy, and has gradually achieved high-level ecological and environmental protection alongside high-quality economic growth.

The Group has successively established production bases in Guangxi, Xinjiang, Shanxi, Shaanxi, and other regions, significantly boosting local economies.

It is one of the first leading national pilot enterprises for “Resource-Conserving and Environmentally Friendly” development; a key enterprise of the national “Double Hundred Project” for comprehensive resource utilization and a national base for comprehensive utilization of bulk solid waste.

## 2. A Unique Circular Industry Model

Xinfa Group has always adhered to the concept of green development and actively explored the application of the circular economy model in the aluminium industry chain. Through years of practice and innovation, by building, extending, strengthening, and upgrading the industrial chain with intelligence and sustainability, the Group has successfully developed an efficient circular economy model (Figure 1) centred on the aluminium and power sectors. This model maximizes resource utilization and minimizes waste emissions, demonstrating the strong advantages and competitiveness of the circular economy and driving the company toward green, low-carbon, and high-quality development.

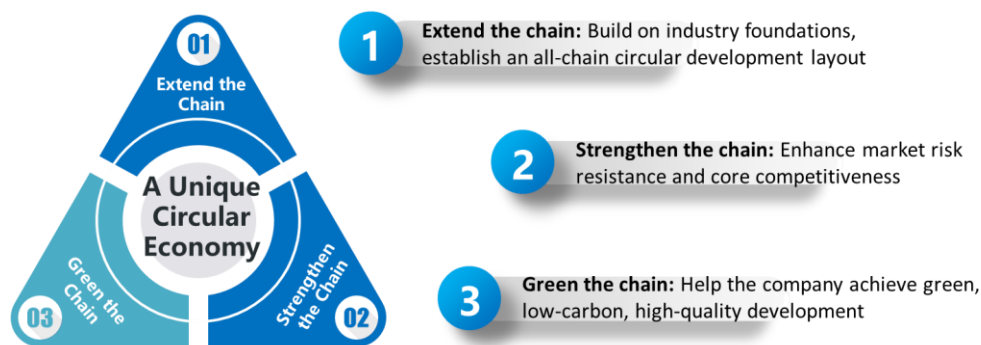


Figure 1. Circular economy model.

### 2.1 “Extend the chain” journey

2018: Building Materials Project  
 2006: Chemical Project  
 2004: Alumina Project, Aluminium powder integration  
 1998: Electrolytic Aluminium Project  
 Early 1990s: Combined heat and power (CHP)  
 1972: Plant established

#### 2.1.1 Energy industry

Mainly focused on coal mining, power generation, and heat supply. Electricity and steam are used in the industrial park, while residual heat is utilized for agricultural parks and urban heating. The Group’s main units are 1.1 GW and 660 MW “high-efficiency ultra-supercritical” units, which are among the most advanced in the world. Power generation coal consumption is 248 g coal/kWh, 20 % lower than the industry average, and emission indicators are more than 95 % better than those of natural gas power units. The project has won the Asian Power Award and the German Innovative Energy Efficiency Project Award.

### **2.1.2 Non-ferrous metals industry**

Mainly focused on bauxite mining, alumina production, carbon materials, electrolytic aluminium, and processing of aluminium. This has driven 53 large-scale aluminium processing enterprises in the region, making it an important national base for advanced aluminium processing.

### **2.1.3 Chemical industry**

Mainly focused on salt mine development, caustic soda, lime, calcium carbide, polyvinyl chloride (PVC), and advanced processing, with world-leading technology and equipment levels.

### **2.1.4 Ecological and environmental protection industry**

The above three sectors all generate solid waste. To address this, we have focused on building an eco-friendly building materials industry chain. By using by-products such as fly ash, coal slag, and desulfurized gypsum as raw materials, and transporting them through pipelines to produce environmentally friendly building materials, we have achieved “*no visible ash when ash is discharged, no visible slag when slag is discharged, and turning pollution into resources.*”

### **2.1.5 Industrial Ecosystem**

The four major industry chains are interconnected vertically and horizontally, forming an “interlinked, closed-loop” industrial ecosystem.

Example of limestone recycling:

Stones are used to produce lime → lime is used to produce calcium carbide → calcium carbide combines with chlorine and hydrogen to produce PVC, while generating carbide slag  $\text{Ca}(\text{OH})_2$  as a by-product.

Carbide slag can replace lime in alumina production and can also be used for desulphurization in power plants, aluminium plants, and carbon plants. The desulfurization process produces gypsum, which is then used to make gypsum powder and gypsum boards.

Thus, a single stone passes through the four major industry chains and is utilized in six stages.

By developing a circular economy, we can reduce solid waste stock by 14 million tonnes annually and create economic benefits of over 10 billion RMB (1.38 GUSD approx.), becoming a successful example of industrial chain integration and collaborative development.

## **2.2 Strengthen and upgrade the chain**

The objective is to enhance the resistance to the market risk and to improve the core competitiveness.

Ten major industries are at the leading level in their respective sectors worldwide.

It is driven by the Company’s culture:

- Globalized concepts or Internationalized philosophy
- High-end industrial development
- Humanized management
- Refined production or Precision manufacturing

Xinfa Group has always regarded innovation as the key to enhancing core competitiveness. By introducing advanced international technology and equipment, promoting data-driven process reengineering, and implementing intelligent transformation, it has achieved high-end upgrades of traditional industries.

The drivers are the following ones:

- Adhere to international benchmarking, promote equipment upgrades and replacements, and maintain industry leadership.
- Implement data-driven management, optimize process flows, and improve economic efficiency.
- Advanced intelligent transformation to enhance work quality and efficiency, and reduce labour intensity.

### **2.2.1 Production Tool Efficiency**

The Group has invested 1.8 billion RMB (250 MUSD approx.) to replace water cooling with indirect cooling units, and built a fully automated, unmanned water treatment workshop, achieving a water-saving rate of 97%.

High-efficiency ultra-supercritical unit, the Group completely shut down units with low energy efficiency below 300 MW, and invested in building nine 660 MW high-efficiency ultra-supercritical units.

Aluminium alloy rod production line: Use of the advanced production line from Hydro (Norway).

Gypsum board production line: Introduced four Grenzebach production lines from Germany to ensure equipment standards remain at the forefront of the industry.

### **2.2.2 Data-Driven Management**

The NC-ERP System relies on over 100 modules across eight major domains.

It addresses the data empowerment across the entire value chain, the logistics, the capital flow and the decision-making and command systems, to achieve efficient integration and collaborative management of personnel, finance, materials, production, supply, and sales.

It significantly improves the decision-making efficiency and the operational accuracy.

### **2.2.3 Advanced Intelligent Transformation**

Xinfa Group introduces top industry technologies, assimilates and re-innovates them, ensuring core technologies remain firmly in its own hands.

In 2024, the Group implemented 2 467 innovation projects, invested 371 million RMB (51.3 MUSD approx.) in innovation, and achieved an efficiency gain of 2.772 billion RMB (384 MUSD approx.).

Xinfa obtained over 1200 authorized patents, it has developed more than 10 technologies identified as internationally advanced, and 13 of its companies are recognized as high-tech enterprises.

## **2.3 Green the Chain**

Helping enterprises to achieve green, low-carbon, and high-quality development.

Xinfa Group deeply practices the ecological and environmental protection concept that '*clear waters and lush mountains are invaluable assets*,' and continuously promotes green transformation and upgrading.

Examples of realisations,

- Pollution prevention and source control: Construct dedicated railway lines and create innovative intelligent unloading methods
- Emission indicators: Upgrade and transform the industrial chain to fully achieve ultra-low emissions
- High efficiency in water recycling: Improve water cooling and reuse water resources through circulation
- Low-carbon energy: Optimize energy structure and develop new energy green power projects

Since the 18<sup>th</sup> National Congress of the Communist Party of China, Xinfeng Group has increased its installed capacity by 88.87 %, reduced sulphur dioxide emissions by 89.81 %, and reduced nitrogen oxide emissions by 69.57 %, achieving remarkable energy-savings and emission-reduction results.

In the country's first carbon emission trading, Xinfeng Group's trading volume reached 14.076 million tonnes, with a transaction value of nearly 800 million RMB (110 MUSD approx.), accounting for 9.1 % of the national total and ranking first nationwide. After three compliance cycles, the Group's cumulative carbon quota trading volume has reached 35.73 million tonnes, with a transaction value of 2.322 billion RMB (321 MUSD approx.), earning the titles of "China's Industrial Carbon Peak Pioneer Enterprise" and "Outstanding Carbon Market Trading Practice Enterprise."

Xinfeng Group has 12 companies listed as Class A enterprises for emergency emission reduction by the Ministry of Ecology and Environment.

Xinfeng Group actively responds to the national "Ten Thousand Enterprises Revitalize Ten Thousand Villages" initiative and the "Rural Revitalization" strategy by applying industrial thinking to agricultural development.

The Group has invested 5 billion RMB (690 MUSD approx.) to build a modern agricultural industrial park, transferring innovative ideas, management advantages, technological strengths, and resource advantages from industry to agriculture. It vigorously promotes ecological agriculture, smart agriculture, and facility-based agriculture, taking a new path of intelligence, intensification, low-carbon development, and ecological recycling. Cherries, strawberries, and sea bass are developed in synergy, achieving fish-fruit symbiosis and creating a 'Qilu Model' for rural revitalization. The Xinfeng approach applied in this park:

- Replacement of natural gas with industrial waste heat for heating and cooling, solving the biggest cost issue in facility agriculture and enabling off-season crop production.
- Utilisation of modular blocks to build planting racks, increasing land utilization from 40 to 94 %.
- Utilisation of carbon dioxide produced by the magnesium smelting project, transporting it via pipelines to greenhouses to enhance crop photosynthesis.
- Smart agriculture system involving intelligent control of eleven production factors, including temperature, humidity, carbon dioxide, and supplemental light.
- Strawberry cultivation with an integrated water-fertilizer system, achieving water and fertilizer recycling.
- Utilisation of cherry tree branches and strawberry stems and leaves to make organic fertilizer.
- Sea bass viscera and fish scales are processed and fermented into fish protein feed.
- Fish pond wastewater is filtered and reused for irrigating cherry trees.
- Distributed new energy generation, achieving green self-sufficiency in electricity.

The park has earned honours such as Modern Facility Agriculture Base and Smart Agriculture Application Base. It has been recognized by the China–Central and Eastern European Countries Modern Agricultural Science and Education Innovation Alliance as a 'Demonstration Base for New Quality Productive Forces.' It has become a 'Qilu Model' for rural revitalization, achieving

coordinated and mutually beneficial development between industry and agriculture, as well as between urban and rural areas.

### 3. Social Responsibility

Xinfa's Commitment: Staying true to our original mission and actively giving back to society. Since the 18<sup>th</sup> National Congress of the Communist Party of China, Xinfa Group has earnestly implemented the Party's policies, remained focused on industrial development, and doubled its total assets from 142.8 billion yuan to 310 billion RMB (19.8 to 42.9 GUSD approx.) – all without any bank loans. Paid taxes have grown from 2.5 billion to over 10 billion RMB (0.346 to 1.38 GUSD approx.), a fourfold increase. The Group has cumulatively contributed more than 100 billion yuan in taxes to the state.

Xinfa Group regards “*giving back to society and improving people's well-being*” as the core of its responsibility culture, achieving a “triple win” of environmental, economic, and social benefits.

For five consecutive years, the Group has funded farmers' cooperative medical care, ensuring that farmers pay nothing; donated to build one hospital and five primary and secondary schools; invested 500 million RMB (69.2 MUSD approx.) to establish Liaocheng Xinfa Senior High School; funded the construction of the Party Member Education Base “Ma Zhou Memorial Hall,” Jinniu Lake, and two pedestrian overpasses; and contributed 38.67 million RMB (5.35 MUSD approx.) in donations and supplies during the pandemic.

In total, the Group has donated more than 3 billion RMB (415 MUSD approx.) to public welfare causes, demonstrating the social responsibility of a national enterprise.

### 4. Looking ahead

Xinfa Group will continue to be driven by a circular economy and aim for green, low-carbon, high-quality development. We strive to elevate traditional industries to the highest level and optimize foundational industries to their utmost, creating maximum social value with minimal resource and energy consumption, and building a world-class enterprise.

We will increase investment in technology, strengthen innovation, and advance toward high-end, intelligent, and green development. We will actively respond to the Belt and Road Initiative, enhance international cooperation, expand overseas markets, and improve global competitiveness.

The green transformation of the electrolytic aluminium industry involves technology, energy, and business models. Through years of practice and innovation, Xinfa Group has developed a circular economy model centred on the aluminium-electricity core business, supporting green, low-carbon, and high-quality growth. In the future, overcoming technical challenges will be essential, expanding green power capacity will be critical, and achieving aluminium recycling and enhancing by-product value will be effective measures to jointly drive the industry's low-carbon transition.