

III Key white biotechnology products

III-1 Existing commercial products

III-1-1 Bio-products

III-1-1.1 Yeast

- Market situation of yeast for fuel ethanol

Hubei Angel, the biggest yeast producer in China, has developed a yeast strain that has greater tolerance to ethanol (17% by volume) and to sugar (60%) by the end of 2006, which is named as super brewer's high activity dry yeast. Currently, about 80% of fuel ethanol in China employs this type of yeast. The yeast for distilled spirits can also be used to produce fuel ethanol.

The main customers are the appointed fuel ethanol producers. Besides them, Angel also exports its super yeast to US. In 2007, China's output of fuel ethanol is about 1.7 million tonnes. The consumption of super yeast for fuel ethanol is estimated to be 600~700 tonnes.

Table III-1-1.1 -1 Fuel ethanol producers in China

Project	Launch time	Capacity, t/a
██████████	2004	300,000
██████████	1999	100,000
██████████	2001	400,000
██████████	1998	440,000
██████████	2007	██████████
██████████	Under construction	██████████
Total		██████████

.....

- Manufacturers

Table III-1-1.1 -3 Major yeast manufacturers in China, 2008

No.	Manufacturer	Location	Capacity '08	Comment
1	██████████	Hubei	██████████	Six plants
2	██████████	Heilongjiang, Hebei, Shandong, Guangdong, Xinjiang	30,000	Six plants
3	██████████	Guangdong	██████████	
4	██████████	Guangdong	██████████	
5	██████████	Anhui	██████████	
6	██████████ ██████████	Shandong	██████████	
7	██████████ ██████████	Guangdong	██████████	

8		Shandong		New player
9		Heilongjiang		New player
Total				

The yeast industry is becoming more and more concentrated in China and the top 3 players share over 80% of the market in China. In recent years, the top 2 have put great effort to expand their capacity.

The capacity of Hubei Angel is 58,000 tonnes in 2008, constituting over 50% of China's total capacity, and it will be expanded to 73,000 tonnes in 2009.

V Key WB researching groups, technical suppliers and top scientists

V-1 Scientists and their directions

White biotechnology is a comprehensive science and developing rapidly in China. At present, the active research groups, top scientists and their research directions in this field are as follow:

Table V-1-1 The researchers of biofuel in China

Scientists	Institution	Present Directions
		Saccharomyces cerevisiae
		Industrialized production of biobutanol
		Bioenergy and zoology chain of stalks
		Microorganism fuel battery used in waste water treatment
		The biodegradation of aromatic compound

.....

Table V-1-3 The researchers on bio-production

Scientists	Institutions	Present directions
		Microorganism used in food production

[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	Chemical-enzymic technology in pharmaceutical
[REDACTED]	[REDACTED]	Enzyme catalyzer
[REDACTED]	[REDACTED]	Synthesis glycosyl-chemicals catalysis by enzyme

VI Future prospects

VI-1 Drivers

Drivers for White Biotechnology:

- ✓ Better products for consumers
- ✓ More economical for industry and consumers
- ✓ More dependable, renewable and lower-cost feedstocks
- ✓ More environmentally friendly products/processes; smaller environmental footprint
- ✓ Policies and environmental issues

.....

- More economical products

White biotechnology provides ways to reduce the production cost:

- Feedstocks. More cheaper and renewable feedstocks can be used, instead of fossil materials, to produce chemicals. Cheaper lignocellulosic biomass still cannot be utilized to produce ethanol in mass production. If this door is opened up completely, the shortage of food and fuel supply will be relieved to some extent. Genetically modified crop is another way to reduce the cost.
- Production process. By optimizing the enzyme and fermentation strain, the production efficiency can be enhanced and the production cost reduced.
- Comprehensive utilization of biomass. With biological routes, residues and wastes can be re-used and then reduce the production cost.

.....

VI-3 Future Prospects

VI-3.1 Bio-fuel

- Product oil consumption in China

The product oil price in China is controlled by the government at a relative low price which indirectly restricts the profit margin of fuel ethanol and bio-diesel. In recent five years, the crude oil price has soared. The price (Apr-15, 2008) has risen by over 250% compared to that in Jan. 1, 2003. However, the product oil price in China has just risen by about 70%, 70.7% for diesel and 67.3% for gasoline (in Guangdong province). The current price of diesel and gasoline in China is RMB5,520/t and RMB5,980/t respectively.

The oil consumption grows fast in China. The CAGR '02~'07 for crude oil and product oil consumption is 8.98% and 9.12% respectively. The growth will slow down with the macro-control on fuel consumption.

- CAGR '05~'10: 4.5% for crude oil, 5.5% for product oil.
- CAGR '11~'20: 3.3% for crude oil, 4.3% for product oil.

.....

- **Future market development of Bio-fuel**

Many factors affecting bio-fuel industry have been discussed above and the forecast is made based on these factors and key drivers. Three scenarios are illustrated: low growth, expected growth and high growth.

Projections

As discussed above, the future of biofuel will be determined by the general state of the fuel consumption, the biological technology improvements and the policies. But many other factors and drivers will either change the demand for bio-fuels or influence the nature of the product in some way.

The data has been derived from a wide range of sources including a number of telephone interviews and governmental documentations.

In making projections it is usually useful to compare different scenarios in order to get a balanced view. (The word "scenarios" is used here to describe a set of assumptions.) Therefore, three scenarios have been chosen as follows.

- **Low growth**

- ✓ Product oil demand growth: [REDACTED]
- ✓ Crude oil demand growth: [REDACTED]
- ✓ Technology: lignocellulosic ethanol is industrialized since 2015
- ✓ Policies: Bio-fuel production from food crops is banned. No new subsidies are given to bio-fuel production.
- ✓ Food Supply: tight to 2020.
- ✓ Raw materials: specific fuel plants are planted, lignocellulosic materials utilized

effectively since 2015

- **Expected growth**

- ✓ Product oil demand growth: [REDACTED]
- ✓ Crude oil demand growth: [REDACTED]
- ✓ Technology: lignocellulosic ethanol is industrialized since 2015
- ✓ Policies: Bio-fuel production from food crops is banned. No new subsidies are given to bio-fuel production.
- ✓ Food Supply: balanced to 2020.
- ✓ Raw materials: genetically modified plants and specific fuel plants are planted, lignocellulosic materials utilized effectively since 2015.

- **High growth**

- ✓ Product oil demand growth: [REDACTED]
- ✓ Crude oil demand growth: [REDACTED]
- ✓ Technology: lignocellulosic ethanol is industrialized since 2010
- ✓ Policies: Bio-fuel production from food crops is banned. New subsidies are given to bio-fuel production.
- ✓ Food Supply: balanced to 2020.
- ✓ Raw materials: lignocellulosic materials utilized effectively since 2010, genetically modified plants and specific fuel plants are planted.

Based on these scenarios, the bio-fuel proportion in product oil consumption is forecasted and then the bio-fuel market forecasted is illustrated in figure.

Table VI-3.1-1 Proportion of bio-fuel in total product oil consumption in China, 2008~2020

Year	Low	Expected	High
2008	[REDACTED]	[REDACTED]	[REDACTED]
2009	[REDACTED]	[REDACTED]	[REDACTED]
2010	[REDACTED]	[REDACTED]	[REDACTED]
2015	[REDACTED]	[REDACTED]	[REDACTED]
2020	[REDACTED]	[REDACTED]	[REDACTED]

Table VI-3.1-2 Market development of Bio-fuel, forecasted to 2020, million tonnes

Year	Low level	Expected level	High level
2010	[REDACTED]	[REDACTED]	[REDACTED]
2015	[REDACTED]	[REDACTED]	[REDACTED]
2020	[REDACTED]	[REDACTED]	[REDACTED]
CAGR'10~15	[REDACTED]	[REDACTED]	[REDACTED]
CAGR'15~20	[REDACTED]	[REDACTED]	[REDACTED]