Challenges and Opportunities for Low Carbon Development of Chinese Steel Industry

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PLAN FOR FUTURE STUDY FOR DEVELOPMENT

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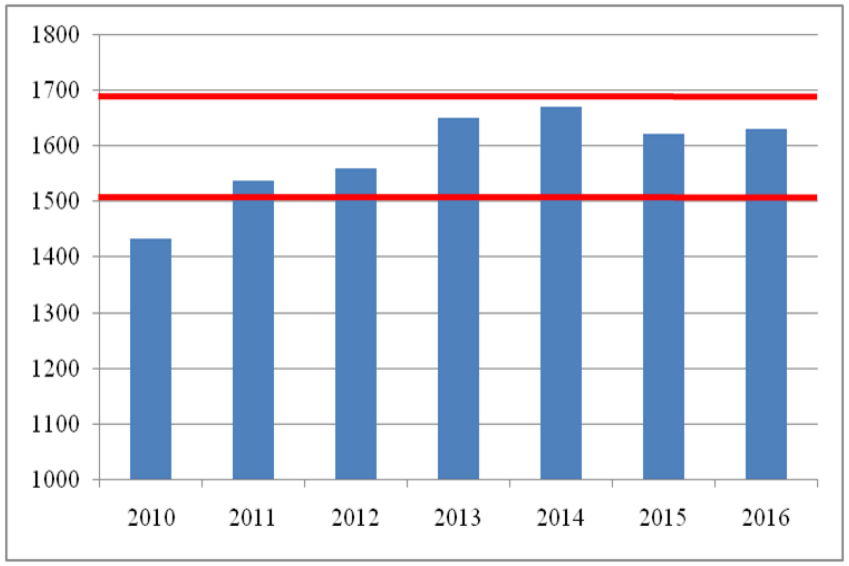
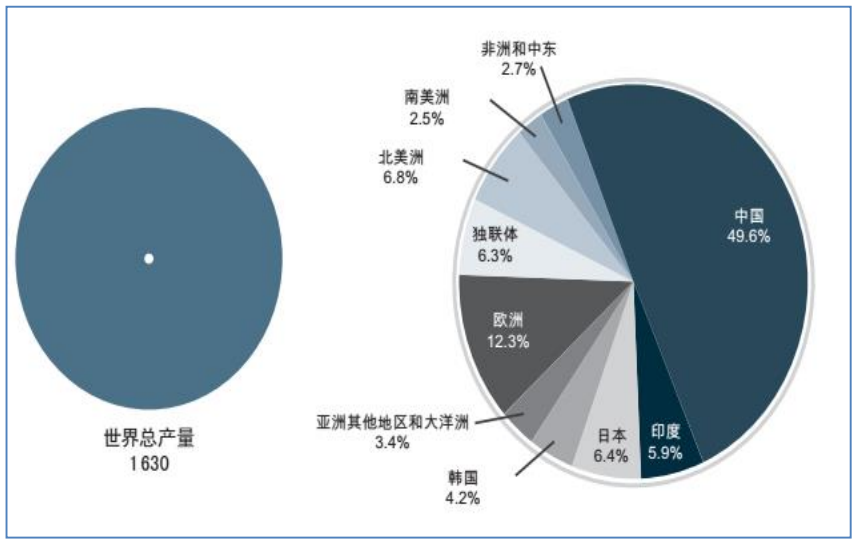
Ⅰ Review and outlook of Chinese steel industry

1.1 Important role of Chinese steel industry





- In 2016, the world crude steel output was 1.6285 billion tons increased by 0.6% y-o-y, which was more than 1.6 billion tons in 4 consecutive years since 2013 showing a small fluctuation.

- In 2016, Chinese crude steel output was 808.4 million tons increased by 1.2% y-o-y, accounted for 49.6% of the world output based on 49.4% in 2015.
- From January to September 2017, crude steel output of 66 countries was 1.2669 billion tons increased by 5.6% y-o-y. Chinese crude steel output was 638.73 million tons increased by 6.3% y-o-y, accounted for 50.4% of total output of main steel producing countries. Crude steel output of other countries was 628.185 million tons except for mainland China, increased by 5.9% y-o-y.

1.2 China made great contribution to address overcapacity

- **Promote supply-side structural reform**

5 major tasks

address overcapacity

reduce inventory

bolster areas of weakness

lower costs

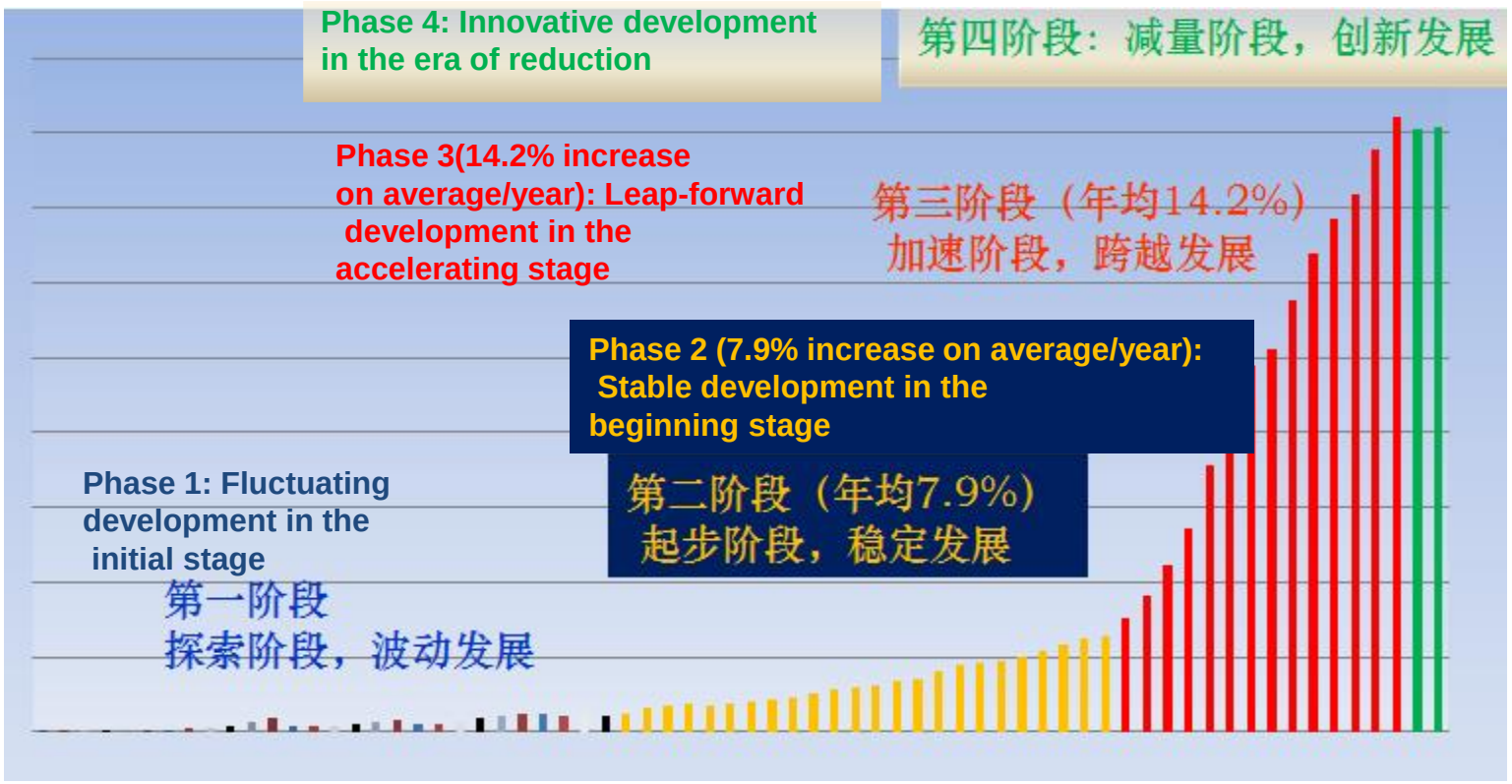
deleverage

As the biggest steel producing and consuming country in the world, China recognizes and performs responsibility to address overcapacity of the steel industry, although that is the common problem worldwide. China proposed and participated in organizing G20 GFSEC (GLOBAL FORUM ON STEEL EXCESS CAPACITY)to set a good example for address overcapacity.

In virtue of implementation of supply side structural reform to address overcapacity, China not only set an image of responsible power in the world, but also improve profitability of steel enterprises. Steel enterprises have to improve effective supply driven by innovation complying with new development idea.

In 2016, world crude steel output was 1.6285 billion tons with capacity utilization rate of 69.3%. China eliminated excess capacity of more than 65 million tons making contribution to improve utilization rate of 1.9 points, while that of other regions except for China was -2.3 points. **115 million tons eliminated in two years**

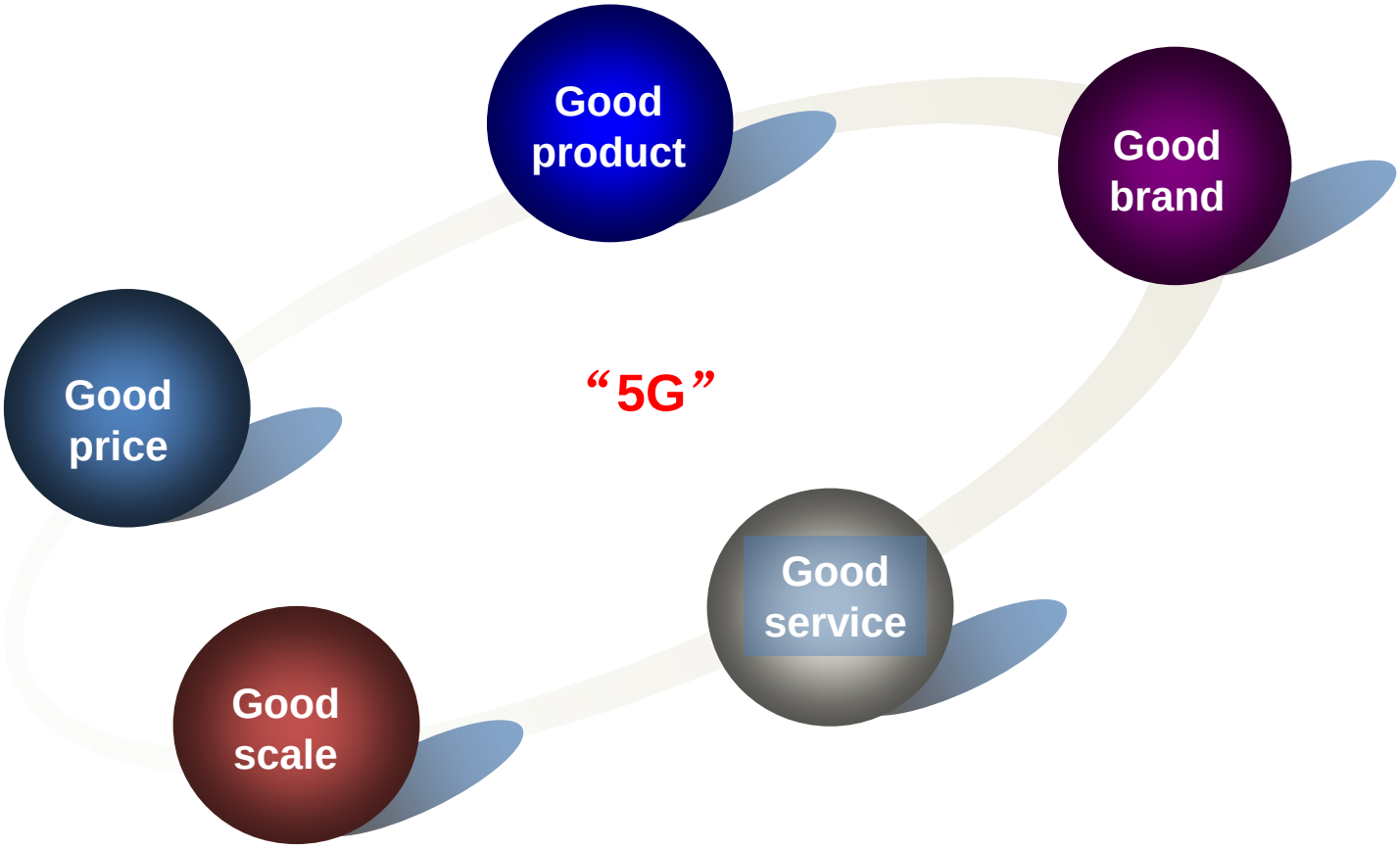
1.3 Review of Chinese steel production and consumption



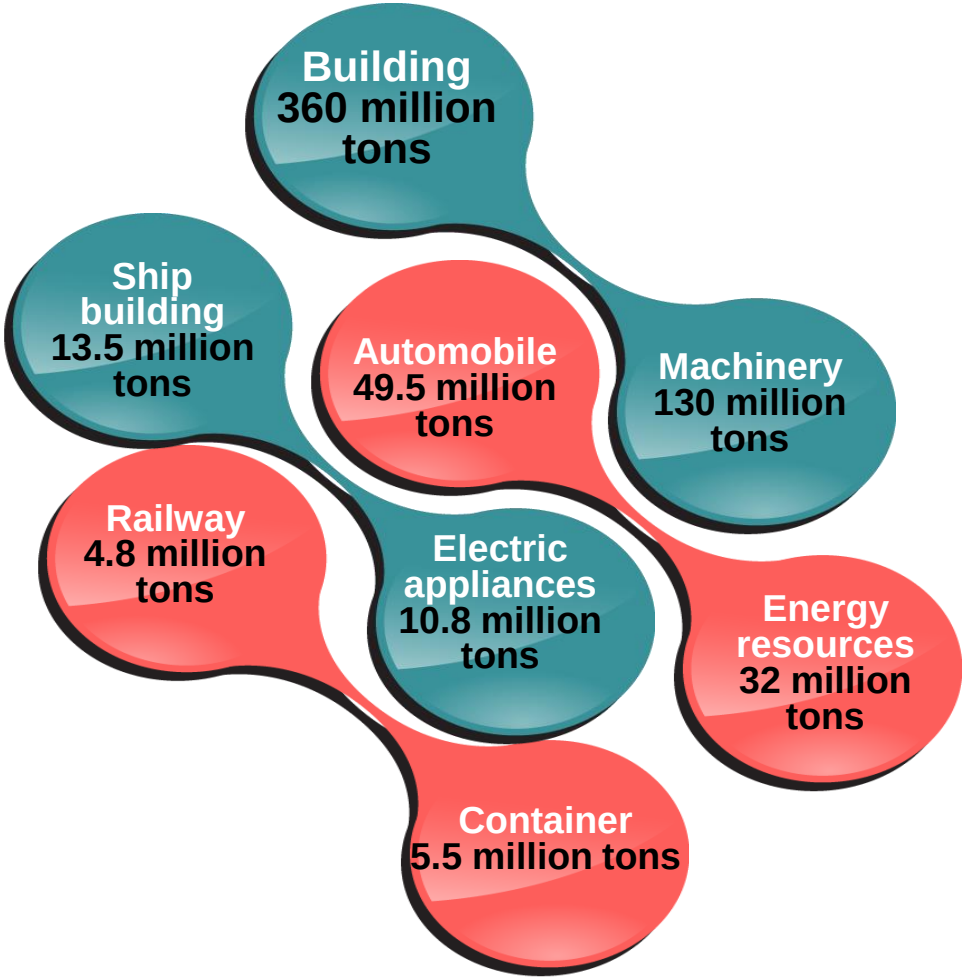
Chinese steel production and consumption has passed four stages since establishment of the PRC in 1949.

- **Phase 1: Fluctuating development in the initial stage;**
- **Phase 2: Stable development in the beginning stage;**
- **Phase 3: Leap forward development in the accelerating stage;**
- **Phase 4: Innovation development in the era of reduction.**

The steel industry, as one of the most competitive Chinese manufacturing industries, has already achieved "5G".



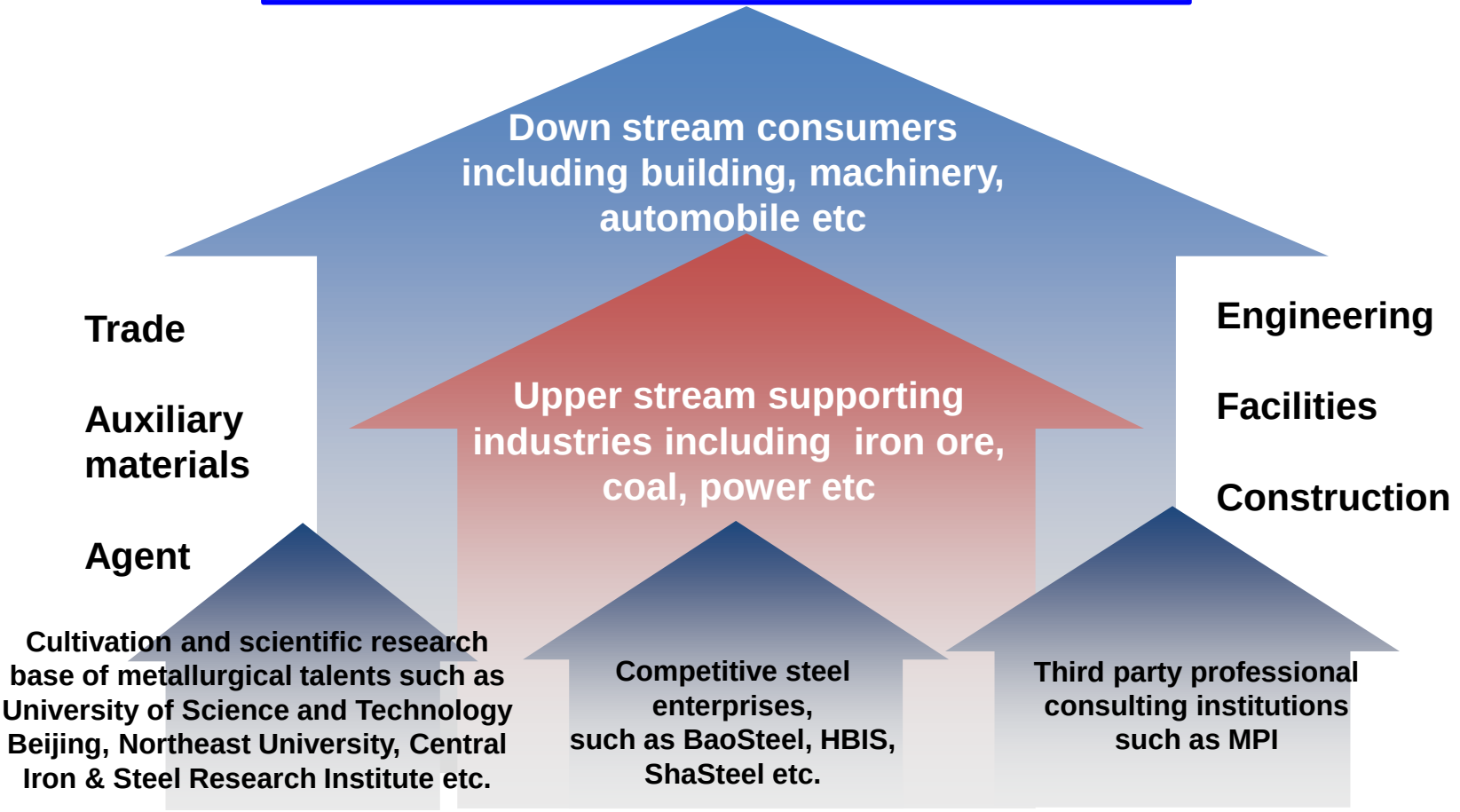
largest and most dynamic market



- Chinese steel industry enjoys the world's largest and most dynamic domestic demand. In 2016, actual steel consumption in China was about 670 million tons accounted for about 45% of total steel consumption in the world;
- China, as the largest and most dynamic steel market will not be changed over a long period, which was the strongest foundation for Chinese steel industry to maintain and improve their competitiveness.

complete industrial system

The complete industrial system has led to great development of Chinese steel industry

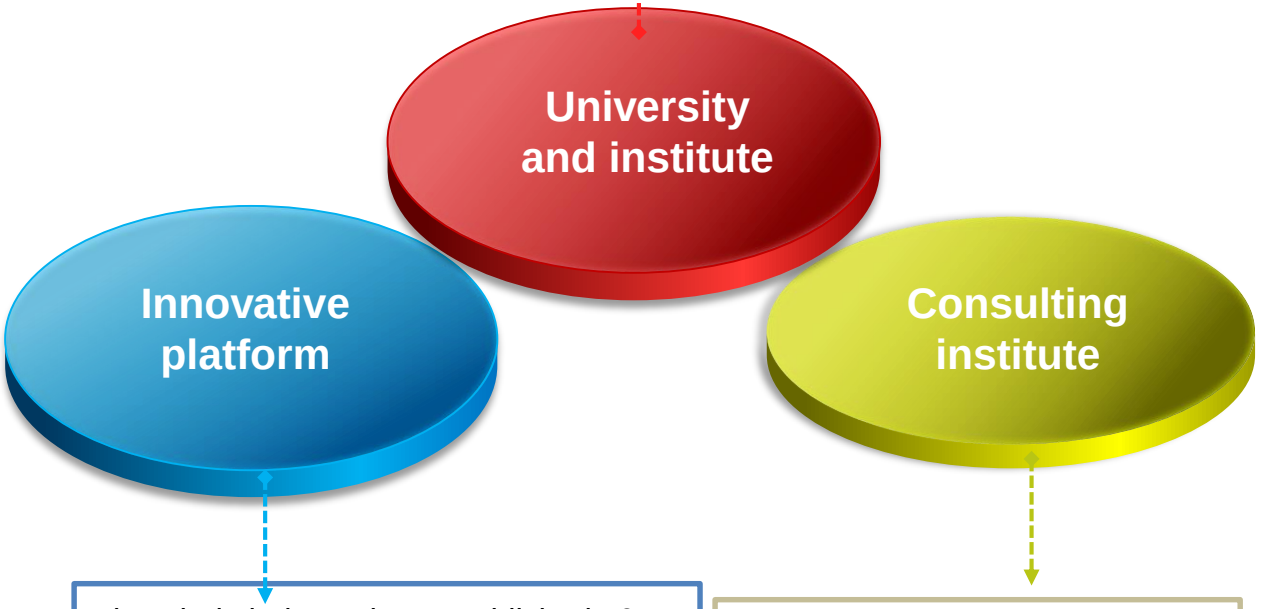


1.4 Competitiveness of Chinese steel industry

● most valuable human resources

Professional colleges: University of Science and Technology Beijing; Northeastern University
Professional scientific research institutions: Central Iron & Steel Research Institute ; Institute of Process Engineering
Enterprise research institutes: BaoSteel research institute and WISCO research institute

Professional technical staff
Professional management staff
Professional research and development staff



Professional technical staffs
Professional technical transfer staffs
Professional project application staffs

The whole industry has established 16 national key laboratories, 5 project laboratories, 12 project technical centers, 10 project research centers, 33 enterprise technical centers and 17 innovative enterprises.

Professional consulting institution: MPI
Professional trading group: Minmetals
Professional design and construction group: MCC

Professional consulting team
Professional training team
Professional design team
Professional construction team

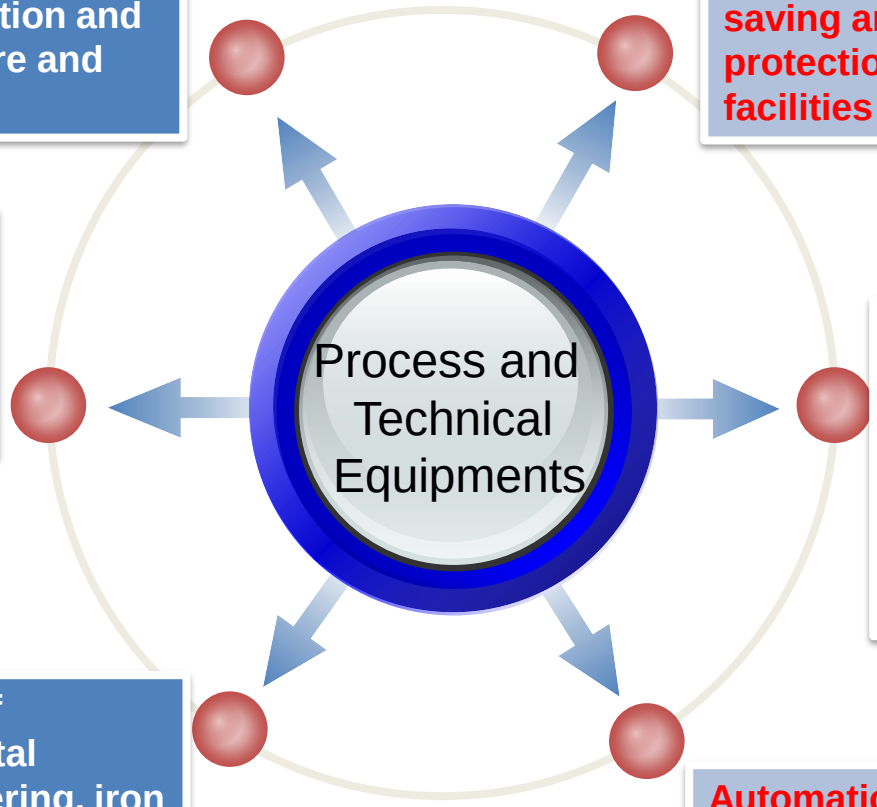
Most advanced equipments

Advanced process and technical equipment and concept of systemization and integration have laid a solid foundation for the rapid development of Chinese steel industry.

Systemization: The integrated and systematic optimization and upgrading are being more and more valued.

Green development: The energy saving and environmental protection technologies and facilities are applied widely.

Precision: The product dimension control and controlled rolling and cooling technologies are promoted rapidly.



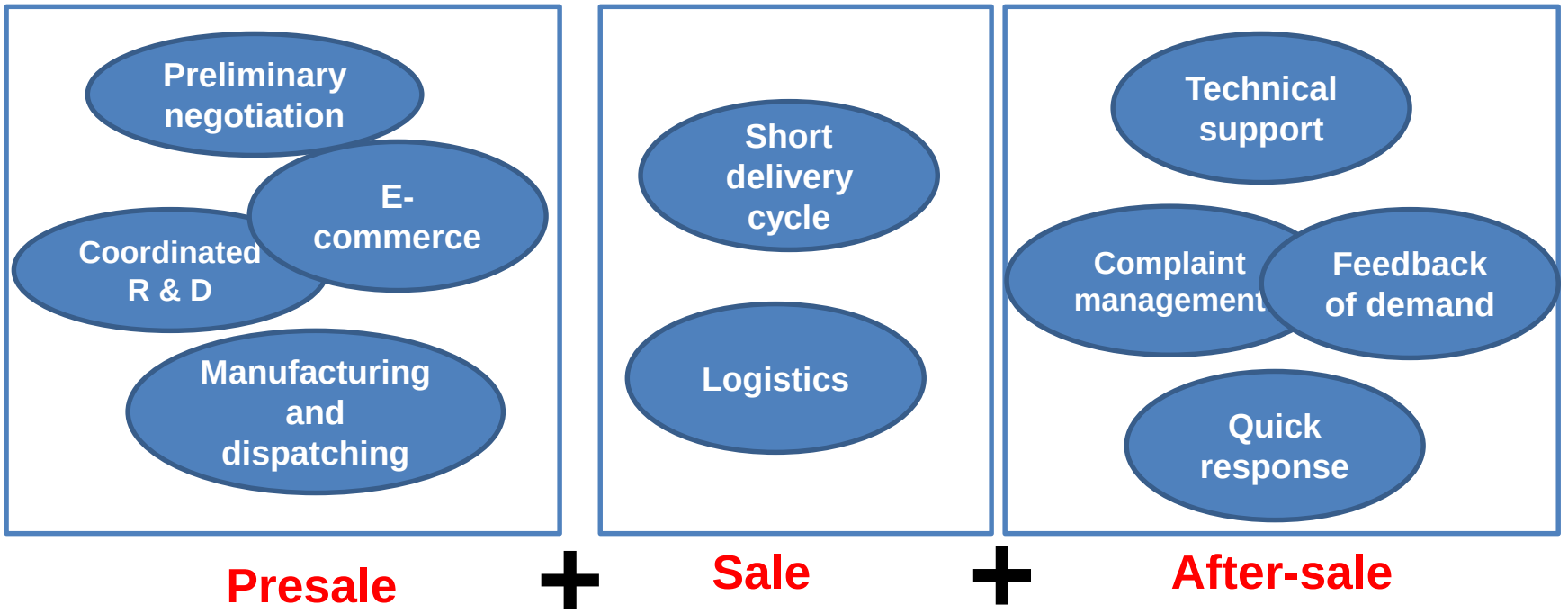
Continuity: The continuous casting and rolling processes and technologies are optimized constantly, and the process completeness is constantly upgraded.

Large scale: The ratio of advanced capacity to total capacity of coking, sintering, iron making, steel making and steel rolling increased constantly.

Automation: One-key automatic steel making as well as Level II and Level III of steel rolling are applied widely.

Timely service

Intensified market competition push the steel companies to strengthen sense of service and to improve service ability and skill in order to occupy a larger market share by differential service.



Improvement of customers' satisfaction

1.4 Competitiveness of Chinese steel industry

● Expected to be the leader of the world steel industry over 100 years.

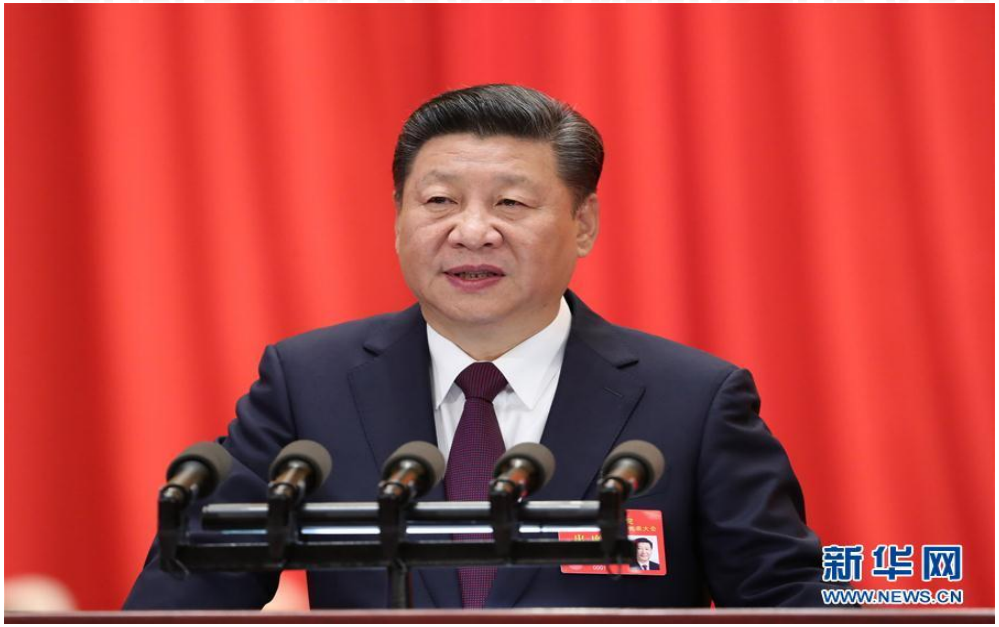
- ✓ China: accelerated industrialization and urbanization based on 10^9 population promote China to become the core of the world steel industry;
- ✓ It is not likely to see another country or region with 10^{10} population in the future, or it is difficult to see accelerated industrialization and urbanization even if there is another country or region with 109 population;
- ✓ It is predicted that Chinese steel industry will be the leader of the world steel industry for 100 years, even longer than the period have been occupied by the UK and USA.

Main route of transfer of the world steel industry

◆ From the historical view, there are three countries have produced half of world crude steel and maintained the leadership i.e. the United Kingdom in West Europe, the United States in North America and China in East Asia, which illustrates the main route of transfer of the world steel industry 。

China will move from high speed to high quality growth and continue to press ahead with supply-side structure reform. More effort are made to accelerate industrial restructuring and upgrading. The principal contradiction has evolved from one between the ever-growing material and cultural needs of the people and backward social production to that between unbalanced and inadequate development and the people's ever-growing needs for a better life.

THE STEEL INDUSTRY PROVIDES AN ESSENTIAL SUPPORT TO MEET PEOPLE'S INCREASED NEEDS FOR A BETTER LIFE



The report delivered in the 19th National Congress of the Communist Party of China on Oct 18th 2017

- Insist on excess capacity elimination, inventory and leverage remove, cost reduction, shortcoming improvement, optimization of resources configuration and expansion of high-quality additional supply to realize dynamic balance of supply and demand.

1.5 Requirements for the steel industry in the new era of socialism with Chinese characteristics

Further excess capacity elimination and accelerate deleverage.

Strengthen innovation on technologies, management and development mode.

Satisfy steel demand for rural construction and agricultural modernization.

Optimize industrial layout, develop one belt, multi points and network.

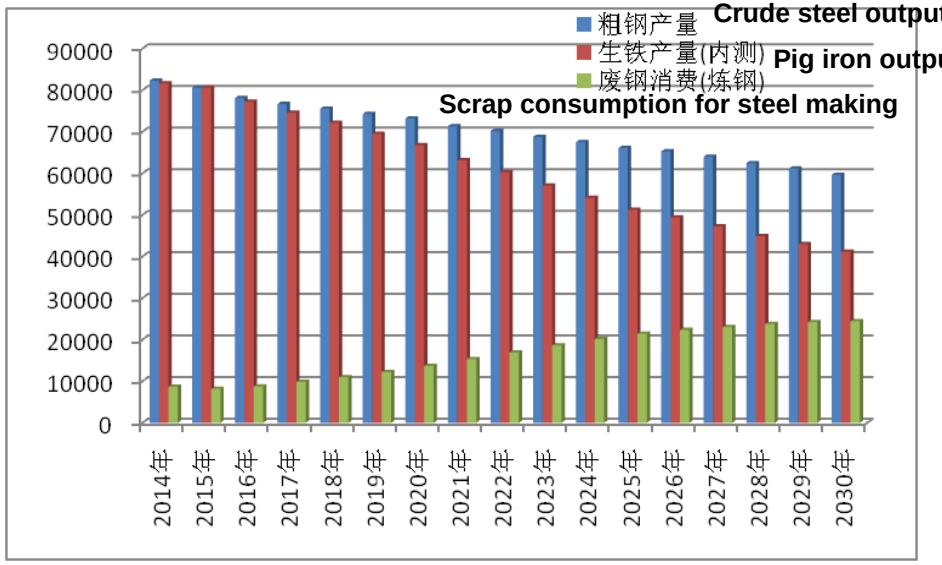
Promote international industrial cooperation.

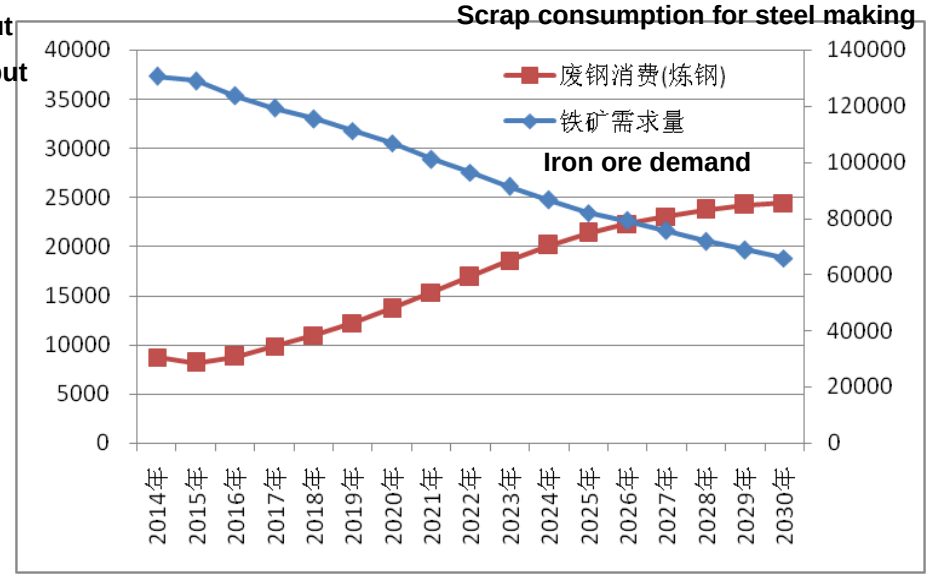
Promote optimization and industrial management and reform of SOE.

1.6 Chinese steel industry in an era of reduction

- **The subject of development of the steel industry will be changed from increase and expansion into reduction and adjustment**

✓ Chinese steel demand up to 2020 and 2030 is predicted based on analysis of down stream industries and GDP consumption intensity. From a medium/long-term view, Chinese steel consumption will show a peak round and descending channel, as well as fluctuation and rebound in individual year will not be excluded.





1.7 Development orientation of Chinese steel industry

Environmental friendly

绿色化

Consolidation & Coordination

有序化

Quality first

品质化

Standardization

标准化

Differential

差异化

Service oriented

服务化

Diversified operation

多元化

Intelligent

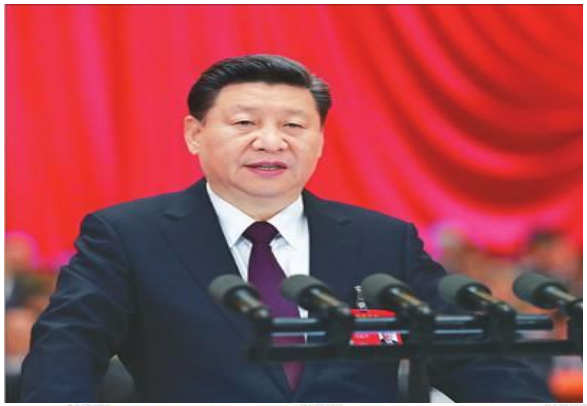
智能化

国际化

Internationalization

Ⅱ Challenges and opportunities for low carbon development of Chinese steel industry

2.1 Opportunities——ecological civilization highly valued by Chinese government



According to the work report issued in the 19th National Congress of CPC, China should be an important participant, contributor and leader of the world ecological civilization construction.

Accelerate systematic reform of ecological civilization.

- ✓ Formulate regulations and guidance for green production and consumption; establish and complete green circular economy system;
- ✓ Set up market oriented green technical innovation system and develop green finance;
- ✓ Establish clean, safe and efficient energy system;
- ✓ Promote comprehensive conservation and circular utilization of energy resources.

Two stages (2020-2050)

✓ **Stage 1: from 2020 to 2035**

Struggle for another 15 years based on building a well-off society in an all-round manner to realize the socialist moderation basically.

✓ **Stage 2: from 2035 to the middle of 21st Century**

On the basis of basically realizing modernization, strive for 15 years to build a prosperous, strong, democratic, civilized and beautiful socialist modern country.

2.2 Opportunities——policies support and guidance

National policies

Policies	General targets	Implementation period	Description of green development policies of steel industry
Self-Independent Contribution of China	**CO_2 emission hitting the peak in 2030; non-fossil energy accounts for about 20%; CO_2 per unit GDP decreased by 60%-65% based on that in 2005.**	**2020-2030**	1.Formulate control targets and action plan; 2. Formulate emission standards; 3. Improve energy efficiency by energy conservation.
Guidance on Excess Capacity Elimination of the Steel Industry	**Eliminate crude steel capacity of 100-150 million tons; solid progress of industrial restructuring; significant improvement of energy utilization efficiency, product quality and supply of high-end products; better profitability.**	**2016-2020**	Steel capacity fail to comply with environmental, energy consumption, quality, safety and technological standards should exit in compliance with rules and regulations.
Work Plan of Greenhouse Gas Emission Control in the 13th Five-year Period	**CO_2 emission per unit GDP in 2020 decreased by 18% based on that in 2015; effective control of total C emission.**	**2016-2020**	1. Effective control of total C emission; 2. Management and control of C emission quota.
Comprehensive Work Plan of Energy Saving and Emission Reduction in the 13th Five-year Period	**Control of intensity and total volume; energy consumption of GDP decreased by 15%; total energy consumption control with 5 billion tons standard coal.**	**2016-2020**	1. Steel capacity fail to comply with environmental, energy consumption, quality, safety and technological standards should exit in compliance with rules and regulations. 2. Energy utilization efficiency meet or nearly meet the world advanced level; 。 3. Stepped energy utilization; 4. Comprehensive energy consumption per ton steel production ≤560kgce/t.

- **Low carbon development targets up to 2020 and 2030; control targets in respect of intensity and total volume;**
- **Eliminate backward capacity as per rules and regulations;**
- **Improve energy utilization efficiency.**

2.2 Opportunities——policies support and guidance

● Department policies

Policies	General targets	Implementation period	Description of green development policies of steel industry
Industrial Action Plan on the Climate Change	Up to 2020, CO_2 emission per unit industrial added value will decrease by about 50% based on that in 2005 and the industrial system characterized by low carbon emission will be formed basically.	2012-2020	1. Guided by policies and plan; standards formulation and delicacy management. 2. Promotion and application of secondary energy recycling. 3. Pilot sample of CCS, low carbon park and enterprises.
Implementation Guidance of Green Manufacturing Project	Advanced level of green manufacturing; establishment of green manufacturing system; energy consumption, water consumption and pollutants & C emission reduced significantly comparing with that in 2015.	2016-2020	Encourage promotion and application of sintering fume recycling, by-product gas utilization, raw materials substitute, process optimization etc.
National Plan on Climate Change	CO_2 emission per unit GDP decreases by 40%-45% based on that in 2005; non-fossil energy accounts for about 15% of primary energy consumption; forest area and reserves increases by 40 million hectare and 1.3 billion m^3 based on that in 2005.	2014-2020	1. Control capacity; 2. Product upgrading; 3. Promote high pressure and temperature CDQ, coking coal wetting, sintering surplus heat power generation, energy comprehensive utilization etc. 4. Develop EAF process using scrap. 5. Total emission in 2020 nearly the same as that in the end of 12^{th} Five-year period.
Adjustment and Upgrading Plan of the Steel Industry	Significant achievements of supply side structural reform of the steel industry up to 2020; Change Chinese steel industry from large into strong up to 2025.	2016~2020	1. Implement green upgrading, develop circulate economy and promote green consumption. 2. Total energy consumption decreases by more than 10%; comprehensive energy consumption per ton steel production≤560kgce/t; total pollutants emission decreases by more than 15%; fresh water consumption per ton steel production ≤3.2m3/t; SO_2 emission per ton steel production ≤0.68kg; comprehensive slag utilization rate ≥90%.

- **Accelerate promotion and application of advanced energy saving and low carbon technologies;**
- **Develop EAF process using scrap';**
- **Pilot sample of CCS, low carbon industrial park and enterprises.**

2.2 Opportunities——policies support and guidance

- **Promote energy saving and emission reduction by means of market force**

Carbon trade market has been experimentally launched since 2011 covering the area of 480,000 m^2 involving the population of 199 million.

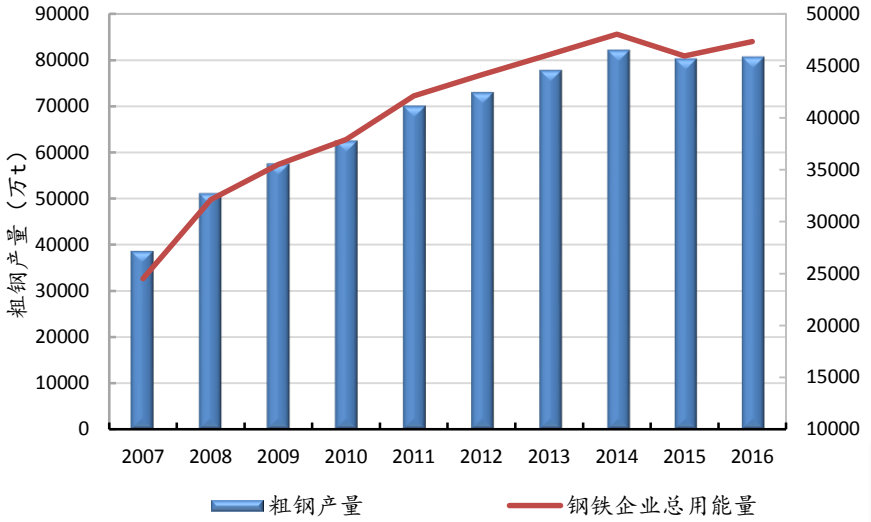
Up to September 2017, the pilot carbon market in 7 provinces contributes the trade volume of 197 million CO_2 equivalent with turnover of about 4.5 billion RMB. Both carbon trade and intensity in the pilot zone dropped.

✓Steel companies in Hubei, Tianjin, Shanghai, Guangdong and Chongqing among of 7 pilot zones participated in carbon market, crude steel output of which accounted for 11% of total output in 2016. Many steel companies participated in the experimental trade and completed the contract successfully to form a solid foundation of low carbon transformation.

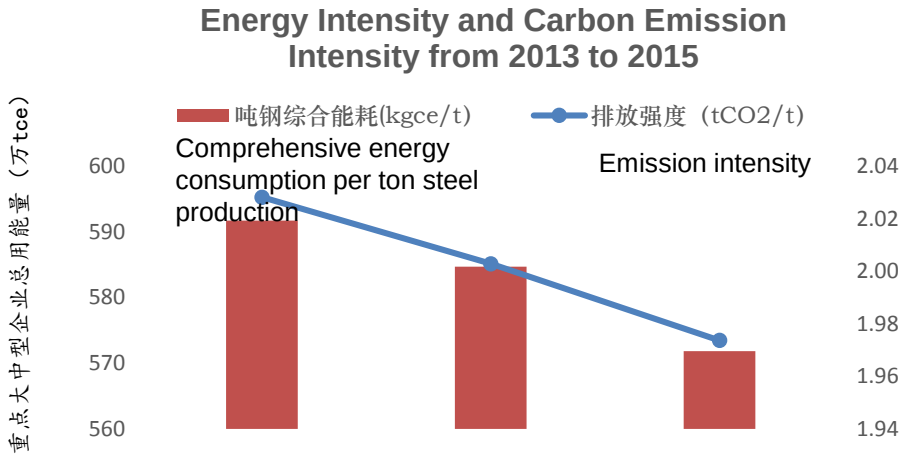
✓A national carbon trade market is being launched. The steel industry is preparing in different aspects of data submission, carbon verification, quota distribution research etc.

2.3 Opportunities——capability of low carbon development

Solid foundation



Crude steel output　　Total energy consumption



Backward Capacity Elimination of the Steel Industry from 2011 to 2015

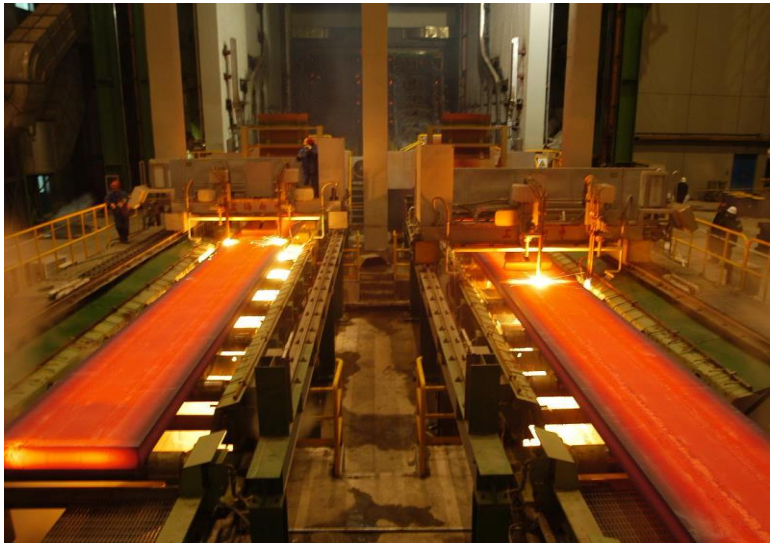
Year	2011	2012	2013	2014	2015	Total
Iron making（10,000 t）	3192	1078	618	2823	1378	9089
Steel making（10,000 t）	2846	937	884	3113	1706	9486

Many years experience with significant achievements

- **Total volume: from 2007 to 2016, Chinese crude steel output increased by 108% with annual growth of 7.6%; total energy consumption increased by 93% with annual growth million tons standard coal have been saved according to product energy saving rate.**
- **Intensity: both comprehensive energy consumption and C emission per ton steel production decreased with drop of about 3% from 2013 to 2015.**
- **Structural reform: from 2011 to 2015, Chinese steel industry eliminated backward iron making capacity of 90.89 million tons and steel making capacity of 94.86 million tons, exceeded 44.3% and 50.6% respectively comparing with the targets.**

High efficiency process

From 1980 up to now, steel making process is adjusted and optimized to become a continuous, compact and light system.



CCM ratio in key steel companies was 99.71% up to 2014.

Shaft furnace has been eliminated completely up to the end of 2002.

● Advanced process equipments

➢ **Main equipments in key large/medium-scale companies reached international advanced level;**

➢ **Refer to key steel companies, capacity of coke oven with 5m and above accounts for 48% of total coking capacity, capacity of blast furnace with 1000 m^3 and above accounts for 65% of total iron making capacity, and capacity of BOF with 100 tons and above accounts for more than 56% of total steel making capacity.**

- **Wide application of advanced technologies**

➢ **Wide application of key technologies such as CDQ, dry dedusting, sintering surplus heat recovery, dry TRT, high efficiency PCI, regenerative combustion, fully combustion gas power generation, hot charge & delivery etc.**

➢ **Largest number of sintering surplus heat recovery unit, CDQ unit and TRT unit in the world.**

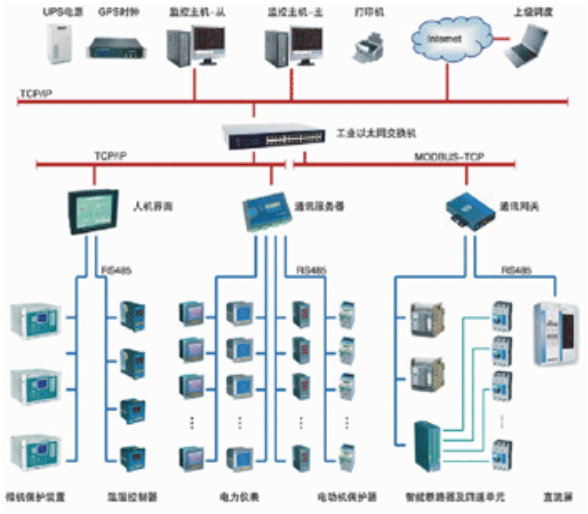
➢ **The largest unit low calorific value fuel and steam combined circulate power generator in the world.**

Improvement of energy management

- **Energy resources management: from experience oriented management to modern management.**
- **Energy saving management system: from department to comprehensive management system covering the whole company.**

Standard summary

Energy Management system



Energy management &control center

2.3 Opportunities——capability of low carbon development

Baowu

- ✓ Green design and manufacturing methodology and standards system;
- ✓ Research on improvement of calorific value of BF gas and CO_2 capture and utilization;
- ✓ Solar photovoltaic power generation.

Shougang

- ✓ Establishment new C management system and process;
- ✓ Application of new technologies;
- ✓ Research on C capture and recovery.

TISCO

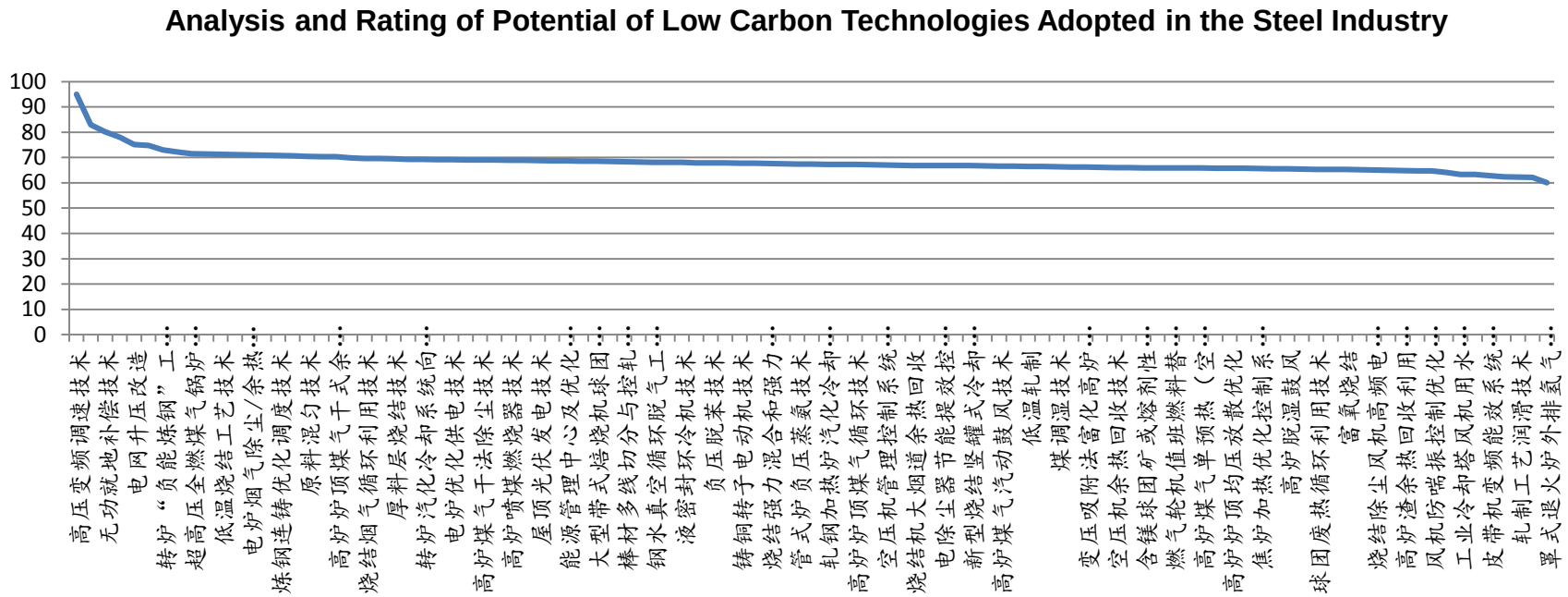
- ✓ Integrated innovative circulating technologies.

Others

- ✓ Dazhou Steel: methanol generation by coke oven gas;
- ✓ Jianlong Group: natural gas generation by coke oven gas;
- ✓ Sha Steel and Ma Steel: solid waste treatment by hearth furnace;
- ✓ Zhongjin Taihang Mining: Shaft furnace iron direct reduction by coke oven gas.

- **Many Chinese steel companies not only possess advanced idea of low carbon development, but also made fruitful practice already.**

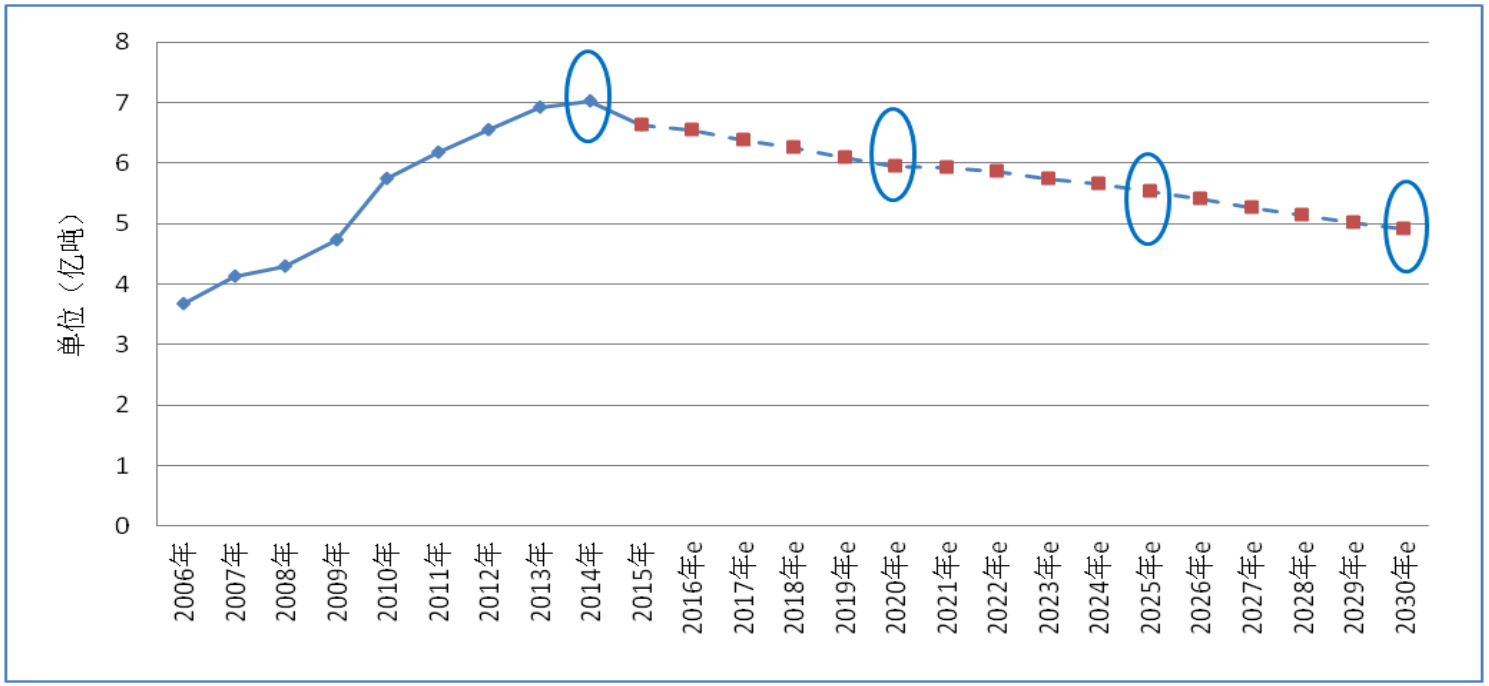
2.3 Opportunities——supported by advanced available low carbon technologies



MPI rated the technologies according to mature level, reliability, application, development potential, impact to the whole industry, promotion, investment etc.

103 technologies available to be adopted to improve energy efficiency, among of which 3 for raw materials preparation, 10 for coking, 18 for sintering, 3 for pelletizing, 19 for iron making, 15 for steel making, 14 for steel rolling and 21 for energy & power. It is predicted to reduce 200kgCO_2/t steel production based on existing level if all technologies applied and promoted as per the master schedule.

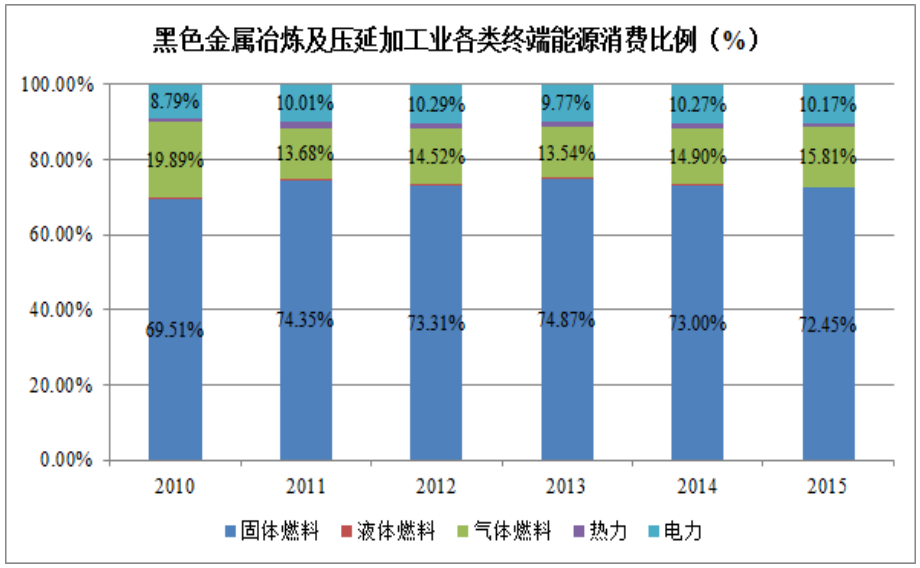
2.3 Opportunities——industrial development promotes energy structure adjustment



- **Scrap increase rapidly**
- **Passed scale expansion**
- **Stricter environmental protection requirements and promotion of power reform.**

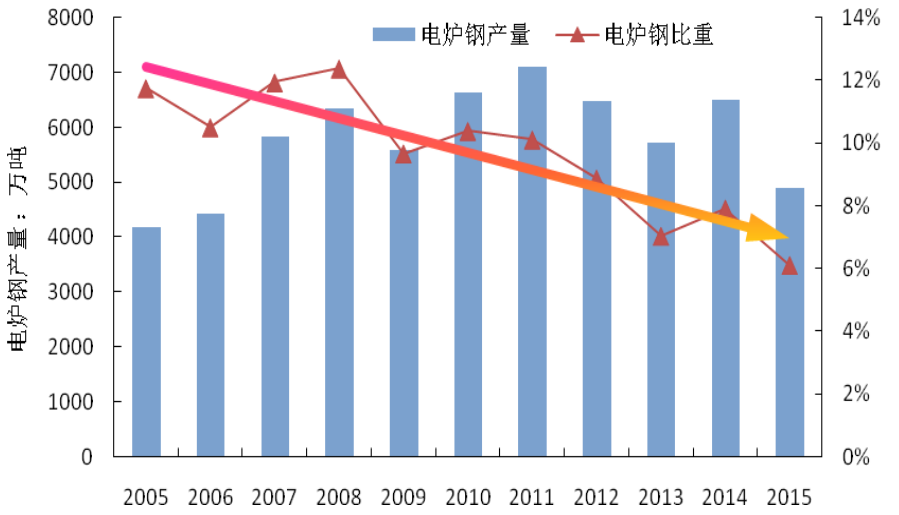
2.4 Challenges——long way to go to realize low carbon energy structure

terminal energy structure of
Ferrous metal smelting and rolling processing industry

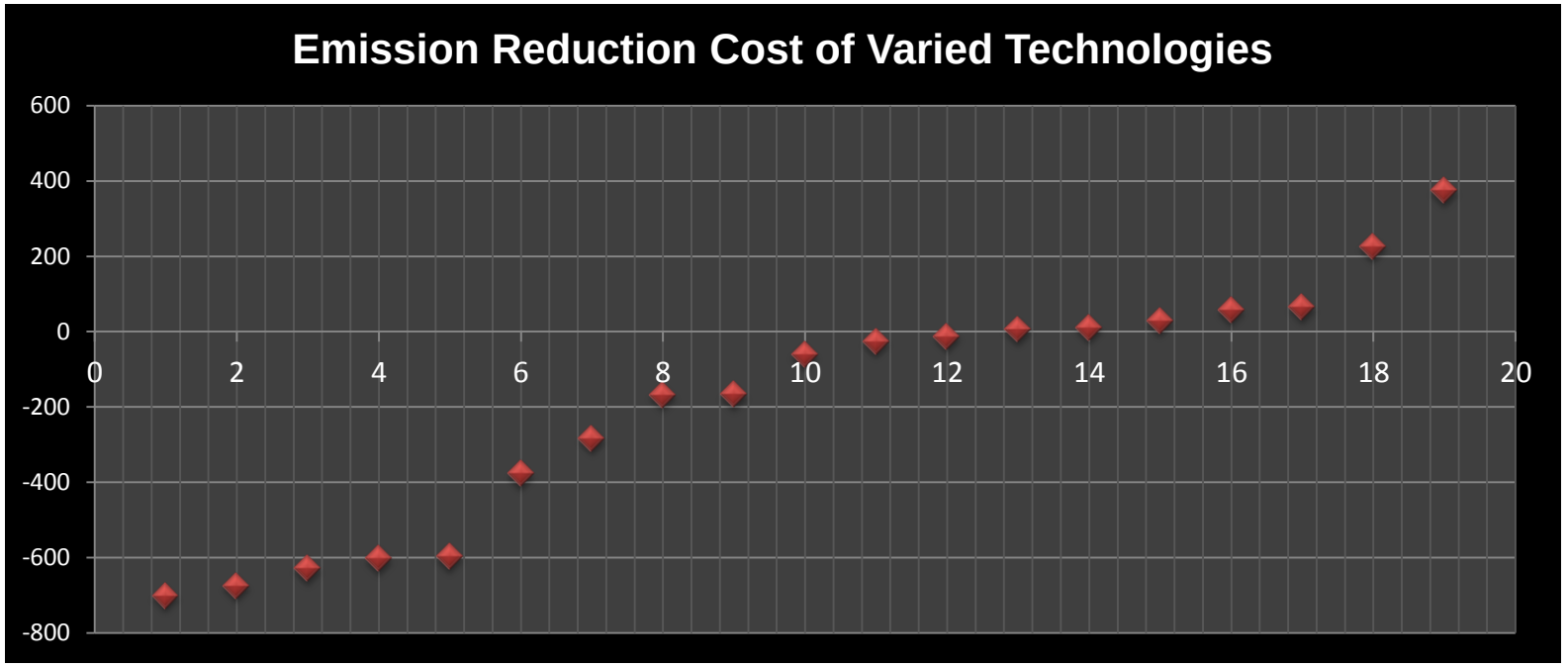


Solid fuel | liquid fuel | Gas fuel | Heat | Power

EAF steel output　EAF steel ratio



- As the biggest steel producing country in the world, Chinese crude steel output accounts for nearly 50% of the world total output. Energy consumption and CO2 emission of the steel industry accounts for about 12% to 15% of total volume in China.
- BF-BOF iron & steel making process, mainly consumes coal and coke is the dominant process.
- Follow the rules of industrial structure transformation and development. It is not possible to be realized in a short term.



- More difficult with higher cost;
- Big gap of emission reduction cost among different technologies, which will impact promotion of certain technologies.

2.4 Challenges——self innovation of key process technologies and facilities

Chinese steel industry should pay more attention on self innovation of basic research and advanced technologies although it has already gained outstanding achievements. Key process technologies and facilities are still mainly learned abroad and **insufficient innovation conversion is still the restriction for the further development of the whole industry.**

Adjustment and Upgrading Plan of the Steel Industry

- **Support technologies** integration centering on energy saving technologies and upgrading of steel demand for high-end facilities;
- **Implement combined innovation** mode covering production, education, research and application;
- **Establish national innovation platform** for the steel industry by means of market operation and diversified cooperation;
- **Develop the national innovation sample steel companies** and set up industrial base dominated by the steel industry;
- **Encourage coordinated innovation** among advantaged steel companies, colleges, design institutes and down stream customers.

Ⅲ Roadmap of low carbon development of Chinese steel industry

3.1 Prospect of low carbon development of Chinese steel industry

Internal

Short-term:

- ✓ Implement green modification and lean management to improve energy utilization efficiency;
- ✓ Remove backward facilities;
- ✓ Emphasize scrap utilization to reduce iron and steel ratio;
- ✓ Further processing to increase added value.

Medium/Long-term:

- ✓ Significantly increase scrap utilization and develop EAF steel;
- ✓ Application of clean energy such as renewable energy, solar energy etc.
- ✓ Develop low carbon smelting technologies.

External

Short-term:

- ✓ Form industrial chain together with some related industries such as chemical, construction materials etc;
- ✓ Whole life cycle assessment including steel consumption reduction, long service life, green consumption etc;
- ✓ Accelerated development of environmental protection industry.

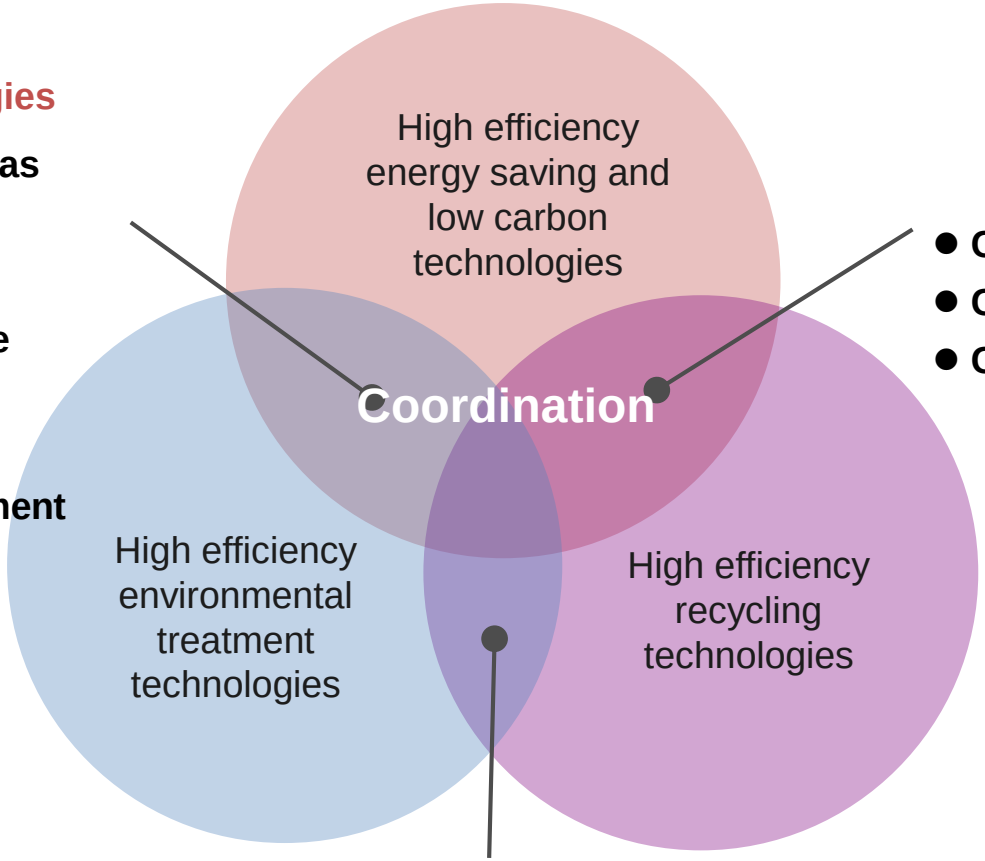
Medium/Long-term:

- ✓ Develop CCS and applied in the steel industry.

3.2 Orientation of low carbon development——green modification

High efficiency environmental treatment technologies

- **Organized waste gas treatment technologies**
- **Unorganized waste gas treatment technologies**
- **Waste water treatment technologies**



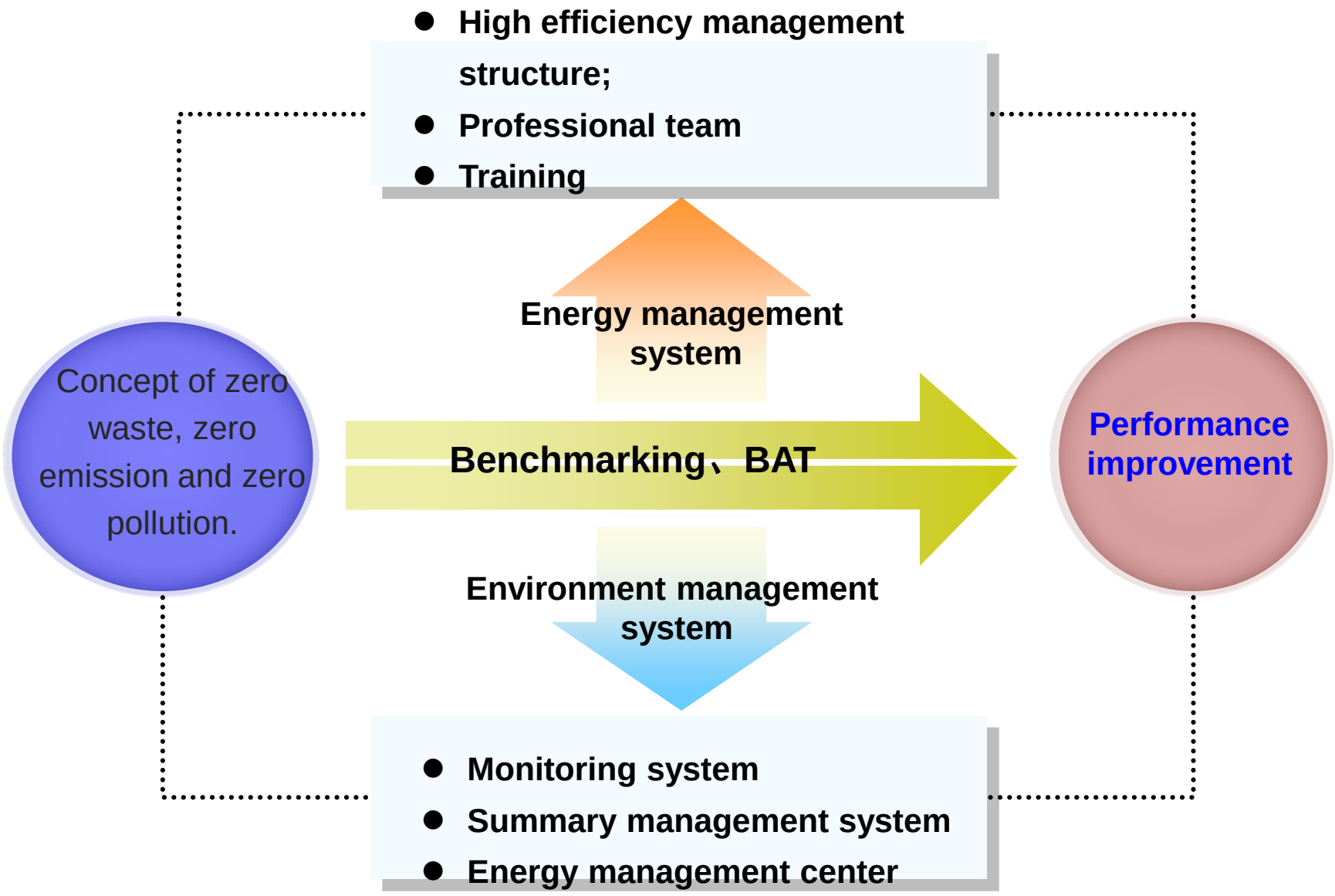
High efficiency energy saving and low carbon technologies

- **C reduction technologies**
- **C-free technologies**
- **C removal technologies**

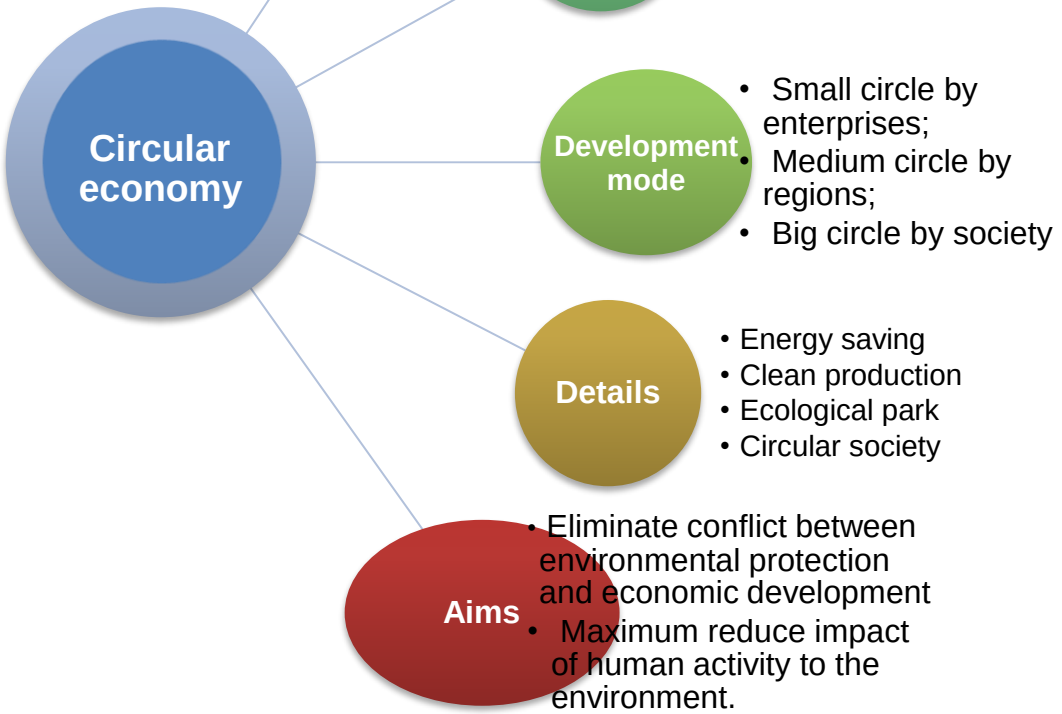
- **Production reducing technologies**
- **Solid waste comprehensive utilization technologies**

Coordination of these three categories.

3.2 Orientation of low carbon development ——lean management



3.2 Orientation of low carbon development ——Developing a Circular Economy



1. Enterprises

Fully use resources and promote clean production from the source of production.

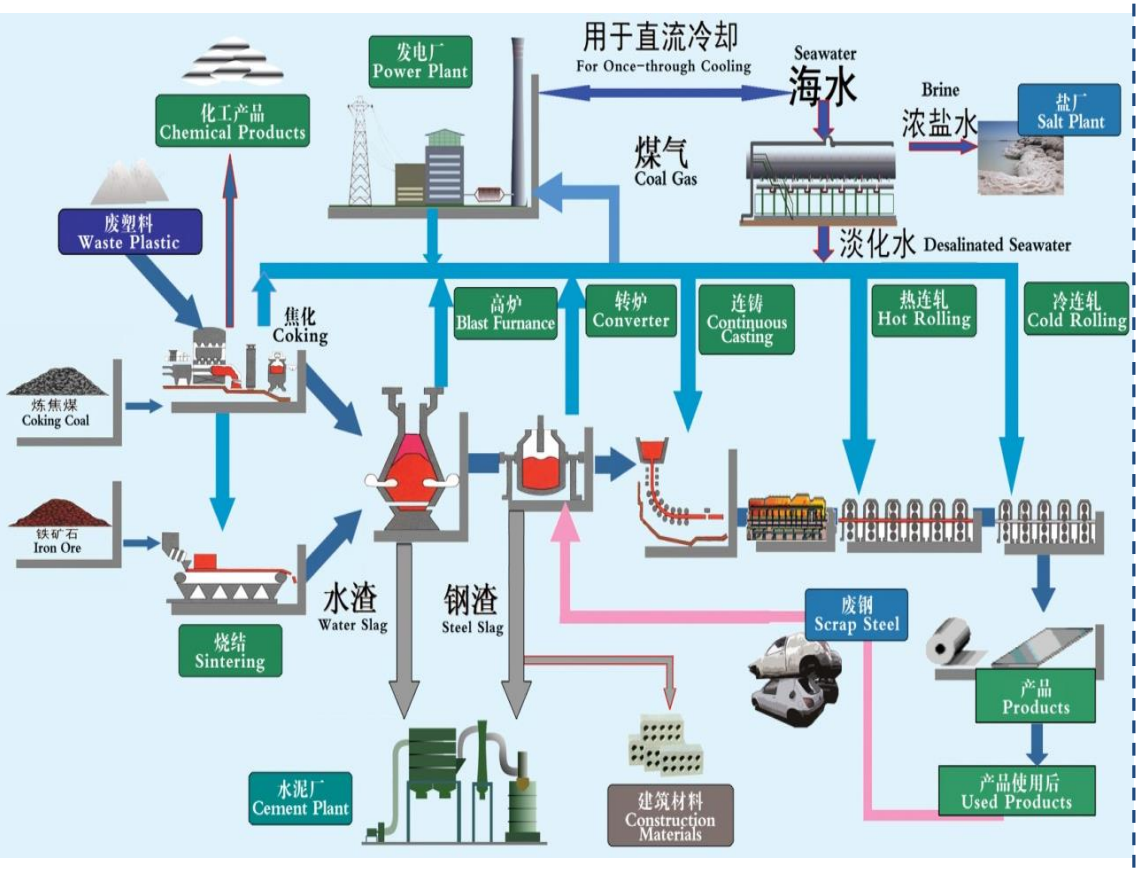
2. Regions

Extend producing chain.

3. Society

Combine industry and agriculture as well as production and consumption by ecological chain to realize sustainable production and consumption.

Diagram of Circular Economy of Shougang Jingtang



- Research on integrated technologies of clean steel manufacturing with high efficiency and low cost;
- Sample of new generation steel plant;
- H analysis and high value utilization;
- Seawater desalination and chemical utilization;
- Gas recovery and power generation;
- Slag processing and construction utilization;
- Surplus heat for urban utilization etc.

3.2 Orientation of low carbon development ——Developing a Circular Economy

4 rules

- Ecological benefit
- Operational
- Dynamic development
- Innovative practice

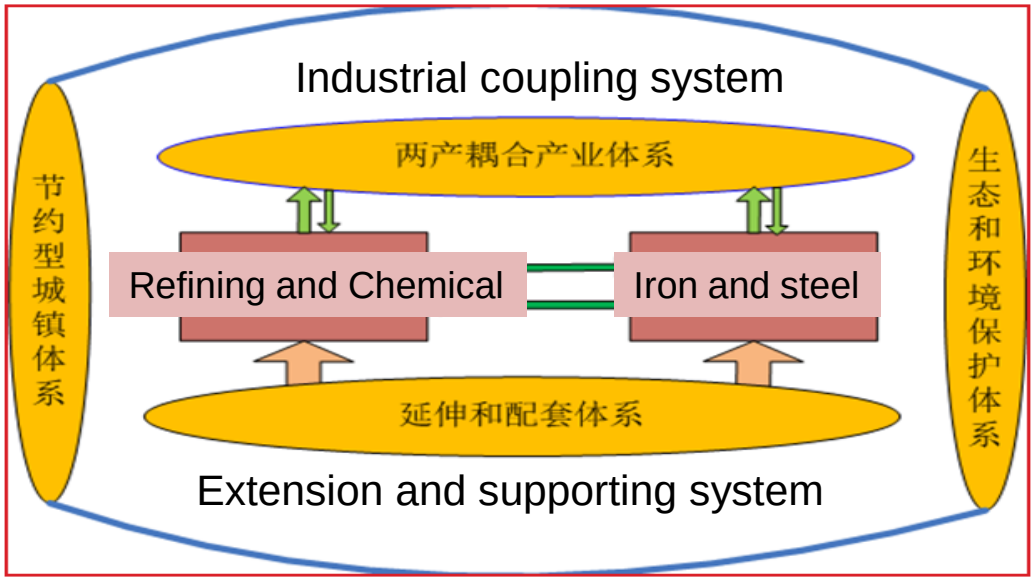
5 systems

- 2 enterprises
- Integration of steel and chemical industries
- Processing extension and supporting service
- Intensive city
- Ecological and environmental protection

6 projects

- Mutual supply of Hydrogen and fuel
- Industrial gas joint project
- Chemical-Steel Thermal and Power joint project
- Solid waste treatment and recycling project
- Water integration project
- Information integration project

Economical town system



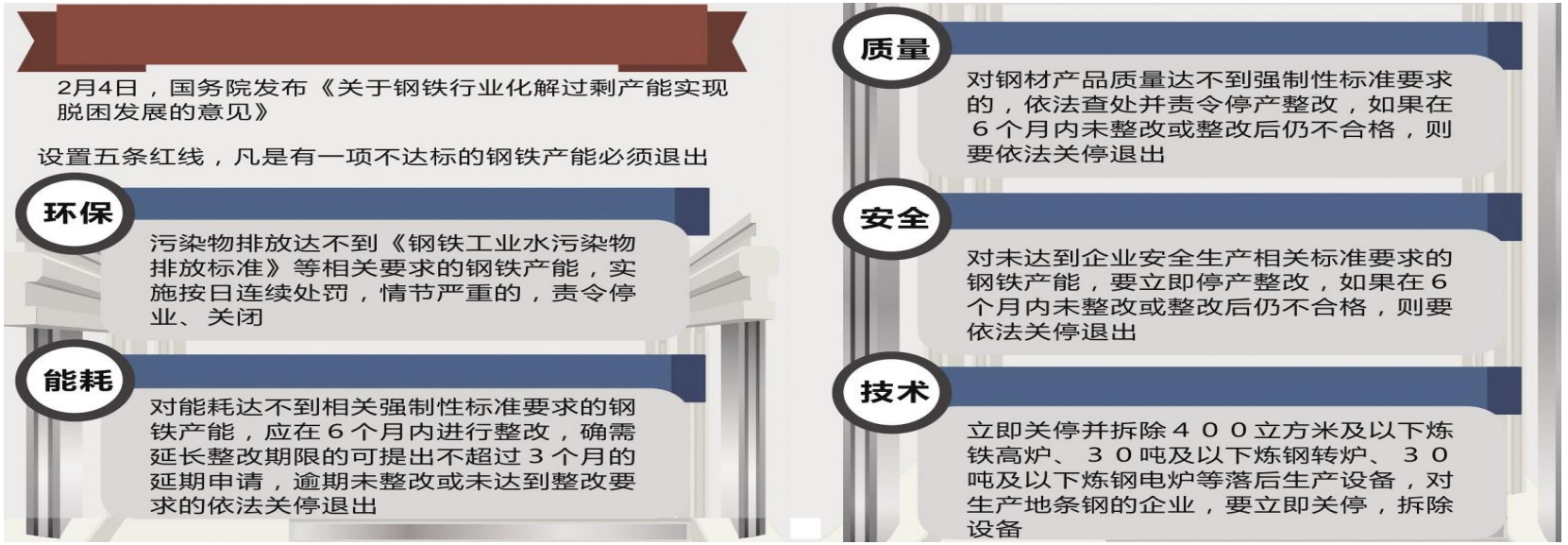
Ecological and environmental protection system

Diagram of Circular Economy of Zhanjiang Steel—Zhongke Refining and Chemical Project

3.2 Orientation of low carbon development ——standards promote excess capacity elimination

Exit complying with regulations and rules

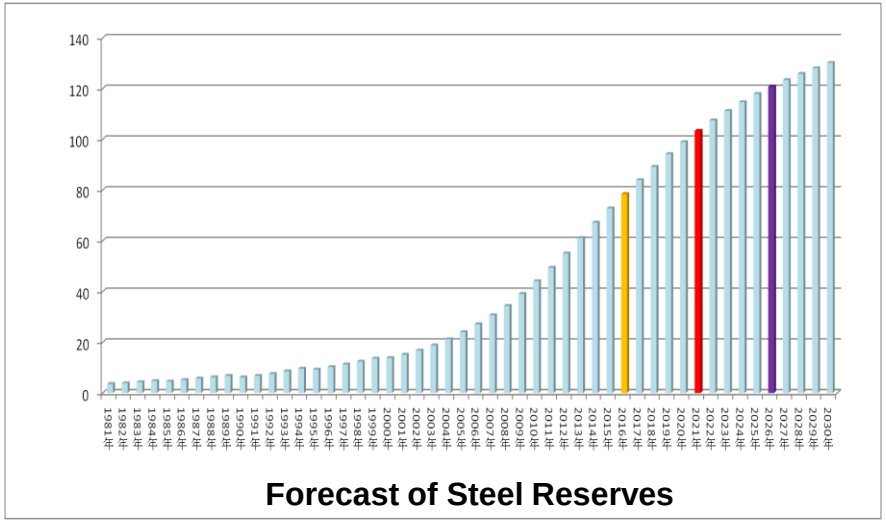
Eliminate the capacity, not comply with regulations, industrial policies or criterions by means of strict enforcement and supervision in environmental protection, energy resources, quality, safety and technologies in order to promote healthy and sustainable development of steel enterprises, which represented by more space given by environmental protection, high profitability contributed by energy conservation, big market share relied on quality and brand, substantial security supported by safe production and solid foundation depended on technologies improvement.



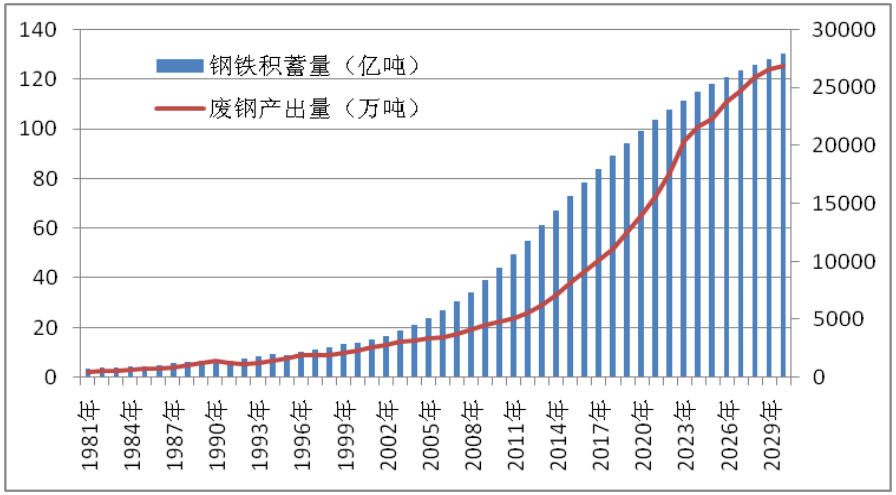
Exit on the enterprises' own initiative

Provide a smooth channel to encourage steel enterprises to remove capacity by means of reduction on the enterprises' own initiative, M & A, transformation, international cooperation etc emphasizing the enterprises without production or cannot survive. It is also strictly prohibited to restart the production once market becomes better.

3.2 Orientation of low carbon development ——promote high efficiency utilization of scrap



Forecast of Steel Reserves



Forecast of Scrap Output

- In 2017, Chinese steel reserves is about 7.8 billion tons, the same expected to be 10 billion tons up to the beginning of the 14th Five-year, and to be 12 billion tons up to the beginning of the 15th Five-year.
- It is estimated that annual scrap output in China is more than 100 million tons, the same expected to be more than 200 million tons at the end of 14th Five-year or in the 15th Five-year.
- Development of EAF steel in China will pass three stages briefly i.e. Primary stage: percentage of EAF steel in China will be 15%-20%; rapid growth: percentage of EAF steel will increase from 20% to 30% as well as slow down and balance: percentage of EAF steel reaches a new balance complying with varied conditions at that time refer to market, resources, environment, technologies, power etc.

3.2 Orientation of low carbon development ——develop steel further processing

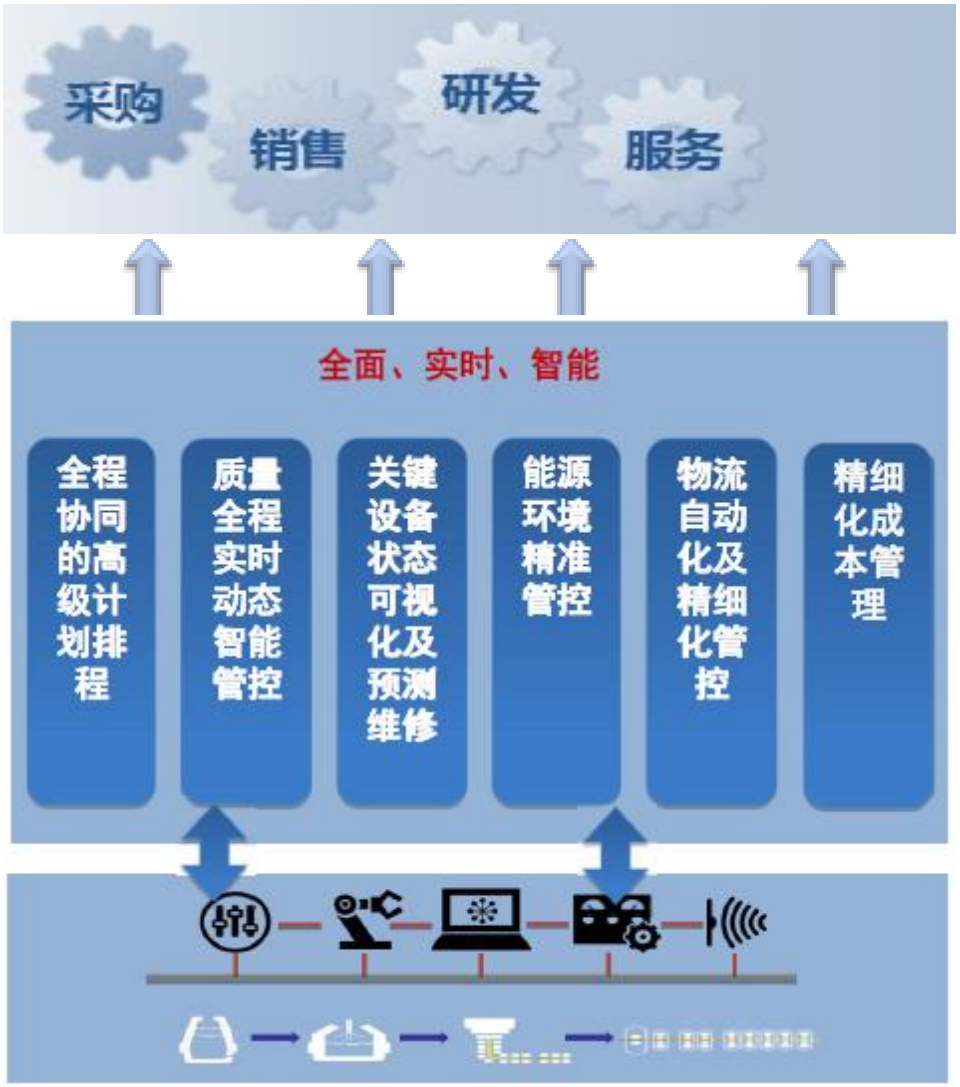
- **Changed the steel industry from conventional production-oriented manufacturing into service–oriented manufacturing;**
- **Set up a bridge between steel companies and end users;**
- **Develop steel further processing characterized by industrial extension and modern service.**

Adjustment and Upgrading Plan of the Steel Industry

Change the steel industry into service-oriented manufacturing.

Solution 1	Solution 2	Solution 3	Solution 4
Establish resources, process and sense of worth meet the targets and industrial characteristics.	Clear direction; familiar with the sector and target customers; further understanding of industrial rules and resources distribution.	Be capable of handling target business; professional team to deal with specific business.	Diversified and innovative system i.e. cross sector development of steel companies by means of joint venture , M & A etc.

Intelligent Service



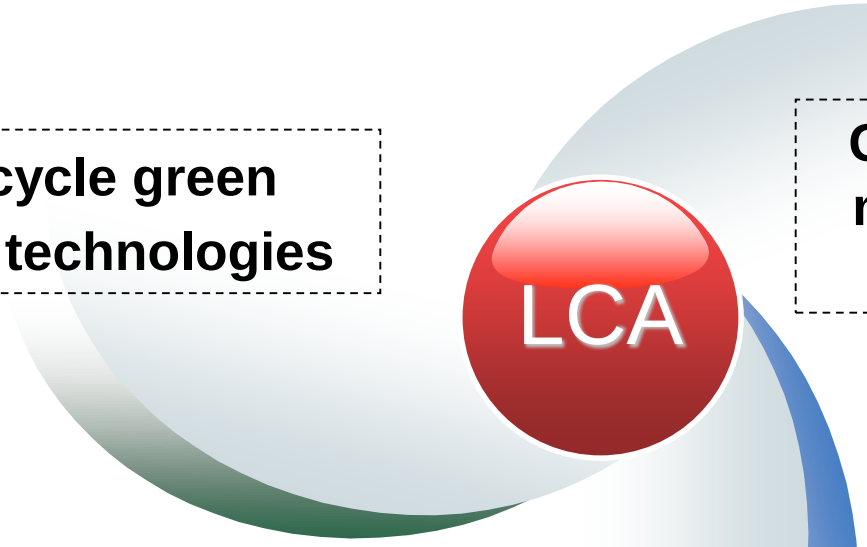
Intelligent plant

Intelligent equipments

Accelerate integration of network, procurement, R & D and service to reduce comprehensive cost of industrial chain.

Integrate production, logistics, equipments and energy by timely data collection and information share to optimize resources allocation and reduce energy consumption and cost.

Improve utilization rate of equipments and materials by means of automation, integration and intelligence modification to improve productivity and proportion of high quality products.



Life cycle green design technologies

Green design and green manufacturing LCA and application

Analysis on modification potential of whole process energy saving and Optimized production plan based on LCA

Renewable Energy Development Plan in the 13th Five-year Period

Renewable energy indicators：By 2020, all renewable energy power generation installed 680 million kilowatts, accounting for 27% of total electricity generation

Green Plant Construction Requirement

- The plant has an energy management system;
- The plant built photovoltaic power plant;
- The plant uses low-carbon, clean new energy;
- Renewable energy is used instead of non renewable energy when feasible;

Bayuquan Steel: 11 wind power generators with installed capacity of 15750 KW, and power generation of 79.83 million kWh in total; utilization rate of unit turbo is more than 80%; annual generation of photovoltaic is about 146000 kWh with productivity of about 80%.

Baowu Group: Sample photovoltaic power generation project with capacity of 50MV.

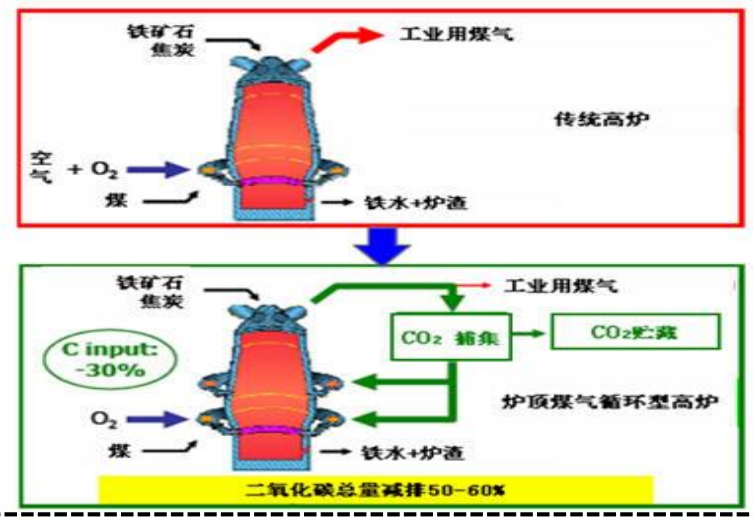
Integrated environmental project service covering design, manufacturing, construction and operation characterized by innovative mode and recycled resources.

energy-saving and environmental protection products : R & D, manufacturing and processing of core environmental equipments emphasizing De-S, Denitration and dedusting; establish producing base capable of manufacturing, fitting and assembling to improve market share.

Jinan Steel	Tangshan Steel	TISCO
1 Stepped water utilization;	1 Modernized water treatment center;	1 Water consumption management;
2 EPC of water treatment;	2 Utilization of reclaimed water;	2 Utilization of reclaimed water;
3 Internal pollution charge;	3 Waste water further treatment	3 Utilization of urban waste water;
4 Zero discharge of living waste water		4 Wet air cooling technology

Integration of steel companies and urban development

1. Environmental products utilization;
2. Urban waste water utilization
3. Urban reclaimed water utilization
4. Waste recycling to realize zero discharge.



Advanced low carbon technology is becoming the core competitiveness of a country, a sector and an enterprise.

Promote and accelerate self independent innovation to develop, reserve and adopt advanced energy saving technologies complying with transformation and upgrading of Chinese steel industry such as slag surplus heat recovery and recycling, complex iron making and coking, coordinated optimization of material flow, energy flow and information flow (big data), CO_2 capture, utilization and storage etc. Pay more attention to the application cost. And implement combined innovation mode covering production, education, research and application.

Ⅳ MPI——your reliable partner

MPI——your reliable partner

Consulting headquarter of government institutions
Guide in steel industry
Brain trust of enterprises planning

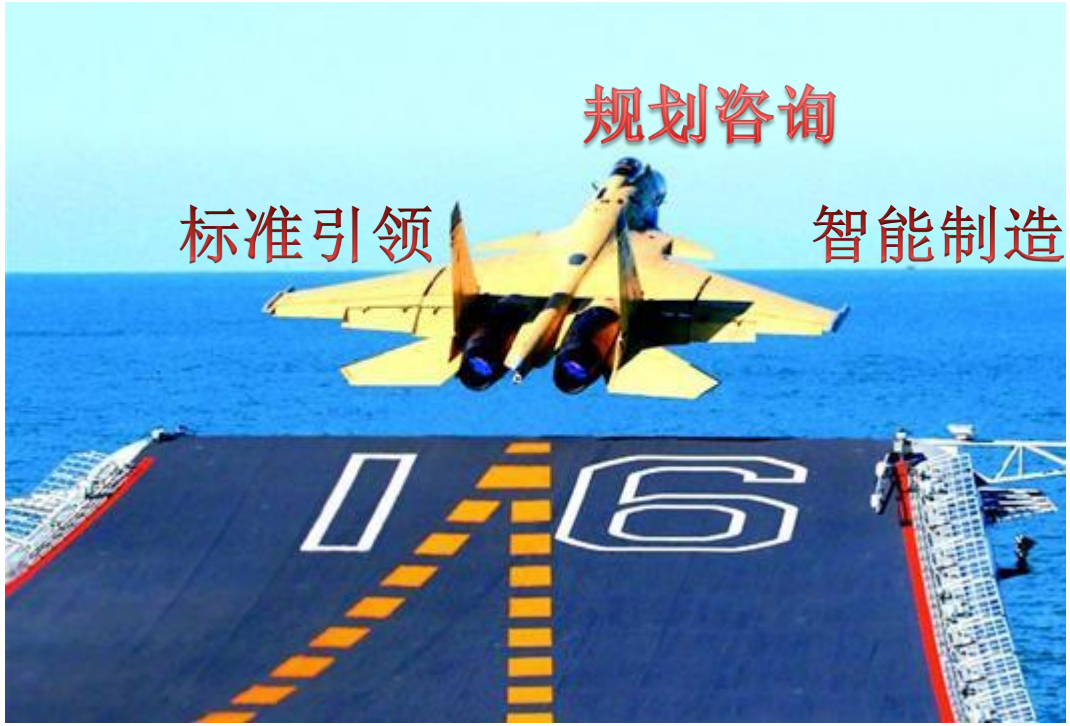
Authorized qualification: MPI was established under the approval of the State Council in1972, which is one of the first engineering consulting institutes with First-grade qualifications.

Excellent references: MPI has already finished more than 5,000 projects providing service for more than 200 government departments, industrial associations, more than 400 metallurgical companies and more than 50 overseas enterprises.

Human resources: The employees who have obtained doctor's and master's degrees account for 90% of the staff, those who have been awarded high-level technical titles account for 70% of the staff, and those who are state registered consulting engineers, senior technicians or who enjoy special government subsidy account for 50% of the staff.

MPI——your reliable partner

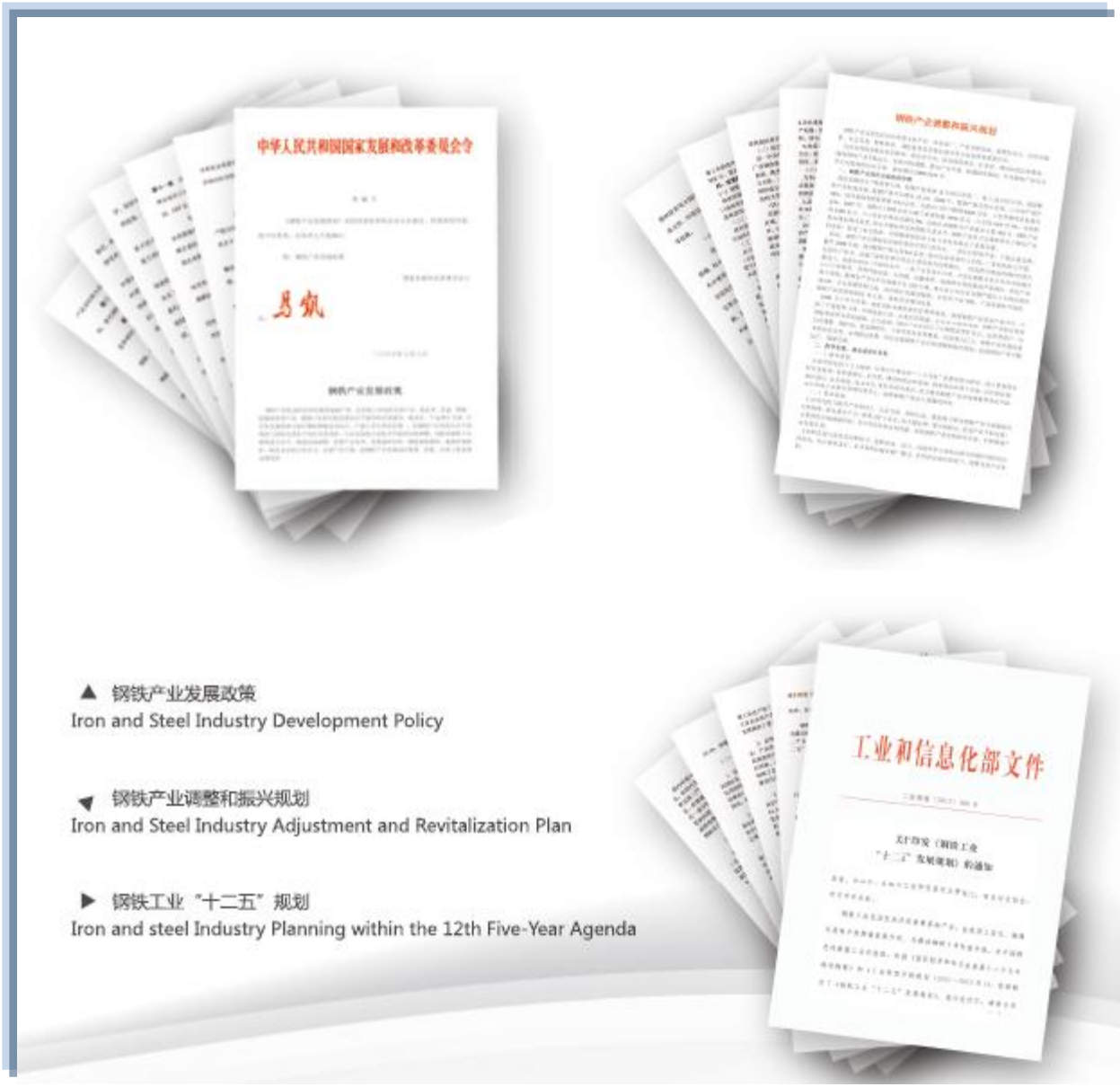
Main body together with two drives



- Planning and Consulting
- Standardization
- Intelligent Manufacturing

Consulting headquarter of government institutions

MPI undertook basic research of preparation of development plan of steel industry from the 5th Five-Year Period up to the 13th Five-Year Period. MPI also participated in formulation of important industrial policies such as *Development Policy of the Steel Industry, Adjustment and Rejuvenation Plan of the Steel Industry* etc. MPI has assisted MIIT completing the research on formulation of development plan of the steel industry in the 13th Five-Year Period.



▲ 钢铁产业发展政策
Iron and Steel Industry Development Policy

◀ 钢铁产业调整和振兴规划
Iron and Steel Industry Adjustment and Revitalization Plan

▶ 钢铁工业“十二五”规划
Iron and steel Industry Planning within the 12th Five-Year Agenda

MPI——your reliable partner

Guide in steel industry: MPI takes lead in China in carrying out market investigation and medium and long term demand forecasts of the iron and steel products. It also organizes the drafting of the Provisional Regulations for Feasibility Study and Economic Assessment of Investment Projects in Iron and Steel Industry and Technical and Equipment Policy for iron and steel industry.

Brain trust of enterprise planning: MPI has already accomplished over 5,000 cases of general planning and consulting services for hundreds of large and medium metallurgical enterprises. MPI participated in planning and research of major domestic steel projects such as Caofeidian of Shougang, Bayuquan of An Steel, Zhanjiang of Bao Steel, Fangchenggang of WISCO etc, as well as completed five-year development plan for many Chinese steel companies.

Development plan in the 13th Five-year Period

Since the end of the 12th Five-year Period, MPI prepared strategic development plan in the 13th Five-year Period for many steel companies such as WISCO, HBIS, Shandong Steel, Benxi Steel, Baotou Steel, Shaanxi Steel, Valin, Rockcheck, Guizhou Steel Rope, Huinan Steel etc.

Specific plan helping companies to improve competitiveness

New business fields include: green development plan, environmental diagnosis, research on One Belt One Road and going abroad of steel enterprise, further processing plan, diversified business development plan, research on cost reduction and efficiency improvement, logistics optimization, management improvement, intelligent manufacturing, E-commerce, mechanism reform, human resources optimization etc.

International cooperation and service

MPI has provided such consulting service as market research, feasibility study and equipment purchasing for Singaporean, Indonesian and China's Taiwan and Hong Kong companies who wish to establish joint ventures or solely foreign founded enterprises in China. MPI have provided service and participated in the research of such projects as the construction of Zimbabwe steel plant, Australian direct reduction iron project, Malaysia and Indonesia's technical service. In recent years, MPI participated actively in consulting of national development plan together with China Development Bank carrying out site investigation in Australia, Africa, South America, CIS, Southeast Asia etc, in order to provide reference for decision-making.

▲President Li Xinchuang had a conversation with Cameroon mining minister.

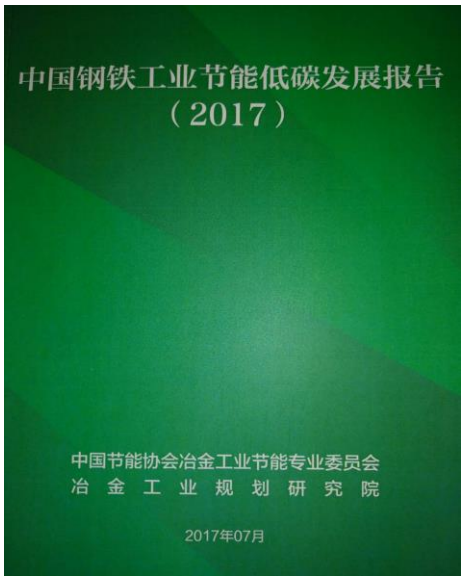
▲ President Li Xinchuang had a conversation with Venezuela mining minister.

China Steel Series Report

China Steel Series Report is a kind of industrial consulting report sincerely prepared by MPI on the basis of rich experience accumulated from more 1800 cases including annual and quarterly forecast report, market analysis report of long products, plate and pipe, as well as market analysis of iron ore, coke, non-ferrous metal and ferroalloy.

Information service

MPI provides additional information service for customers of China Steel Series Report including monthly report, daily highlights, industrial observation etc to ensuring more convenient and comprehensive service.



MPI's effort to promote low carbon development

Topic research

- Carbon verification, target break-up, emission coefficient research, technical support etc cooperate with NDRC, the Ministry of Science and Technologies, the Ministry of Environmental Protection, Quality Inspection Bureau etc.

Methodology formulation

- Participate in formulation of calculation methodology for the steel and coking industry;
- Participate in standard formulation of greenhouse gas emission calculation and submission of steel companies.

Consulting

- Tailored energy saving and low carbon development plan for steel companies

Research on carbon quota distribution plan

- Set up industrial carbon emission data base;
- Industrial carbon emission data analysis;
- Research and formulate carbon quota distribution plan.

MPI's effort to promote low carbon development

2008

Research and Calculation of CO_2 Emission of Key Large/Medium-scale Steel Enterprises with Capacity of more than 5 million tons

2009

Research and Calculation of CO_2 Emission of Key Large/Medium-scale Steel Enterprises with Capacity of more than 2 million tons

2010

Break-down and Implementation Plan of CO_2 Emission Intensity per unit GDP Decreased by 40%-45%

2011

Research on Potential of CO_2 Emission Reduction of Industrial Kiln and Furnace and Pollutants Coordinated Control

2012

Research on CO_2 Emission Coefficient of the Steel Industry

2013

Research on Supporting Technologies of Emission Reduction of Chinese Emission Intensive Industries

2014~now

Climate Technology Needs Assessment

Research on Key Emission Reduction Technologies of Chinese Steel Industry

Calculation Methodology of Guidance of Calculation of Greenhouse Gas Emission of Chinese steel companies

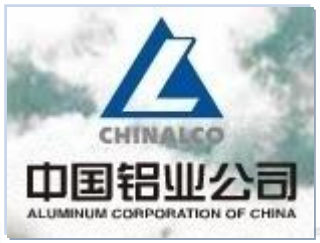
Calculation Methodology of Guidance of Calculation of Greenhouse Gas Emission of Chinese Coking companies

Low carbon development plan for steel companies such as Xiangtan Steel, Eastern Special Steel, Nanjing Steel etc.

MPI's effort to promote low carbon development

1. Analysis on basic data of carbon emission of the steel industry; research on low carbon development route.
2. Research on strategies, policies and development of low carbon development of Chinese and overseas steel industries.
3. Promotion and application of advanced and available low carbon technologies.
4. Strategic low carbon development plan for steel companies.
5. Carbon finance and carbon asset management of the steel companies.
6. International technical, organizational and political exchange in the low carbon sector.

MPI's clients



Thank you for your attention!

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