

Comprehensive Utilization of Resources and Sustainable Development of Phosphate Fertilizer Industry



Industrial Characteristics of Phosphate Fertilizers



- ❖ **Resources**—Phosphate resources is the fundamental raw material that supports production of phosphate fertilizers. Beside phosphate resources, such supportive resources as sulphur, coal, natural gas, potassium, electricity and water are also required. The security and supportive capacity of such resources will directly impact sustainable development of the industry, and the costs of such resources account for the vast majority of the total product costs.
- ❖ **Technology**—The production processes of either high-analysis phosphate fertilizers or low-analysis SSP and FMP are mature conventional process, which could hardly be substituted by any revolutionary new technology or new process.
- ❖ **Products**—“Fertilizer is the grain of grains” . This is particularly true to such a populous country with limited farmland as China, fertilizer is an important means to raise a big population with limited farmland. The data of China Phosphate Fertilizers Industry Association indicated that fertilizers has contributed to 60% of crop yield increases in China, and the highest contribution reached 67%. Experimental results indicated that fertilizer application contributes to 40.8% of Chinese grain output, and it plays an irreplaceable role in the Chinese agricultural production. Therefore, healthy development of the fertilizer industry is vitally important for Chinese agriculture to increase outputs and Chinese farmers to increase incomes.
- ❖ **The Market**—The total phosphate fertilizer production volume in China in 2010 was about 15.50 million tons P₂O₅, in which the production volume of high-analysis phosphate compound fertilizers was about 12.10 million tons P₂O₅, accounting for about 78% of total phosphate fertilizer production volume. Net export of phosphate fertilizers was 2.66 million tons of P₂O₅, which increased by 103% over the previous year. Domestic consumption was 12.84 million tons P₂O₅, with huge domestic consumption volume and market size. Simultaneously, the excess capacity need to be digested by exports, which is very competitive.



Current Phosphate Rock Supply and Demand—— General Situation and Production



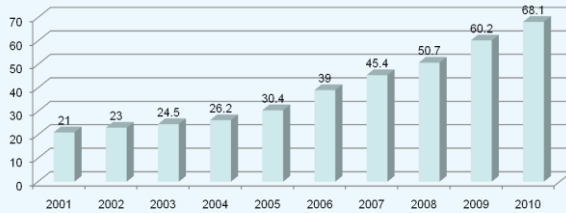
(I) General Description of Global and Chinese Phosphate Rock Resources

- Presently, the total global phosphate rock reserves are about 50 billion tons, in which 18 billion tons are industrial reserves, mainly distributed in more than 60 countries in Africa, North America, Asia, Middle East and South America. Globally, there are more than 30 phosphate rock producing countries, and the annual production volume is about 138 million tons.
- China has 17.86 billion tons of secured phosphate rock reserves, in which reserve is 1.18 billion tons, accounting for 6.6%, basic reserve is 3.17 billion tons, accounting for 17.7%, the quantity of resources is 14.69 billion tons, accounting for 82.3%, only next to Morocco, ranking the second place in the world.
- Chinese phosphate rock resources are large in quantity but not high in grade, and geographically distributed unevenly. The average grade nationwide is 16.95%, and there are but 1.108 billion tons of rich rock phosphate with $P_2O_5 > 30\%$. More than 85% of the middle and low-grade rock phosphate are colloidal phosphate rock hard to beneficiate.

(II) Chinese Phosphate Rock Production Status

In 2010, Chinese phosphate rock production volume accounted for 36.9% of the global total production volume, which increased by 13.1% over the previous year, ranking the first place in the world. The provinces with the highest production volumes are Hubei, Yunnan, Guizhou and Sichuan.

2001-2010年中国磷矿石产量 (单位: 百万吨)

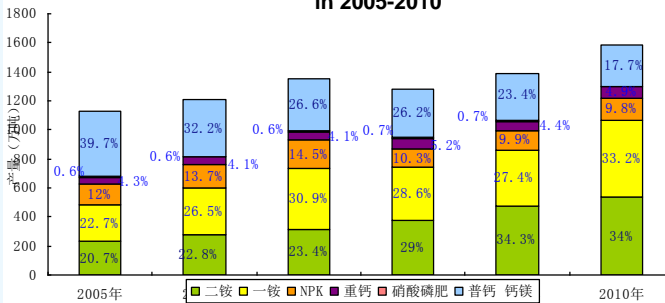


Current Phosphate Rock Supply and Demand Analysis



(III) Chinese Phosphate Rock Consumption Volume

Chinese Phosphate Fertilizer Production Volumes and Product Structure in 2005-2010



About 80%-90% of Chinese phosphate rock production volume is used for production of phosphate fertilizers. If we calculate by the actual phosphate rock consumption of 82 million tons in 2010, about 65.6 – 73.8 million tons of phosphate rock were used for producing phosphate fertilizers.



Sulfur Supply and Demand—— China Sulfur Supply & Demand Balance



- Total sulfur consumption was 26.6 million ton in 2010, of which, sulfur apparent consumption was 13.67 million ton, domestic output was 3.2 million ton, self- supply only accounted for 23.4% ;

- Sulfur and SA need import abroad, and above 50% of smelter acid also supplied abroad. In 2010, 56% of Chinese sulfur resource had to rely on foreign supply.

- ❖ Supply Ability——According to the production situation, the future sulfur production in China will be mainly depend on recovery acidic natural gas and recovery by processing highly sulfur contained crude oil imported abroad. In addition, coal chemical industry is using more and more highly sulfur contained coal, the sulfur recovery is increasing. Expected by experts, Chinese recovered sulfur will reached to 5.1 million ton in 2015.
- ❖ Consumption Demand—— Due to the policy of “Energy Saving and Emission Reduction”, the small SA plants using pyrite will be substituted by sulfur using SA plants, therefore, the SA capacity will increase, and the sulfur consumption will also increase 2.5 -3.5 million ton per year. Therefore, it is expected that Chinese apparent sulfur consumption will reach to 17 million ton in 2015, and the volume of imported sulfur expected remain about 10-12 million ton. So, in a short period it is hard for China to change the situation of that above half sulfur demand has to depend on import.



Natural Gas Supply & Demand—— Reserves, Yield and Import & Export



Global Natural Gas Reserves			
Item	Country	Proved Reserves (trillion feet)	Remarks
1	Russia	1680	Data from EIA Jan. 2010
2	Iran	1045.7	
3	Qatar	899.3	
4	Saudi Arabia	263	
5	USA	244.7	
6	UAE	214.4	
7	Nigeria	185.3	
8	Venezuela	176	
9	Algeria	159	
11	Indonesia	106	
12	Malaysia	85	Data 1st of Jan. 2009
13	China	81	

- Natural gas reserves in China is not abundant, proved reserves is 81 trillion cubic feet, ranked No.3 in Asia Pacific area.

- The total natural gas reserves of the top 3 countries of Asia Pacific area is merely equals with the reserves of the USA.

- The output of natural gas was 94.48 billion cubic meters in 2010, up 12.1% from 2009.

- Foreign Dependence — Chinese foreign dependence on natural gas reached to 11.7% in 2010, up 3% compared with 2009. From January to August of 2011, the foreign dependence on natural gas was 20.5%.

- The total global natural gas of 2010 was 3169 billion cubic meters, up 7.4% compared with the year of 2009.

- Chinese natural gas yield ranks as No. 7 in the world, behind USA, Russia, Canada, Iran, Qatar and Norway, only accounts for 3% of the global yield, but the consumption has sprung into No. 4 in the world, accounting for 3.4% of the global total consumption, up 21.8%.



Coal Supply & Demand—— Reserves, Yield and Import & Export



- By the end of 2009, Chinese proved coal reserves was 114.5 billion ton, Ranked third in the world. International Energy Agency says that there is at most 189 billion ton unmined coal reserves in china. Chinese Per capita coal reserves only equals the half of the world value.
- The proportion of yield and consumption of coal in Chinese primary energy is as high as 70%.
- Chinese coal reserves accounts for about 14% of the global reserves ,but it's coal consumption accounts for 47% of the world, which is 3 times of its reserves, very unsustainable.
- The data of Bureau of Statistics indicates that China totally yielded raw coal 3.24 billion ton in 2010, up 8.9% compared with the year 2009.

Import——The volume of imported coal was 164.78 million tons in 2010, up 30.9% compared with 2009, total imported amount 16.9 billion Yuan, up 60.1% compared with 2009;

Export——The volume of exported coal was 19.03 million ton in 2010(total amount 2.3 billion Yuan), down 15% compared with 2009



Coal Supply & Demand ——China Coal Consumption



国家	消费量 (百万吨油当量)	与 09 年比变动幅度	占全球总量
中国	1713.5	10.1%	48.2%
美国	524.6	5.7%	14.8%
印度	277.6	10.8%	7.8%
日本	123.7	13.7%	3.5%
俄罗斯	93.8	2.1%	2.6%
南非	88.7	1.1%	2.5%
德国	76.5	6.7%	2.2%
韩国	76.0	10.8%	2.1%
波兰	54.0	3.9%	1.5%
澳大利亚	43.4	-16.1%	1.2%

- The global coal consumption of 2010 was about 3,556 million ton oil equivalent, up 7.6% compared with 2009;
- China coal consumption of 2010 was about 1,714 million ton oil equivalent, up 10.1% compared with 2009, accounting for 48.2% of the global consumption;
- China totally consumed coal 3,160 million ton in 2010, up 5.3% compared with the previous year, of which, electric power consumed 1,730 million ton, accounting for 53% of the whole country's raw coal.



Status Quo of Phosphate Fertilizer Industry — Environment



Nature

In the background of global warming, 'low-emission economy' based on low energy consumption, low pollution and low emission has become a global hot point.

With the fast development of the phosphate chemical industry, the industrial 'three wastes' and dust pollution thereby is also becoming worse and worse, and the social conflicts thereby are also intensifying. Protection of plants and animals around the factories and people's health issues could hardly be neglected.



Gypsum, Land ...

Government

Chinese government has officially committed to cut CO2 discharge intensity ratio in unit GDP by 40%-45% over that of 2005. The emission reduction tasks and objectives will eventually be broken down to every enterprise.

"Industrial Access Conditions for Ammonium Phosphate" promulgated in this year specified all the environmental specifications to be met by producers in production discharge, and those who failed to meet the specifications will be closed. Thereafter, the state promulgated "Industrial Water Pollutants Discharge Standard for the Phosphate Fertilizer Industry", etc., which further raised the safety and environmental protection standards for the phosphate fertilizer producers. This indicated that the Chinese government is dedicated to push the phosphate fertilizer producers to be safer and more environmentally friendly.



Clean production, environmentally friendly discharge



Status Quo of Phosphate Fertilizer Industry — Environment



- ❖ Gypsum is a byproduct of wet process phosphoric acid (WPPA), and while producing a ton of WPPA (100% P₂O₅), about 5 tons of gypsum (dry basis) will be generated. Presently, China generates about 70 million tons of gypsum every year, in which about 17 million tons in Yunnan Province, and about 10 million tons by Yuntianhua International Co., Ltd.
- ❖ Some Chinese WPPA producers adopt the dry process to discharge gypsum, and have it piled on flat land; Some producers adopt wet process to discharge gypsum, have it piled up in a dammed valley, and build pipes to collect and recycle the water. The current ways of disposal require considerable land, large gypsum storage construction investments and high operation costs. Simultaneously, it also has potential risks and safety hazards to the surface and underground water, and dusts in the air, which has become an important bottleneck for sustainable development of the phosphate fertilizer industry.

Huge quantity

As a byproduct of WPPA, its output volume is much higher than phosphate fertilizer products. To realize total utilization of it as a resource, no matter making building materials or as a raw material for sulphur and calcium chemical products, it requires a huge market. Simultaneously, it requires huge construction investments and logistics support, which is hardly affordable for the producers.

Technical Restrictions

If gypsum is used for such purposes as making building materials or as soil regulating agent, road foundation filler, they are generally products with low added value, its sales range is subject to radius of transportation, and the size of the target market is also limited.

Economic Restrictions

One way to utilize gypsum in large quantity is to make sulphur and calcium chemical products. It is especially noteworthy that making sulfuric acid together with cement may fully realize recycling use within the plant. However, the existing mature technologies have such restrictions as high investment, high energy consumption, high costs, small production scale, and failure to match large WPPA plants.

Competition of Substitute Products

Comprehensive utilization of phosphogypsum faces competition from natural gypsum and flue gas desulfurization gypsum. Yunnan has abundant reserves of natural gypsum, with low mining costs. Simultaneously, there are many thermal power plants remove sulfur from flue gas by wet process and produce desulfurization gypsum as a byproduct. These two products have such advantages as high purity, easier to handle than phosphogypsum, which imposes more challenges to the comprehensive utilization of phosphogypsum.



Bottlenecks for Industrial Development — Resources



- Since phosphate rock mining development lags behind, with too few large state-owned mines, the phosphate rock mining rate is low, resulting in serious waste of resources, and high-grade rock reserve depletes by more than 100 million tons a year. The phosphate fertilizer producers without a phosphate rock mine will have more and more difficult access to phosphate rock .
- With the depletion of high-grade phosphate rock resources, the supply of high-grade raw phosphate rock is becoming increasingly tight, the price keep rising, forcing the phosphate rock mining and processing companies to consider meeting the increasing market demands by beneficiating medium and low-grade rock phosphate.
- China has limited natural sulfur resources, and the domestic sulfur production is mainly to recover sulfur from crude oil and natural gas, with too low production volumes to meet the demand, and the deficit is huge. China imports $\frac{3}{4}$ of its sulfur, which could hardly be changed in the near term.
- In the phosphate fertilizer industry, the percentage of sulfur cost in the total cost has increased significantly, and the sulfur import price decides the profitability and developments of the Chinese phosphate fertilizer producers.



Bottlenecks for Industrial Development — Energy



- China's natural gas reserve is low, and with the depletion of the reserves, the state surely will control the production volume, save energy and restrict industrial use of natural gas. Simultaneously, dependence on imported natural gas is very high. Some experts projected that by 2020, China's dependence on imported natural gas will reach 50%, and with the steady rise of import price, the domestic energy consumption price will be troublesome.
- Coal, as an important energy for electricity, metallurgical and industrial production, accounts for as high as 70% of China's primary energy production and consumption. The policy of "integrating coal resources" further reinforced the voice of coal companies in negotiation, and the high-analysis phosphate fertilizer production is subject to both the restriction of electricity and coal.
- Energy cost accounts for a large percentage in phosphate fertilizer production, and in the costs of coal or natural gas-based ammonia, the costs of coal and natural gas accounts for 60% and 70% of the total costs.



Bottlenecks for Industrial Development — Technology



- ❖ The production processes of either high-analysis phosphate fertilizers or low-analysis SSP and FMP are mature conventional process, which could hardly be substituted by any revolutionary new technology or new process.
- ❖ Creativity being poor, with few patent technologies with autonomous intellectual property rights. Since the enterprises are normally small, their R&D abilities are insufficient, and they lack of financial strength for autonomous innovation.
- ❖ Most of the Chinese large phosphate chemical enterprises focused on the primary processing stage of fertilizer products, without adequately developing high-purity phosphate chemical products more demanding for purification of WPPA.
- ❖ Technologies for disposal of phosphogypsum, discharge, treatment and recycling use of three wastes restricted further development and growth of the enterprises.



Bottlenecks for Industrial Development — Environment




- ❖ Due to rough means of economic growth and poor environmental protection in the past three decades, China has paid a huge environmental price, and will have to repay the environmental debt in future development.
- * Ministry of Environmental Protection and AQSIQ published “Standard on Discharge of Water Pollutants in Phosphate Fertilizer Industry” dated October 1 further reinforced control and management of wastewater discharge of phosphate fertilizer enterprises. Simultaneously, the promulgation of this standard means that the producers will have higher environmental pressures.
- ❖ Phosphate fertilizer industry is a resources-intensive industry with high energy consumption and high risks. Manufacture of phosphate fertilizers involve phosphate rock mining and beneficiation, production of sulfuric acid, phosphoric acid and phosphate fertilizers and ammonia. The wastes generated by phosphate fertilizer production, such as phosphogypsum, are huge in quantity, which have not been effectively treated yet.
- ❖ For the Chinese large phosphate fertilizer producers, the issue of phosphogypsum can no longer be neglected. It is seriously restricting the further expansion and development of the phosphate fertilizer producers. There have been many cases of pollution and improper treatment imposing threats to the natural environment and even to people’s health also alerted us.




Bottlenecks for Industrial Development — Technology


Phosphogypsum



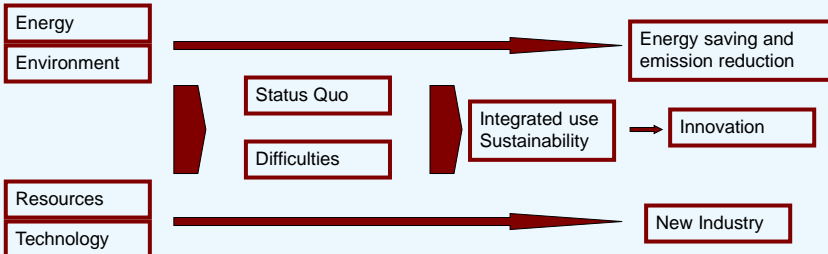
Train of Thoughts	Measures	Achievements
<ol style="list-style-type: none"> (1) It is to adhere to the principle of scientific storage and effective use. (2) It is to combine near-term measures with long-term planning, give priority to environmental benefits, while caring about economic benefits simultaneously. (3) It is to adequately utilize social forces, adopt multiple means of cooperation, and explore multiple means to comprehensively utilize phosphogypsum as a resource. (4) It is to adhere to multiple channels and layers, and actively pursue policy supports. (5) It is to adhere to the principle of technology innovation. 	<ol style="list-style-type: none"> (1) It is to establish a special leading group on phosphogypsum. (2) It is to construct a demonstrative project on comprehensive utilization of phosphogypsum as a resource. (3) It is to tap the advantages in resources to actively pursue cooperation with upstream and downstream enterprises in the industrial chain of gypsum products, enter the gypsum products industry with low costs, and quickly gain experiences in technology, production and market operation. (4) It is to adapt to local conditions, improve the quantity of phosphogypsum to be comprehensively utilized as a resources by multiple means. (5) It is to encourage and promote comprehensive utilization of phosphogypsum by such measures as subsidy, supports and assist in transportation, etc. 	<ol style="list-style-type: none"> (1) In 2010, Yuntianhua International totally consumed 0.89 million tons of phosphogypsum, in which 0.49 million tons were used as soil regulating agent, while 0.4 million tons were used for making construction materials. (2) It is to conduct technical development for adding low-temperature ceramic gluing material, producing bricks and building materials with modified phosphogypsum, which is currently industrialized, and constructing 30 million pieces/yr. no-burning phosphogypsum standard bricks project. (3) The demonstrative project of making construction materials with phosphogypsum has commenced. It is to build 200 kt/a β semi-water construction gypsum power, 60 kt painting gypsum power, 0.5 million m2 gypsum blocks, 0.3 million m2 hollow plates, 0.3 million t/a set retarder for cement plant and auxiliary plants.



Road of Sustainable Development




- ❖ To answer to the call of the state for changing the means of economic development and realize sustainable development of the industry, the enterprises should actively invest in promoting comprehensive utilization of resources, adopt new technologies to lower consumption of energy and water resources, minimize and even eliminate environmental pollution, and realize harmonious development of economic benefits, environmental benefits and social benefits.
- ❖ In the macro environment of policy control becoming more and more strict, market competition becoming fiercer and fiercer, to solve such pressing problems as scarce resources, high costs, and technical primitiveness, it requires the producers to start from more effectively utilize the resources, keep innovation and improving the process and technology, and build kernel competitiveness of the enterprise in the strategy of sustainable development.
- ❖ The status quo of resources and environment requires us to take “energy saving and emission reduction” as the core, and pursue long-term development. Insufficiency and defects in resources and technology push us to break the traditions and take the road of “new industrialization”.



```

graph LR
    subgraph Inputs
        E[Energy]
        Env[Environment]
        R[Resources]
        T[Technology]
    end
    subgraph Status_Quo
        SQ[Status Quo]
        D[Difficulties]
    end
    subgraph Process
        IUS[Integrated use Sustainability]
        I[Innovation]
    end
    subgraph Outputs
        ESE[Energy saving and emission reduction]
        NI[New Industry]
    end
    Inputs --> Status_Quo
    Status_Quo --> IUS
    IUS --> I
    I --> ESE
    I --> NI
    
```

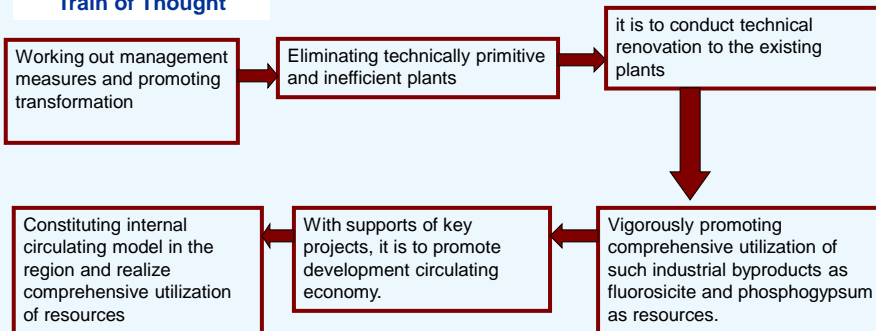


Road of Sustainable Development — New Industry

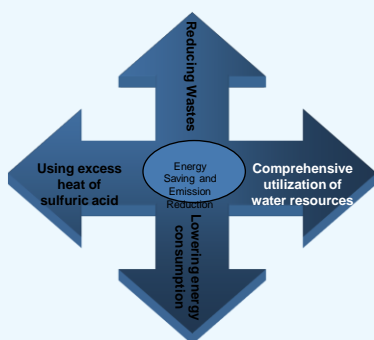


- ❖ Yuntianhua International adheres to the motto of “ becoming a well respected enterprise with social accountability, and becoming an industrial model in terms of economic development, social harmony and environmental protection,” actively explore the road to new type industrialization for developing recycling economy and realizing sustainable development, and achieved good economic return and social benefits.

Train of Thought

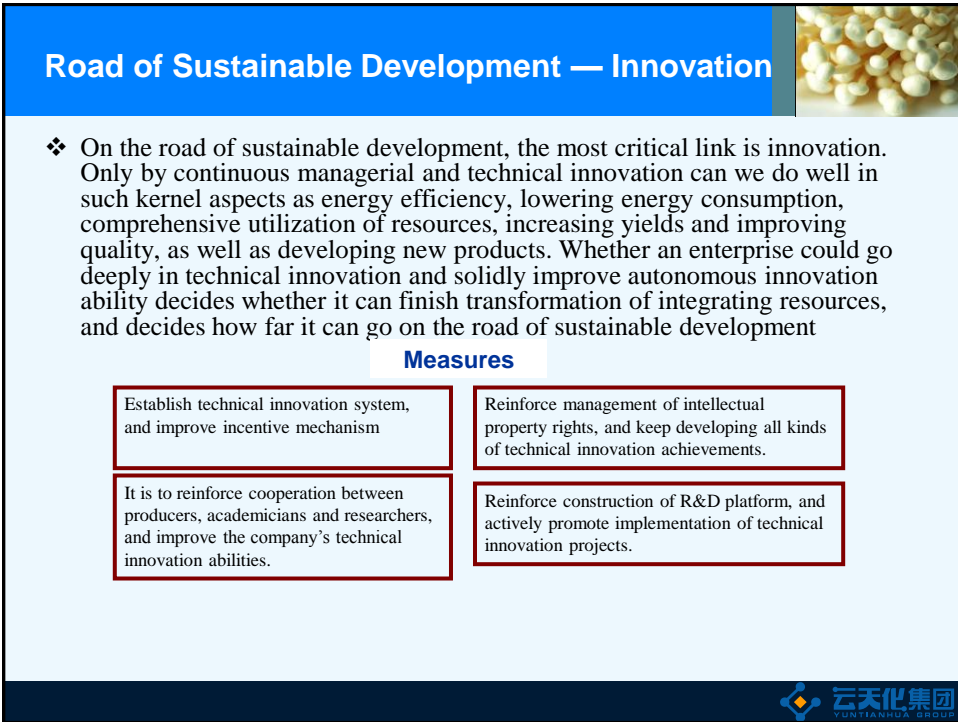
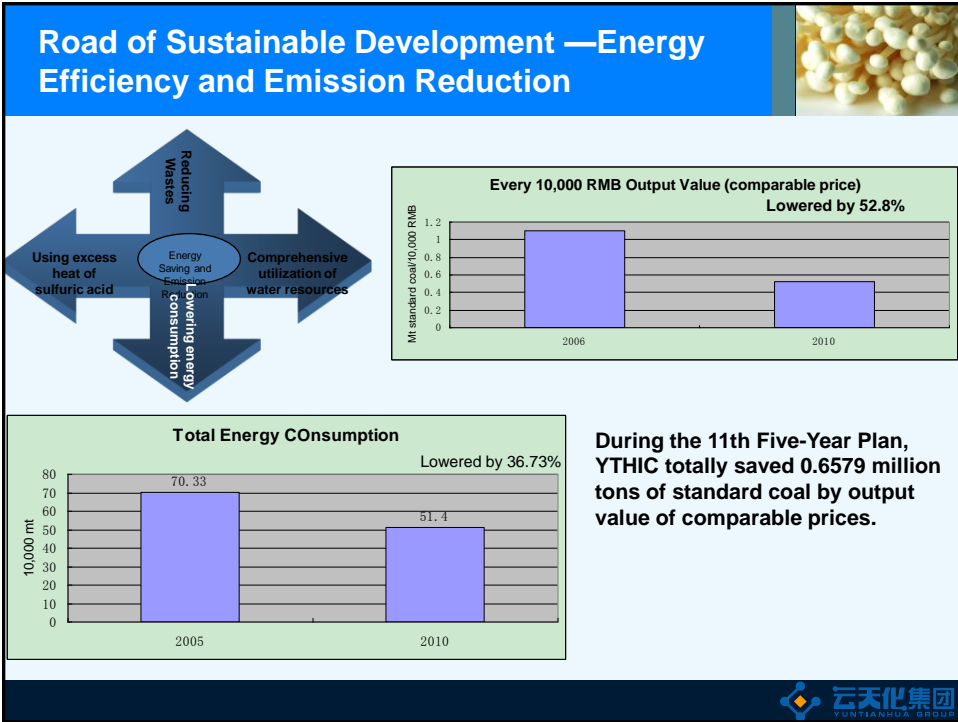


Road of Sustainable Development —Energy Efficiency and Emission Reduction



- ❖ Implemented and finished zero discharge of wastewater, and totally changed from treating production wastewater at the end to preventing pollution and total control of production course, and achieved good economic returns.
- ❖ Implemented such measures as separating clean streams from sewage streams, recycling use of water, increased collection of rain water, and reduced water intake volume, etc.
- ❖ The total industrial water intake volume of Yuntianhua International in 2010 decreased by 2.98 million tons than that of 2009, and the total wastewater discharge volume decreased by 2.96 million tons, and saving about 51.59 million RMB costs.





Conclusions



- ❖ (1) Every enterprise has the wishes of permanent operation and sustainable development. Therefore, it is to put developing recycling economy, energy efficiency and emission reduction, comprehensive utilization of resources and sustainable development into the company's long-term development strategies.
- ❖ (2) It is to pursue the development model integrating environmental benefits with social benefits and economic returns, and only by unifying the social benefits and economic returns of energy efficiency and environmental benefits can the enterprise consciously and continuously promote energy efficiency, emission reduction and develop recycling economy.
- ❖ (3) It is to invest money and technology in saving resources and environmental protection, and consider long-term and comprehensive benefits, but not simply to pursue near-term economic returns.
- ❖ (4) It is to be open-minded, actively pursue cooperation, fully mobilize the incentives of all stakeholders, and use social forces to realize the objective of comprehensive utilization of resources. It is to cooperate with the downstream enterprise on the industrial chain, and pursue harmonious development in the background of regional recycling economy.

During the "12th Five-Year Plan", Chinese economy and society has entered a new stage of promoting development with transformation, and the company's development are subject to more serious restriction of resources and environment. There are not only opportunities but also challenges. Ought the phosphate producers stay in business long and have sustainable development, they must shake off the rough development means of high inputs, high consumption and low returns. To solve the problem of worse and worse eco-environmental pressures and social harmonious development, it is to adhere to promoting clean production, rely on technical progress, and gradually realize the development mode of recycling economy in the enterprises and the neighboring areas. Only by keeping the company's development paces in line with the development trends of the state and the society, can the company realize sustainable development.