

Economics of Oil-Substitutes Enhanced by High Oil Price

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He Zuoyun

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中国石化集团公司经济技术研究院

Economics & Development Research Institute (EDRI), SINOPEC

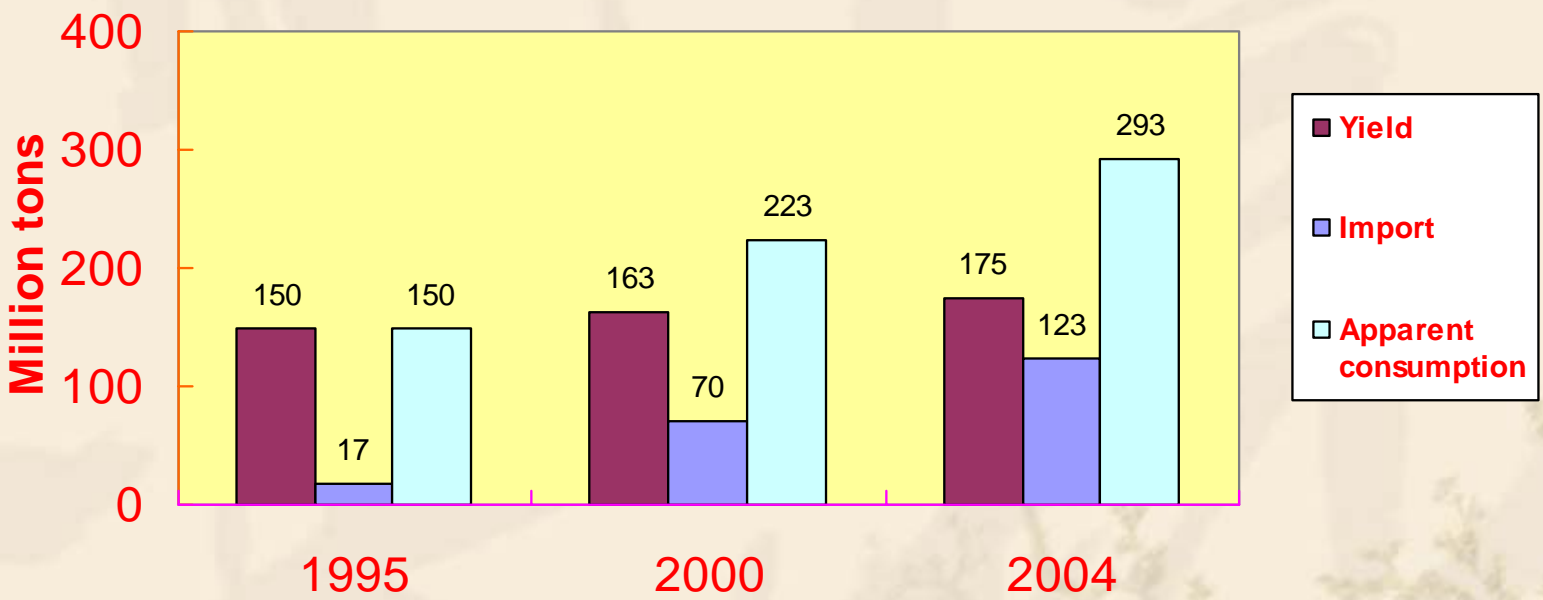
Contents

1. The background of oil-substitutes in China
2. Economics for several oil-substitutes
3. Conclusions and suggestions



1. The background of oil-substitutes in China

❖ China is short of crude oil, it's import dependence is very high

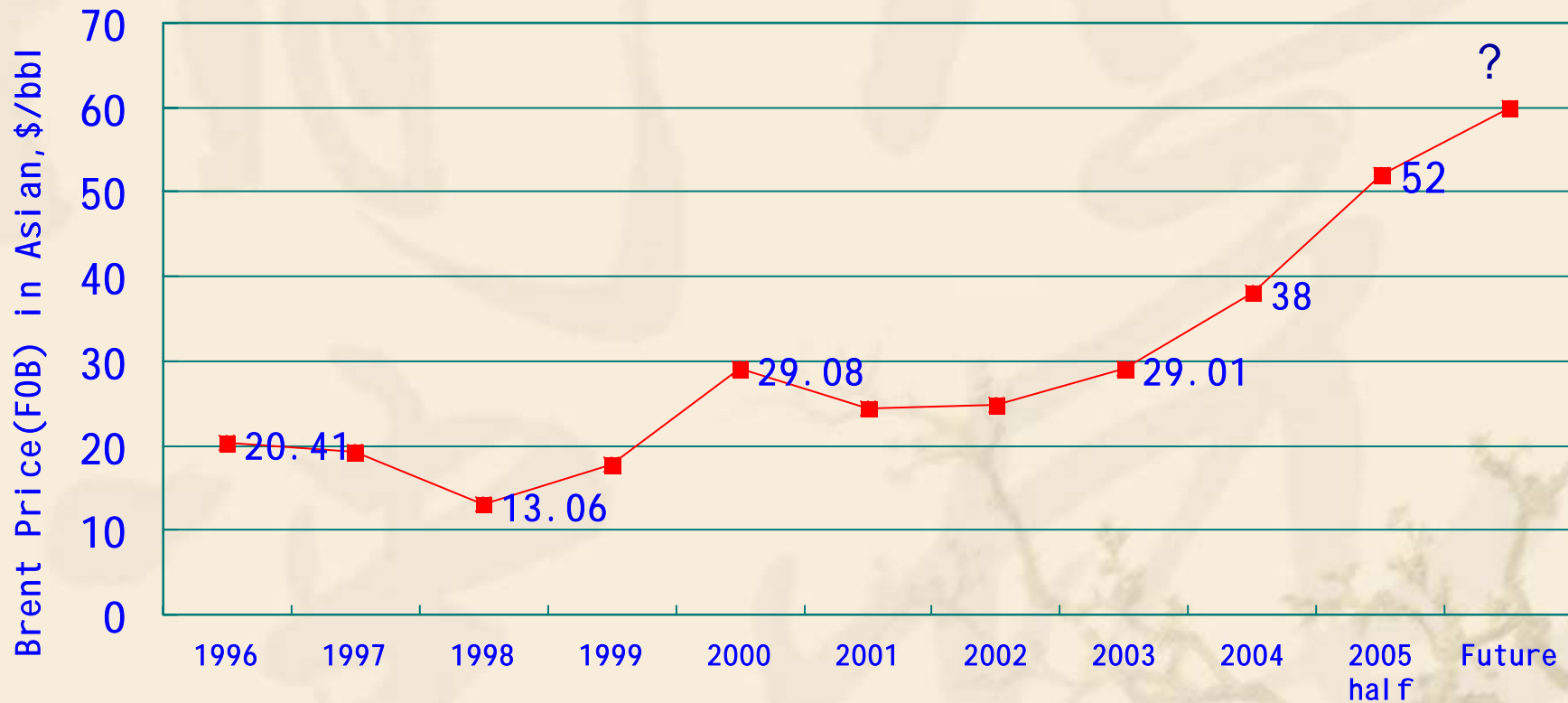


Import ratio : 40% in 2004, 50% in 2010, over 60% in 2020.



1. The background of oil-substitutes in China

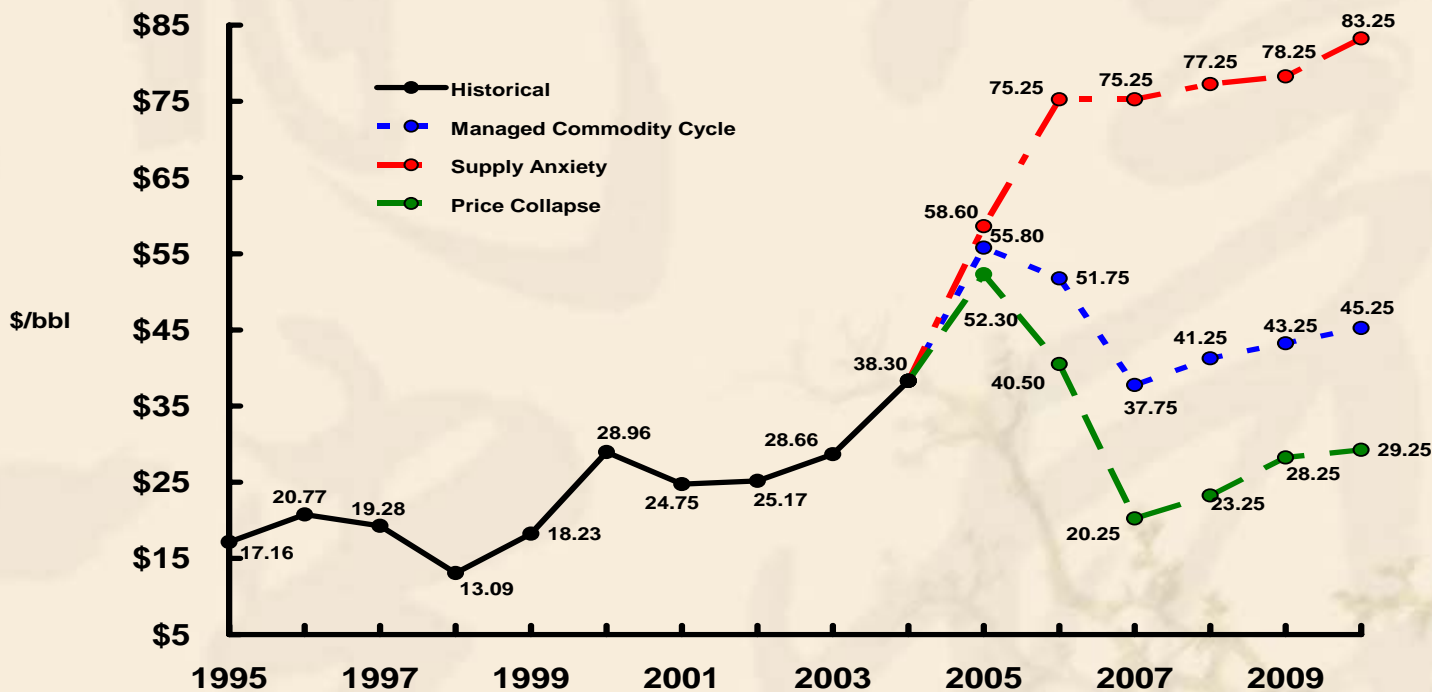
❖ The oil price is growing continually, how about it in the future?



1. The background of oil-substitutes in China

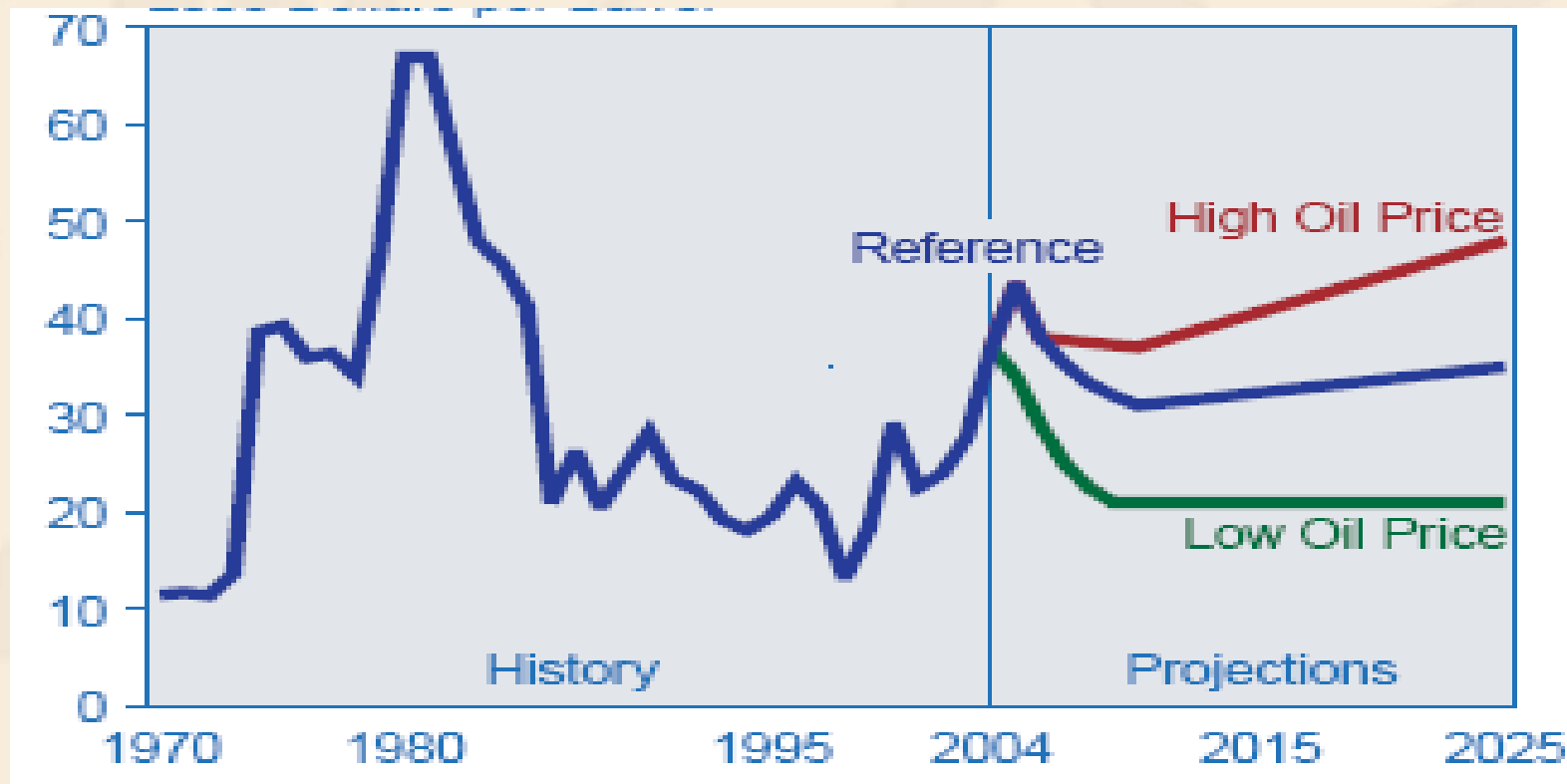
CERA(Cambridge Energy Research Associates) Forecast

Dated Brent Price Scenarios to 2010



1. The background of oil-substitutes in China

❖ EIA's Forecast.



1. The background of oil-substitutes in China

❖ The exploitation years of the remainder resources in the world

BP Statistical Review of World Energy 2005

Oil	40 years
Gas	67 years
Coal	167 years



1. The background of oil-substitutes in China

❖ The energy consumption structure in China

%

	Chi na			Gl obal average
	1997	2004	2010 forecast	2004
Coal	74.4	69.0	62.0	27.2
Oil	21.3	22.3	24.0	36.8
Gas	2.0	2.5	7.4	23.7
Hydropower	1.9	5.4	3.6	6.2
Nuclear	0.4	0.8	3.2	6.1



1. The background of oil-substitutes in China

❖ The technology is becoming more and more mature.

✓ **GTL/CTL:** The mega-coal gasification, F-T synthesis,
The capital cost dropped.

✓ **MTO/MTP :** A new process for utilizing coal or gas,
at the point of commercialization.

✓ **Bio-transformation Energy:**

corn/sugarcane/sweet sorghum → **ethanol** → **ethylene**

❖ The economics of oil-substitutes is becoming more feasible in case of high oil price.



2. Economics for oil-substitutes

1) CTL (Coal To Liquids)

- Two processes: Direct and Indirect liquefaction.
- Direct liquefaction process is not being commercialized, The first commercial-scale plant invested by Shenhua Coal Liquefaction Corp. is being constructed in Erdos, Inner Mongolia, with the capacity of 5,000kt/a. The capacity of phase I is 3,200kt/a, capital investment is about 24,500 million RMB
- The indirect liquefaction plants are located in South Africa , the total capacity is 7,500kt/a.
- Shenhua Group and Ningxia Coal Group are contacting with Sasol and Shell for 2 indirect liquefaction plants(each one 3,000kt/a,in Shanxi Province and Ningxia Province)



2. Economics for oil-substitutes

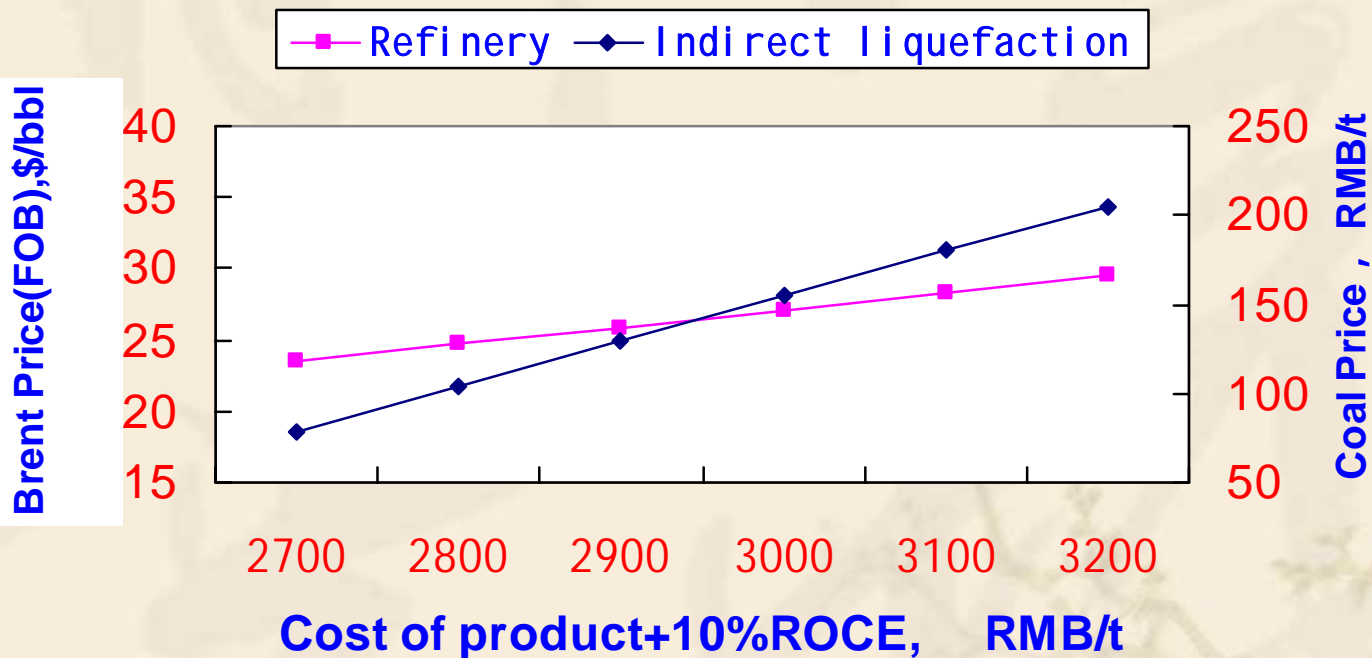
Shenhua CTL project's model

Start-up ceremony



2. Economics for oil-substitutes

- ❖ The comparison of product cost plus ROCE(Return of capital employed) between CTL and Refinery.



2. Economics for oil-substitutes

- ❖ Evaluation of CTL
- The indirect liquefaction process has several decades' experience, the mega direct liquefaction process need to be verified by Shenhua project in Erdos.
- CTL has good economic in case of high oil price, see the next table:

Coal price, RMB/t	Cost+10%ROCE RMB/t	Breakeven Brent oil price \$/bbl
70	2317	23.1
100	2435	24.5
120	2514	25.5
150	2632	26.9
200	2829	29.3



2. Economics for oil-substitutes

2) GTL (Gas To Liquids)

- ✦ The commercial GTL plants are situated in South Africa and Malaysia , with total capacity of 45,000 barrels /day. The “oryx” project in Qatar will be started in 2005, with the capacity of 34,000 barrels /day.
- ✦ Mature technology is owned by Sasol、 Shell and Exxon-Mobil etc..
- ✦ Partial future projects are listed in the following table.



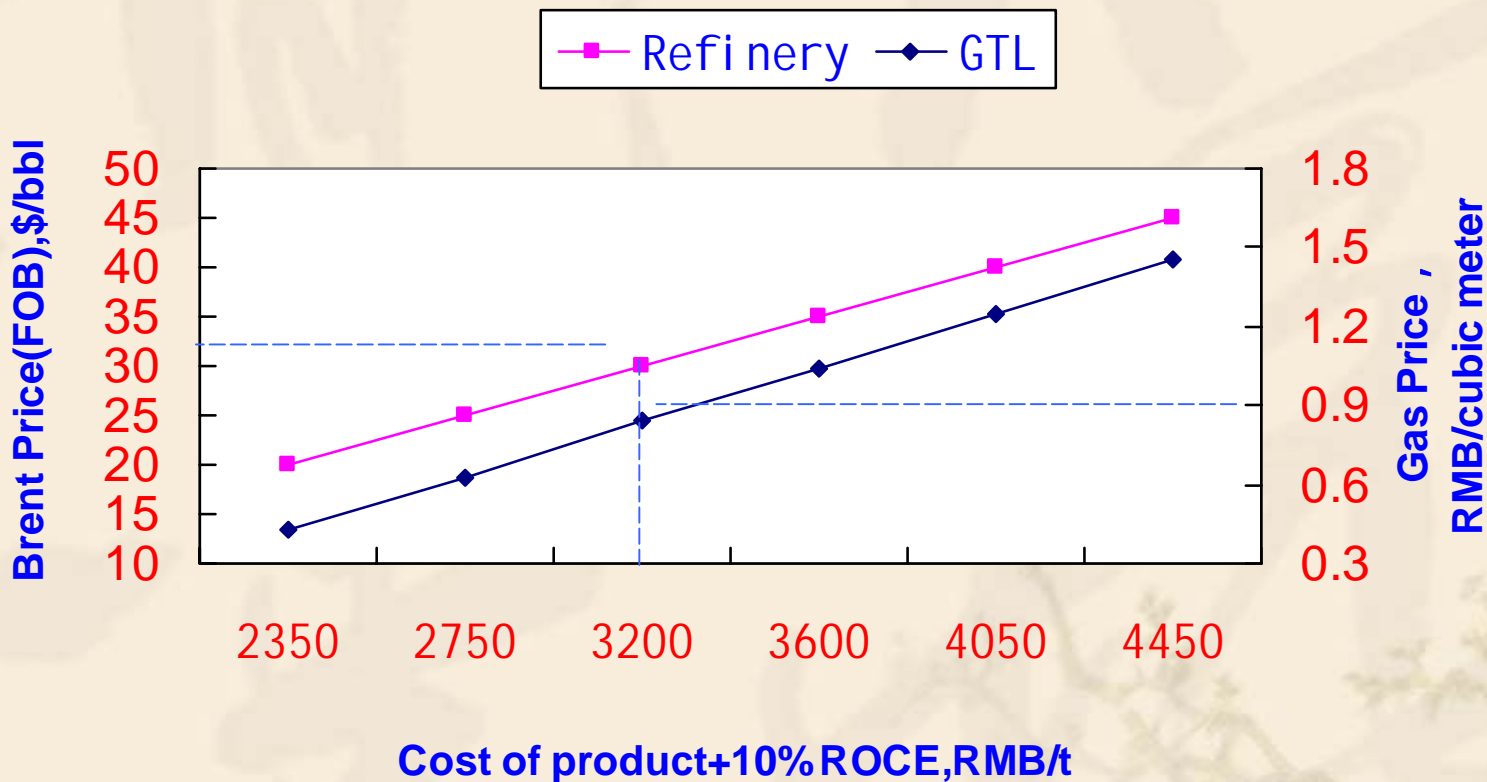
2. Economics for oil-substitutes

Producer	Location	Capacity, bbl/d	Year of start-up
Sasol/QP I	Qatar	34,000	2005
Sasol/QP II	Qatar	65,000	2010
Sasol/Chevron	Nigeria	34,000	2007
Exxon-Mobil	Qatar	154,000	2011
Shell/QP I	Qatar	70,000	2009
Shell/QP II	Qatar	70,000	2011
Conoco-Philips/QP I	Qatar	80,000	2010
Conoco-Philips/QP II	Qatar	80,000	-



2. Economics for oil-substitutes

- ❖ The comparison of cost plus ROCE between GTL and refinery



2. Economics for oil-substitutes

- ❖ The evaluation of GTL
- The GTL process is reliable.
- The GTL process is competitive in case of high oil price.

Gas price RMB/m ³	Product cost+10%ROCE RMB/t	Breakeven Brent oil price \$/bbl
0.43	2350	20
0.63	2760	25
0.84	3180	30
1.25	4030	40
1.45	4450	45

- ✓ The gas reserve is bottleneck for China to develop GTL.



2. Economics for oil-substitutes

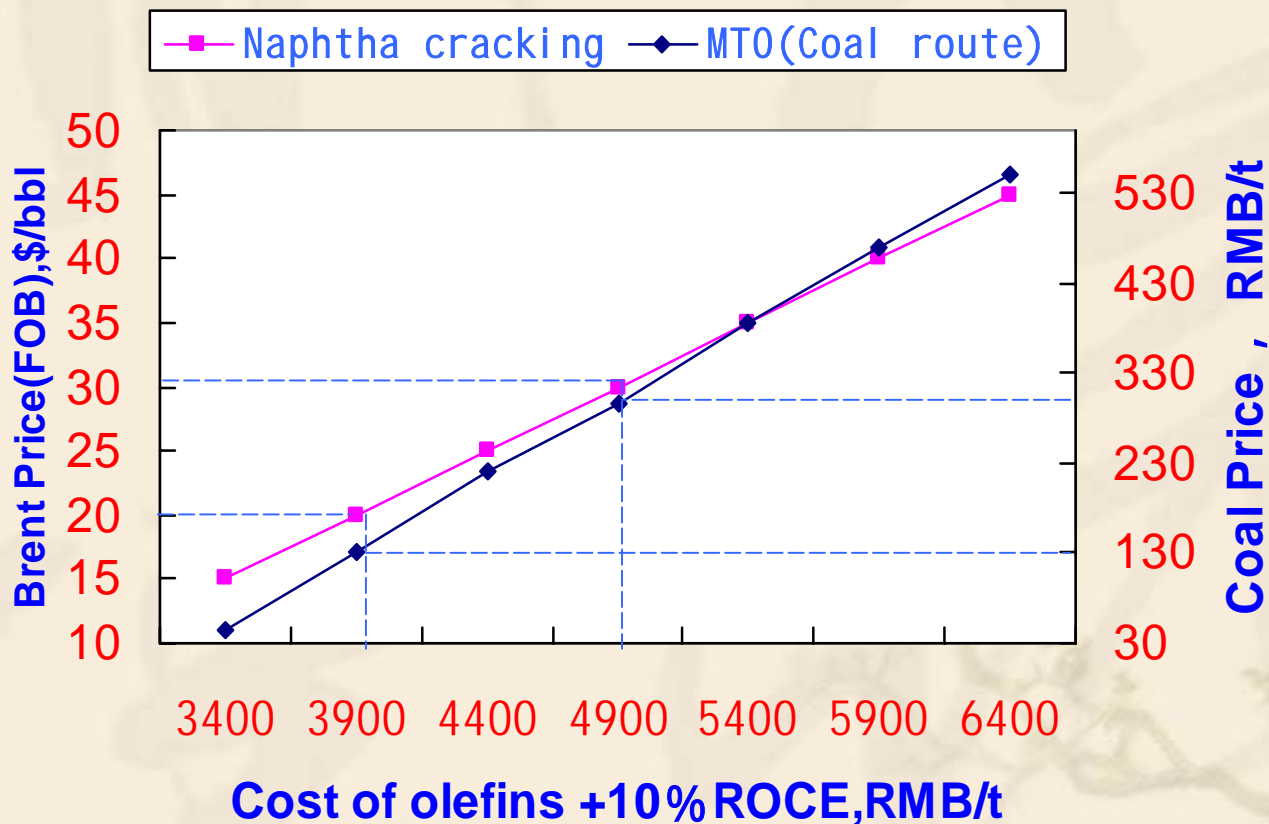
3) MTO (Methanol To Olefins)

- ✦ The MTO process with MTO-100 catalyst is developed by UOP & Hydro. ,
- ✦ Dalian Institute of Chemical Physics is also developing the similar process, now the pilot-plant is being constructed in Shanxi province with the capacity of 10kt/a(feed).
- ✦ The process isn't being commercialized, it has been transferred to two corp., one is located in Nigeria , the project will be completed in 2007. The technology risk is little though it isn't being commercialized yet.
- ✦ The 600kta project invested by Shenhua Group Corp. is now under ratification by the government, which includes 1,800kt/a methanol,300kt/a PE,300kt/a PP, the total investment is about 11,700 million RMB.It is located in Baotou,Inner Mongolia, start-up in 2009.

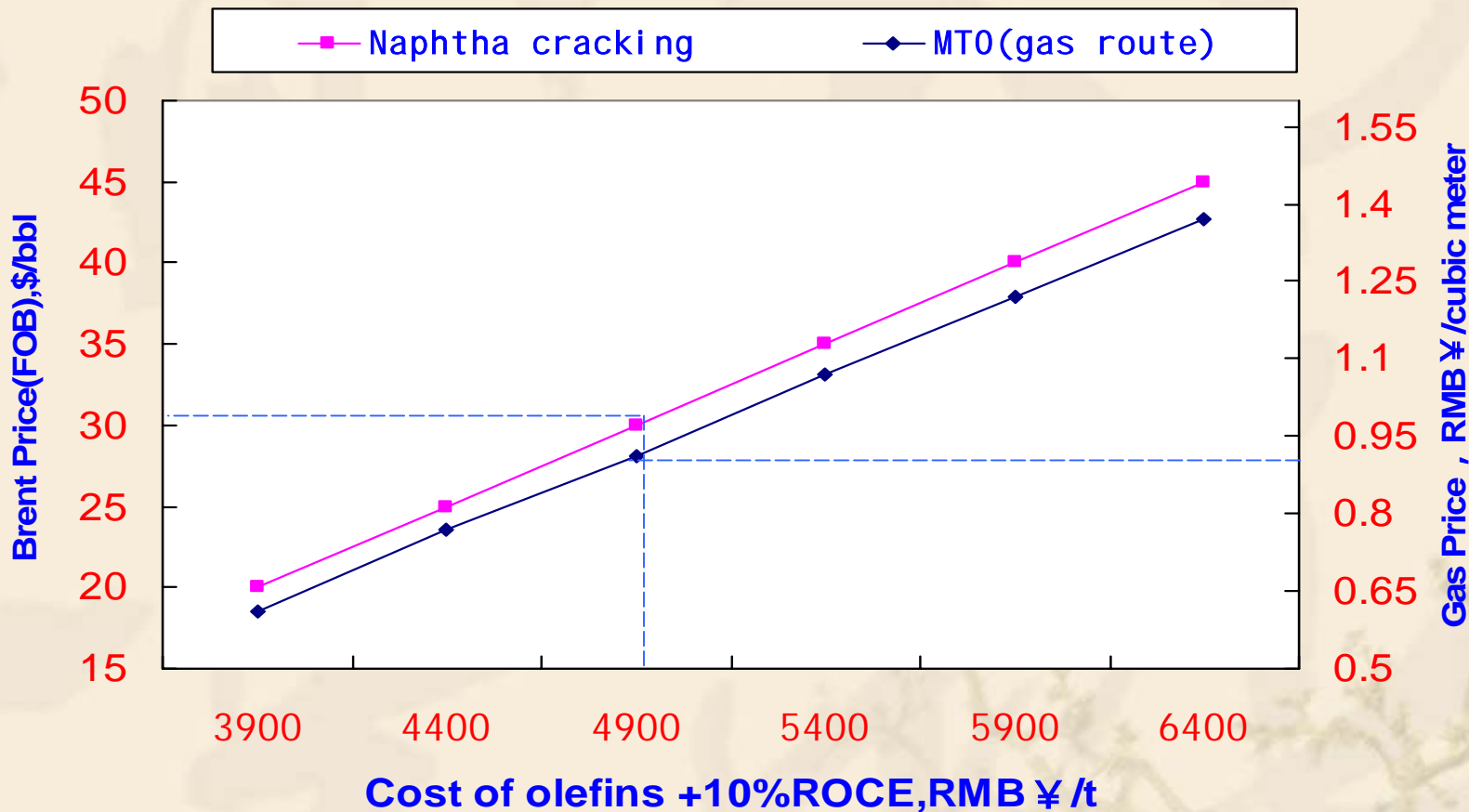


2. Economics for oil-substitutes

- ❖ Olefins cost plus ROCE comparison between MTO and naphtha cracking



2. Economics for oil-substitutes



2. Economic for oil-substitutes

❖ The evaluation of MTO

- The MTO process is reliable.
- The MTO process can compete against naphtha cracking in economics at high oil price.see the next table:

Gas price , RMB ¥/m ³	Cost+10%ROCE , RMB ¥/t	Breakeven Brent oil price , \$/bbl	Breakeven coal price , RMB ¥/t
0.61	3900	20	130
0.91	4900	30	295
1.07	5400	35	385
1.22	5900	40	470
1.37	6400	45	550

✓ The MTO process has the splendid prospect in the future, but it will not be developed widely now owing to lack of commercialization.



2. Economics for oil-substitutes

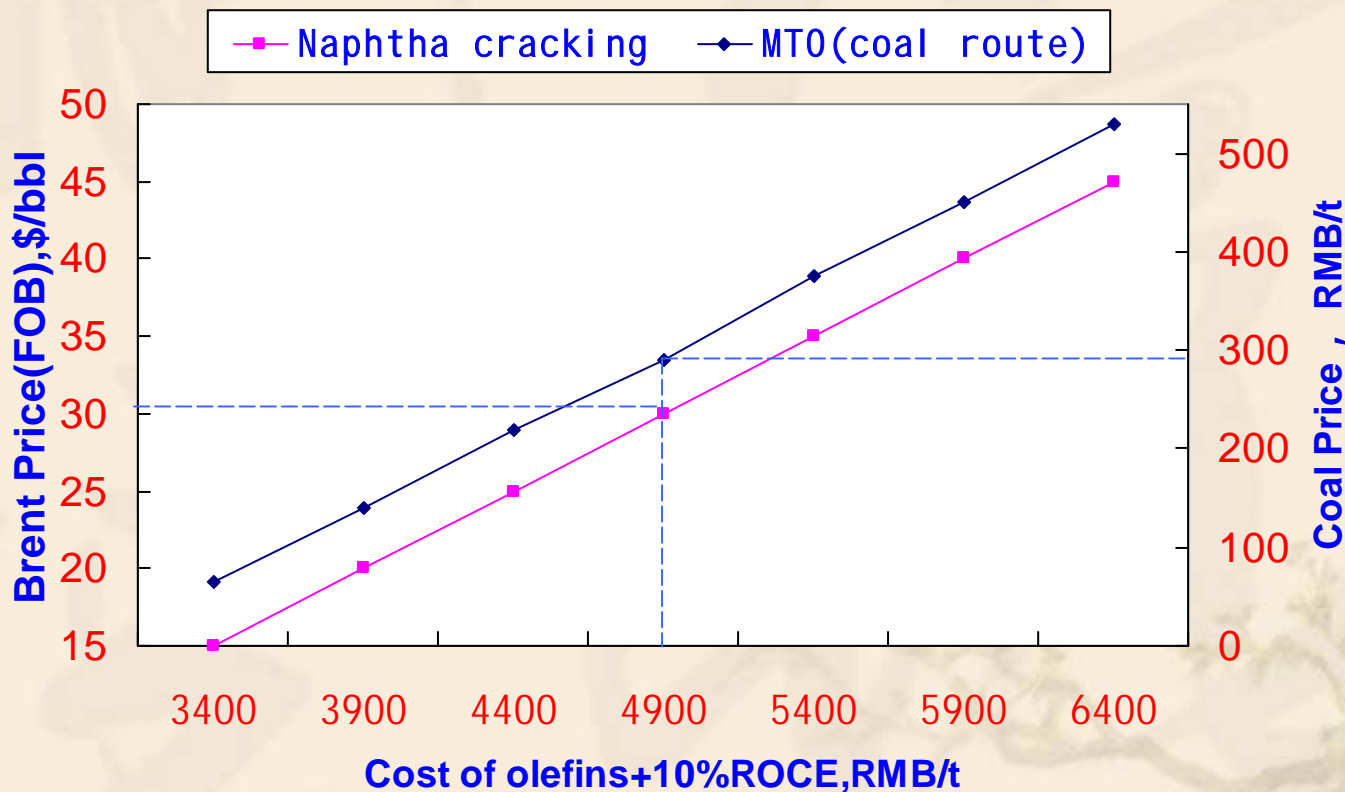
4) MTP (Methanol To Propylene)

- ✦ The MTP process is developed by Lurgi in 1999, with ZSM-5 as catalyst, the reactor is fixed-bed.
- ✦ The process is not commercialized yet. In March 2005, the process was transferred to a corp. in Iran, with the capacity of 100kt/a.
- ✦ The process is easy to be commercialized because of the character of its fixed-bed reactor.
- ✦ A 480kta MTP project in Henan Province China is in programming .

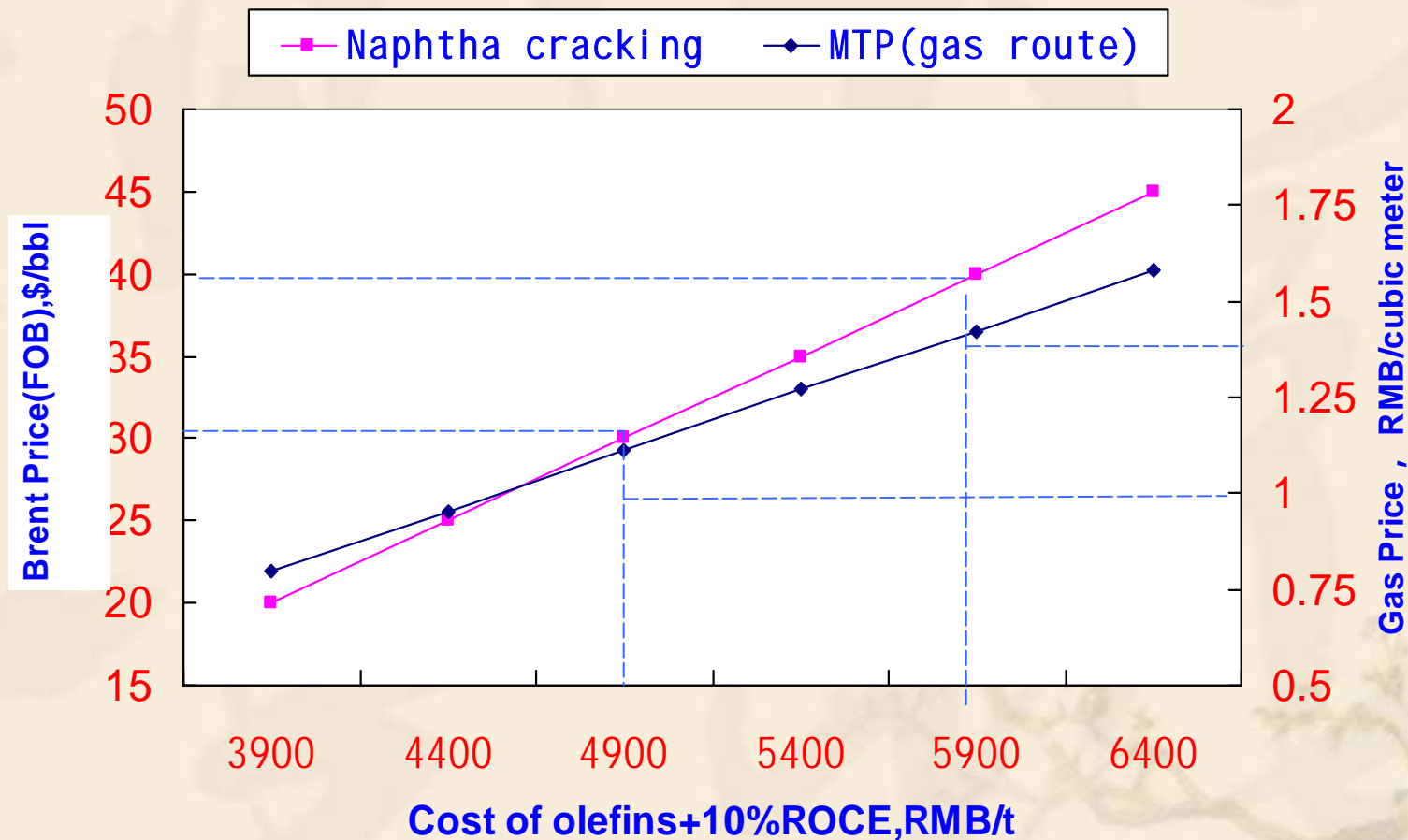


2. Economics for oil-substitutes

❖ Olefins cost plus ROCE comparison between MTP and naphtha cracking



2. Economics for oil-substitutes



2. Economics for oil-substitutes

❖ The evaluation of MTP

- The MTP process can be commercialized now.
- The MTP process can compete against naphtha cracking in economic at Chinese gas price, see the next table:

Gas price, RMB/m ³	Product cost+10% ROCE,RMB/t	Breakeven Brent oil price,\$/bbl	Breakeven coal price,RMB/t
0.80	3900	20	125
1.11	4900	30	290
1.27	5400	35	375
1.42	5900	40	450
1.58	6400	45	530



2. Economics for oil-substitutes

5) Ethylene from Bio-ethanol

- The plants are mainly located in India、 Pakistan、 Peru etc., the largest capacity is 64kt/a.
- The plants in China are all small, the largest is 20kt/a (belong to Anhui Fengyuan group) .
- There are two kinds of process, fixed-bed & fluidized-bed,the fluidized-bed process appears to require lower investment and to have lower cost, but it isn't being commercialized.
- The feed of bio-ethanol plant can be gained from corn or sweet sorghum etc..
- Sweet sorghum has a short storage period because it is easy to go moldy.



2. Economics for oil-substitutes

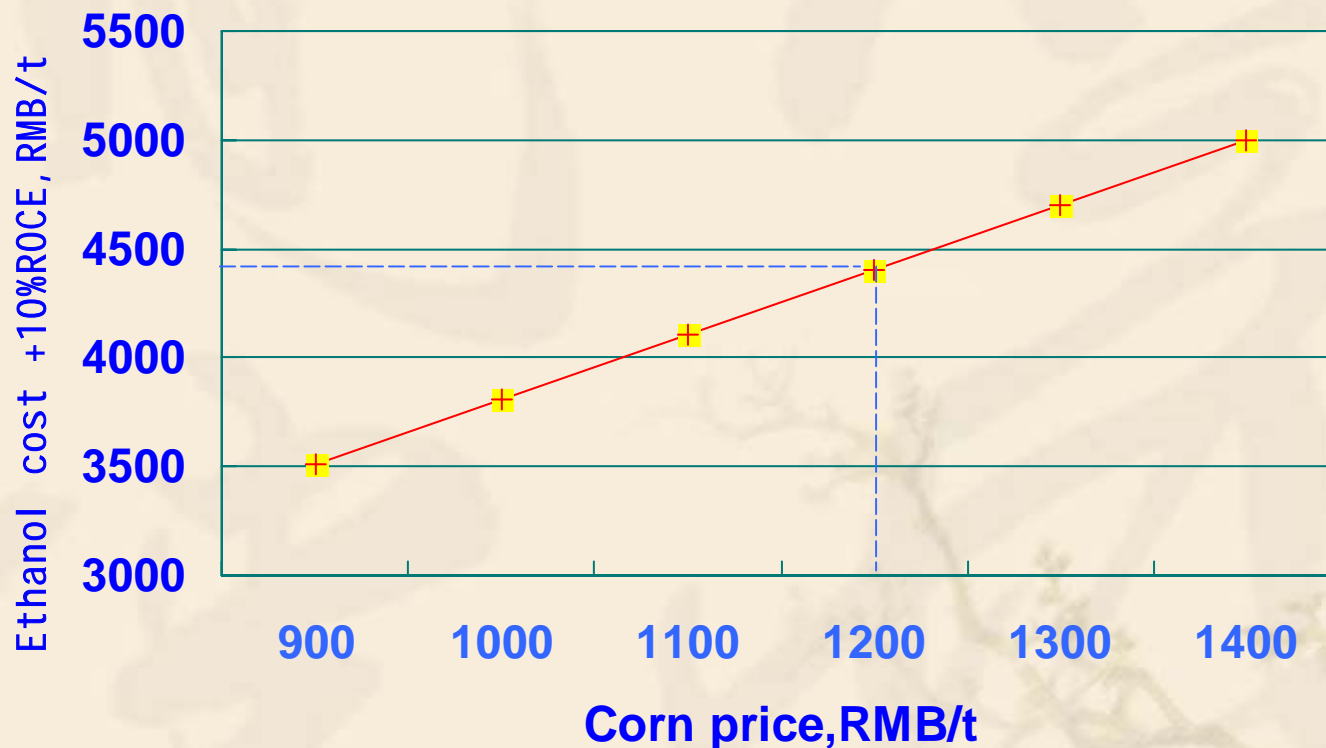
5) Ethylene from Bio-ethanol

Sweet sorghum



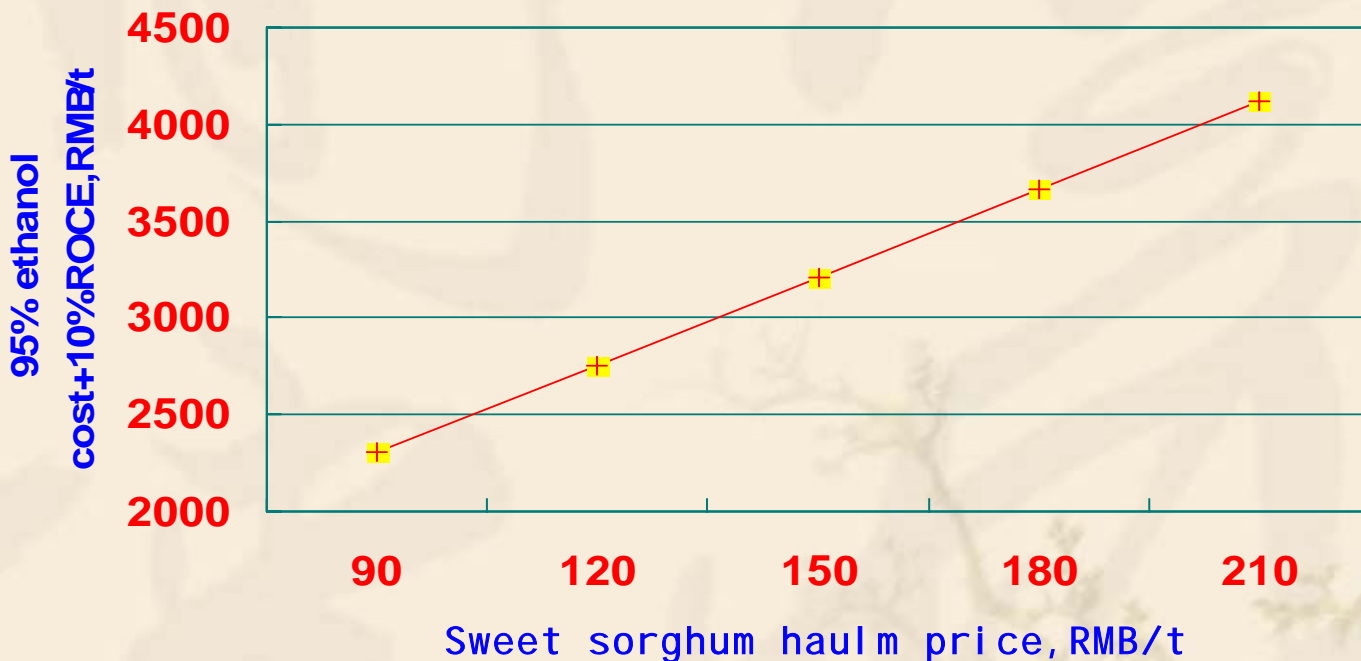
2. Economics for oil-substitutes

❖ Ethanol cost plus ROCE for different corn price



2. Economics for oil-substitutes

❖ Ethanol cost plus ROCE for different sweet sorghum haulm price

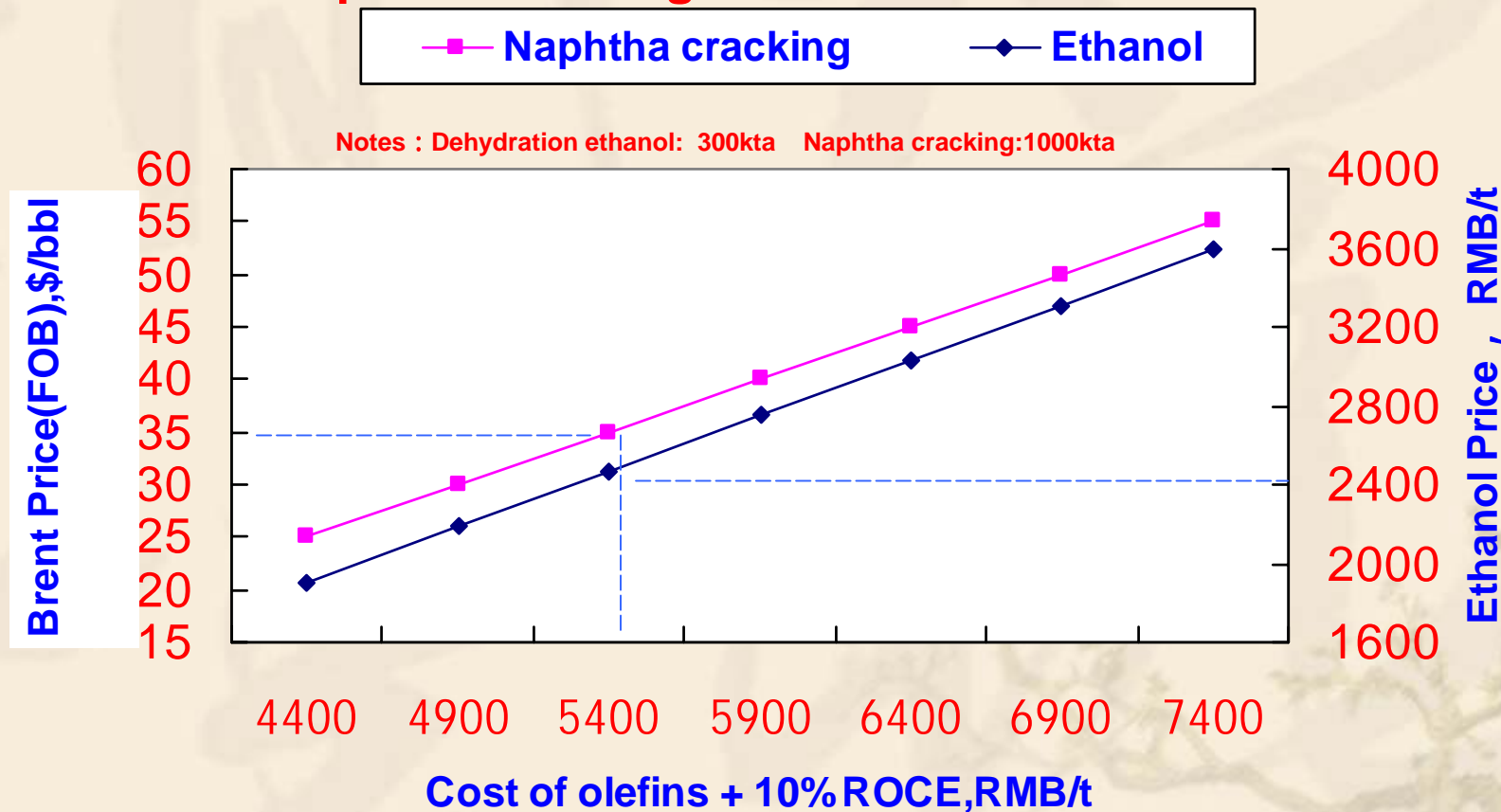


Note: the rate of recovery for by-products is 50%.



2. Economics for oil-substitutes

- ❖ Olefins cost plus ROCE comparison between dehydration of ethanol and naphtha cracking



2. Economics for oil-substitutes

- ❖ Evaluation of ethanol dehydration
- The fixed-bed process is an old process, the fluidized-bed process need to be verified via commercial-scale plant.
- The development of bio-ethanol dehydration to produce ethylene is influenced by the prices of biomass and oil.

Brent price,\$/bbl	Olefins cost+10%ROCE,RMB/t	Breakeven corn price,RMB/t	Breakeven haulm price,RMB/t
25	4400	1300	60
30	4900	1370	80
35	5400	1530	100
40	5900	1700	120

- The recovery rate of by-product is the primary factor influencing the profit and the cost.



3. Conclusions and suggestions

- ❖ Oil shortage and its growing oil price is enhancing the feasibility of oil substitute resources.
- ❖ Oil-substitutes from coal ,gas and biomaterial have good economics at a high oil price.
- ❖ People are recognizing the importance of utilizing bio-mass resources.
- ❖ The oil substitutes industry has the brighter prospect especially in the Oil shortage country like China.



The End Thank You!



•Contact: report@tky.ieej.or.jp

中国石化集团公司经济技术研究院

Economics & Development Research Institute (EDRI), SINOPEC

