

Efficient and environmental solutions commercialized shale gas exploitation in Sichuan Basin

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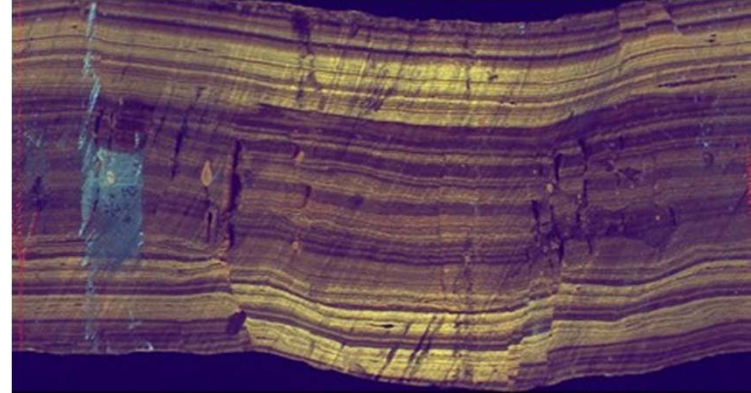


Outlines:

- 1、 Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin;
- 2、 Effective environmental solutions of shale gas exploitation
- 3、 Strategic significance for China

The most important energy events of this century

- Oil and gas exploration from source rock in USA
- The Fukushima nuclear accident
- The coming new era of gas energy



The realistic hope of China is in Sichuan Basin

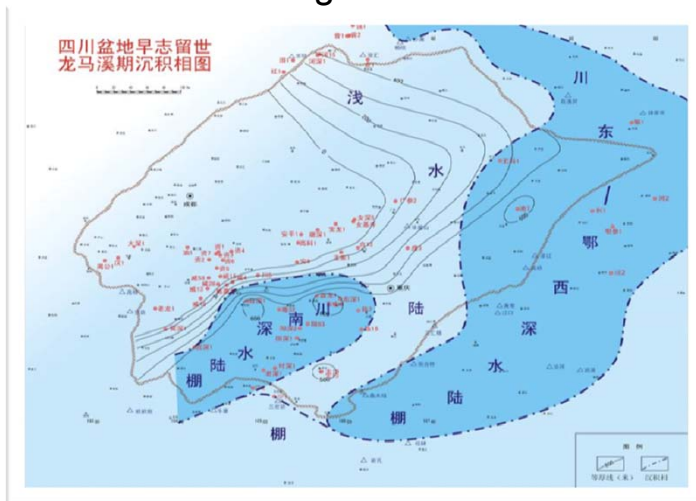
1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

1. Advantage of massive reserves

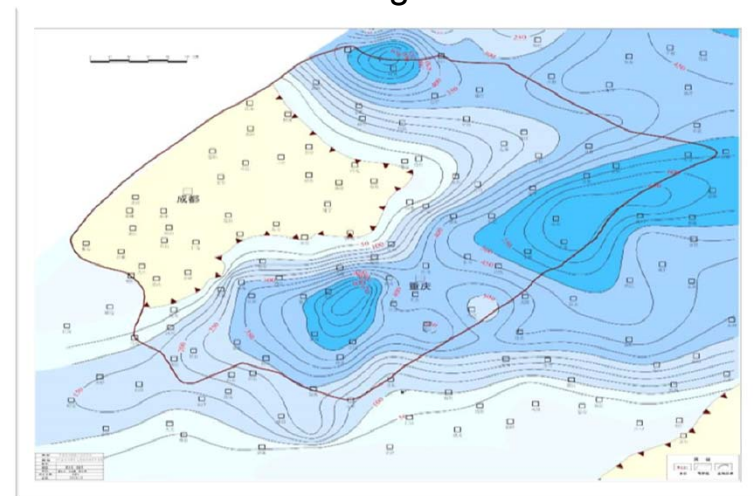
China is abundant in shale resources, nevertheless due to current technology boundaries only marine-origin shale formations in Sichuan Basin can be exploited economically to realize commercial quantities. Longmaxi Formation: average thickness:100-400m;the maximum thickness: nearly 700m; high-quality shale thickness:30-90m;The maximum thickness is at south and northeast of the basin. The whole basin distribution area is 150,000 km², there are about 90,000 km² less than 4000 meters.

Marine shale gas favorable area in Longmaxi formation where have achieved breakthrough is 75,000km². The geological resources is 25 trillion cubic meters, and the recoverable resources is 3.7 trillion cubic meters. There are 35,000km² of shale gas resources are more favorable, geological resources nearly reached 14 trillion cubic meters, recoverable resources is about 2.8 trillion cubic meters.

Area of Longmaxi Formation



Thickness of Longmaxi Formation

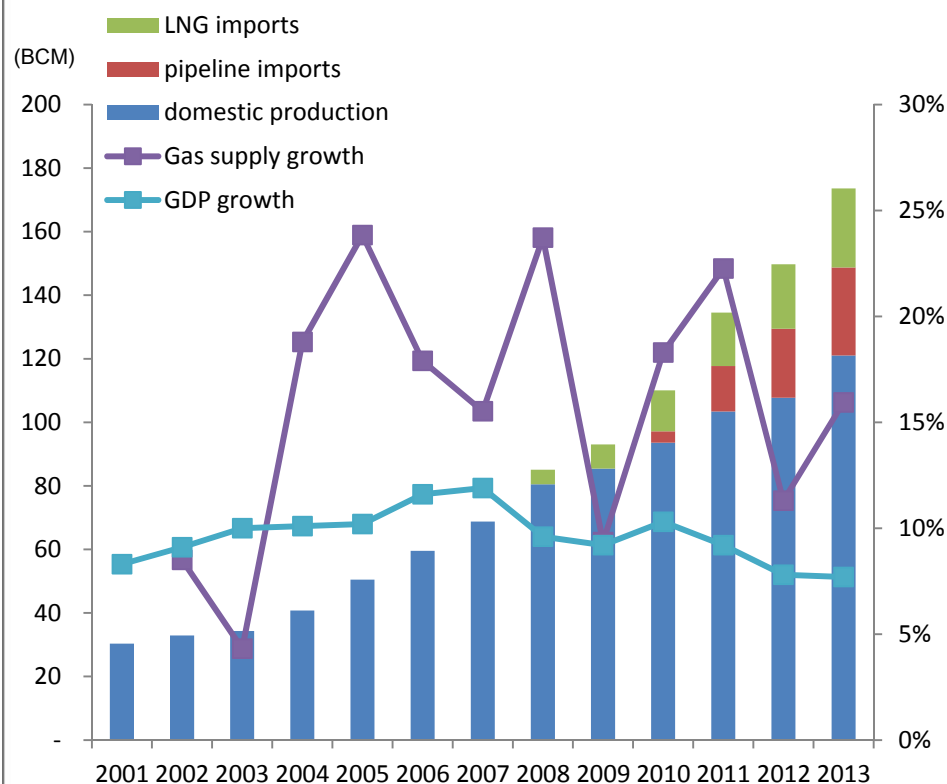


1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

2. Huge demand for Natural gas

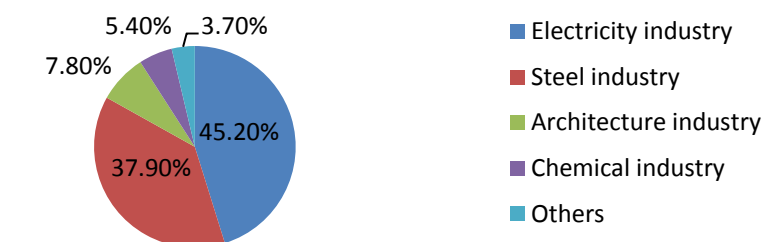
- Natural gas apparent consumption reaches 167.6 bcm* in 2013, accounting for 5.9% of primary energy consumption, yet a significant gap still remains comparing the ratio 24% of global average. Crude oil and coal take 18% and 68% shares in primary energy structure separately, however we project the natural gas apparent consumption will arrive 450 bcm in 2020 and 700 bcm in 2030, in the case of coping with haze

China Gas Supply 2001-13

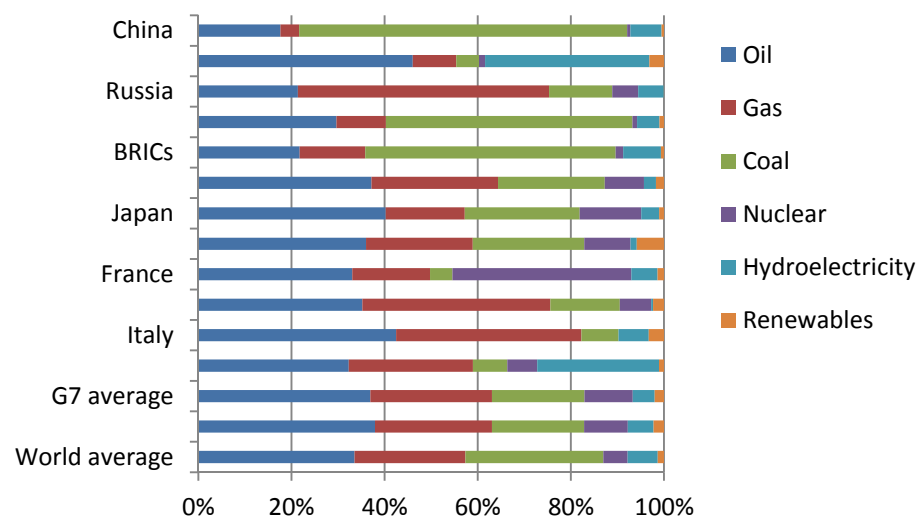


Notes: *bcm, short for billion cubic meters
Source: State Statistics Bureau, BP Energy Statistics, March 2014

Natural gas may be an effective substitute according to coal consumption structure



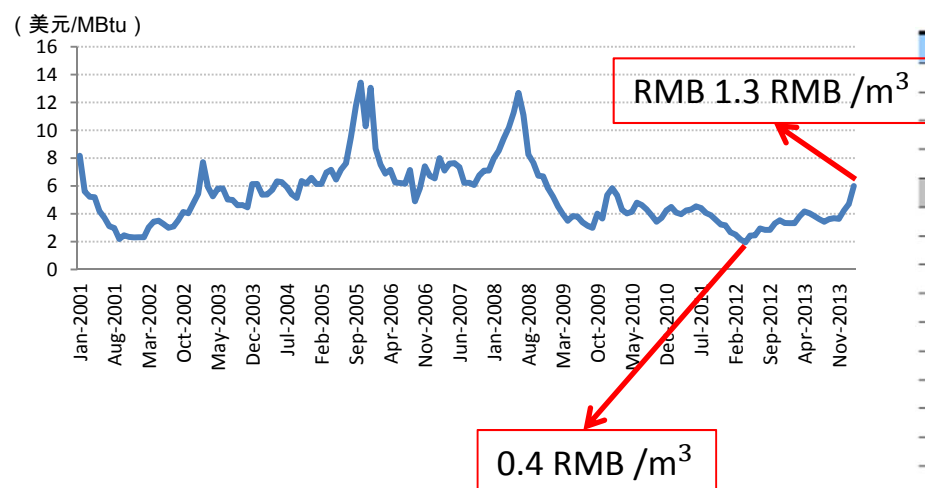
Primary Energy Structure of Major Countries



1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

3. Competitive Price

Henry Hub gas price



China gas price

省份	存量气	增量气	价差	省份	存量气	增量气	价差
北京	2.26	3.14	38.90%	湖北	2.22	3.10	39.60%
天津	2.26	3.14	38.90%	湖南	2.22	3.10	39.60%
河北	2.24	3.12	39.30%	广东	2.74	3.32	21.20%
山西	2.17	3.05	40.60%	广西	2.57	3.15	22.60%
内蒙古	1.60	2.48	55.00%	海南	1.92	2.78	44.80%
辽宁	2.24	3.12	39.30%	重庆	1.92	2.78	44.80%
吉林	2.02	2.90	43.60%	四川	1.93	2.79	44.60%
黑龙江	2.02	2.90	43.60%	贵州	1.97	2.85	44.70%
上海	2.44	3.32	36.10%	云南	1.97	2.85	44.70%
江苏	2.42	3.30	36.40%	陕西	1.60	2.48	55.00%
浙江	2.43	3.31	36.20%	甘肃	1.69	2.57	52.10%
安徽	2.35	3.23	37.40%	宁夏	1.77	2.65	49.70%
江西	2.22	3.10	39.60%	青海	1.53	2.41	57.50%
山东	2.24	3.12	39.30%	新疆	1.41	2.29	62.40%
河南	2.27	3.15	38.80%				

Nature gas prices are more than 2.8 yuan / m³ in the east of Sichuan province. The price advantage is obvious. There is also RMB 0.4 yuan/ m³ subsidy for shale gas offered by the government.

- Construct the efficient competitive market structure and system, so as to form energy pricing mechanism that is determined by markets——Xi Jinping

Even without the subsidy 0.4RMB/m³, it is still economic for shale development in China based on high market pricing to offset the capital and operation expenditures and technical complexities

1、 **Advantages** and challenges confronted in commercialized shale gas exploitation of Sichuan Basin



4. High productivity for each single well

From 2013 to 2014, the exploration of shale gas reservoir in Sichuan basin is very successful. China(especially Sichuan basin) is ready for large-scale commercialized production.

In comparison to the USA, it's easier to realize large-scale production because resources is state-owned in China.



中国石油

- Yang-101-H with production 60,000m³ per day, stable for more than 18 months
- May 6th, Ning-H2-2、 Ning-H2-4 commenced operations
- CNPC Changning block has 6 shale gas wells in production, totally 700,000+m³ per day

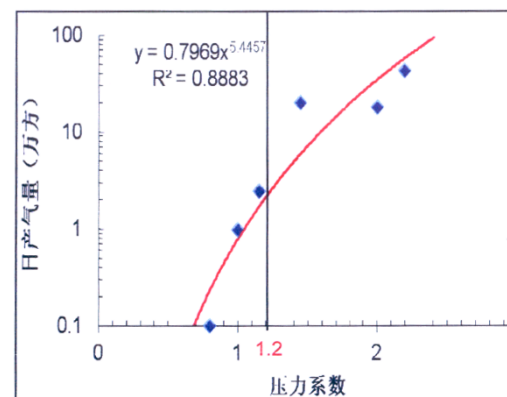


- By the end of 2013, 13 shale gas wells are in production in Jiaoshiba block
- 12 wells achieve 120,000m³ per day except 6-2HF, which applies large pressure differences for commissioning in production testing
- Gas production of total 13 wells is more than 18,00,000m³ per day, cumulative production amounts to 143,000,000m³

1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

5. Production stable

Gas production aligns in positive correlation with pressure coefficient.
The pressure coefficient of Sichuan Basin shale gas wells is usually higher than that of American.



Gas production aligns in positive correlation with pressure coefficient.



Well Code	Depth (m)	Production (10 ⁴ m ³ /d)	pressure coefficient
Ning-201	2560	2.5	2.03
Ning-201-H1	3790		
Yang-101	3577	6	2.25
Yang-101-H			



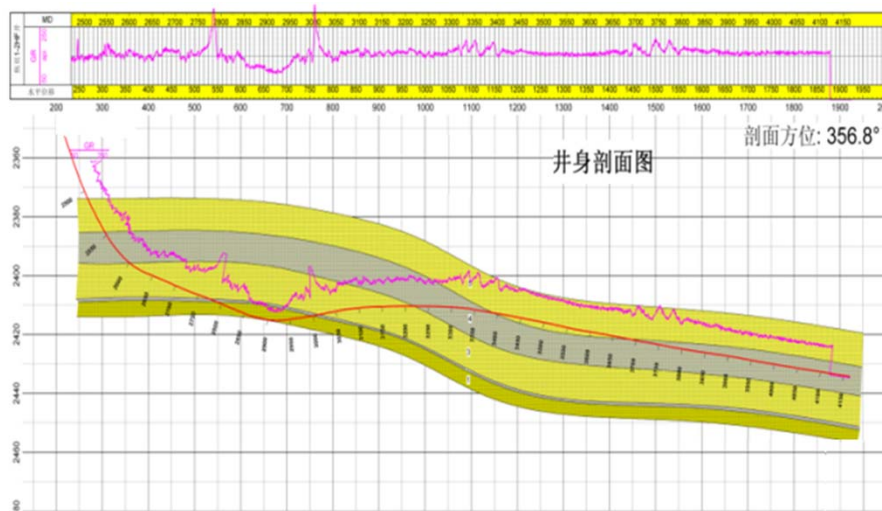
Well Code	Depth (m)	Production (10 ⁴ m ³ /d)	pressure coefficient
Jiaoye-1HF	3692	6 (13年1月9日至今)	1.55

1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin



6. Advantage in technology, equipment, capital and resources ownership

The breakthrough of scale production of shale gas depends on the advanced horizontal drilling and hydraulic fracturing technology. These two key technologies are already widely used in our conventional drilling operation.



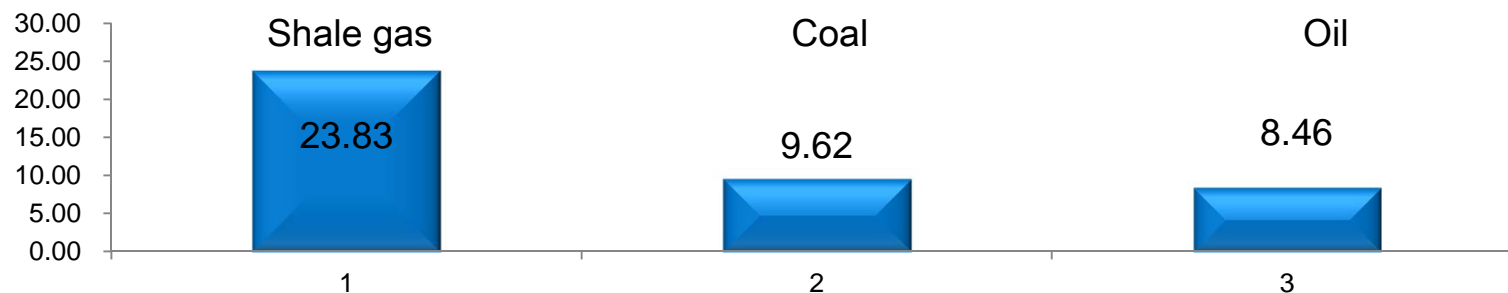
Scale exploitation of shale gas demands huge capital. China holds varied kinds of social capital. In addition to a high enthusiasm for participating in shale gas exploitation and production

State-owned resource makes it is easier to achieve large-scale exploitation and production.

1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

7. Lower water-consumption

Output Quantity and Related Calorific Value Comparisons for Using Water (MMBtu/t)



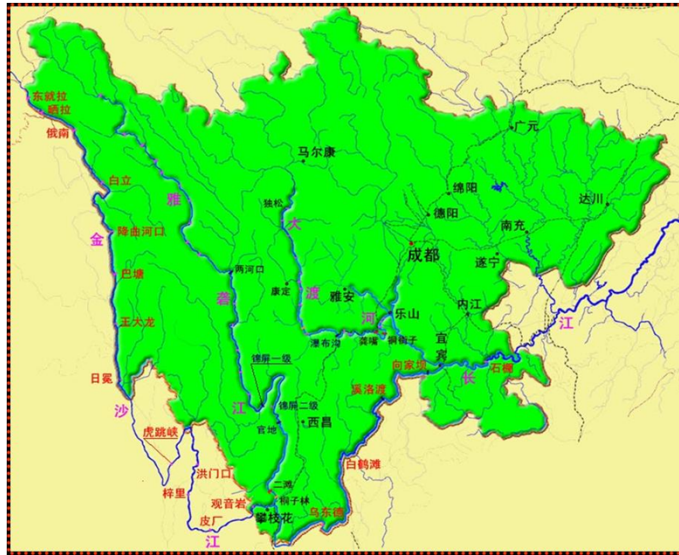
Notes: shale gas is calculated as 279.81MMBtu per cubic meters, 20% purification rate; on average 1 ton water may produce 4000m³ shale gas

Water Consumption of Selected Shale Gas Basins in USA According to MIT

页岩气田 Play	公用 Public Supply	工业/采矿 Industrial/ Mining	灌溉 Irrigation	家畜 Livestock	页岩气 Shale Gas	Total Water Use (Bbbls/yr)
Barnett TX	82.7%	3.7%	6.3%	2.3%	0.4%	11.1
Fayetteville AR	2.3%	33.3%	62.9%	0.3%	0.1%	31.9
Haynesville LA/TX	45.9%	13.5%	8.5%	4.0%	0.8%	2.1
Marcellus NY/PA/WV	12.0%	71.7%	0.1%	<0.1%	<0.1%	85.0

1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

8. Adequate water resource in Sichuan



There are adequate water resource in Sichuan because of Yangtze River.

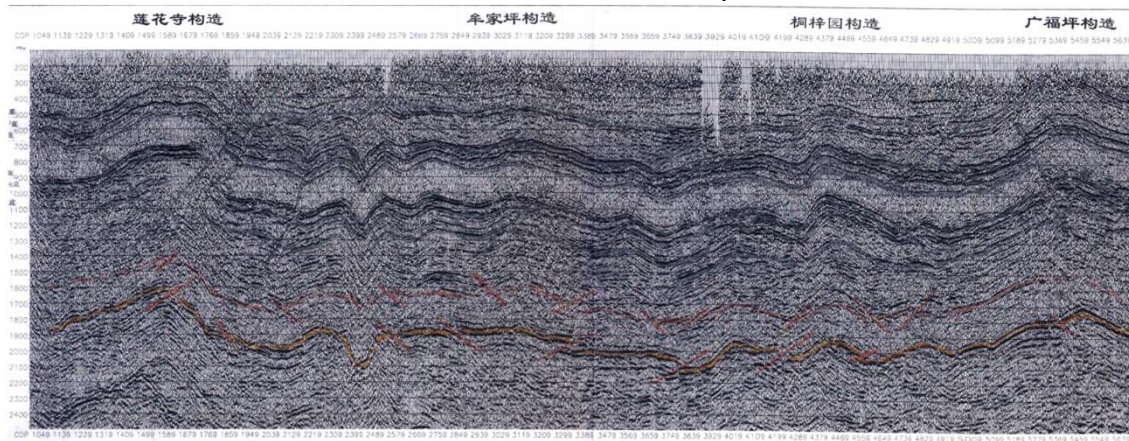
100 bcm shale gas production needs 2.5 million m³ water.
equivalent to 6 minutes peak flow of the Yangtze River.
equivalent to 90 minutes dry season flow of the Yangtze River.
The annual flow of Yangtze River is about 400 billion m³.
2.5 million m³ accounts for no more than 1/10000 of its annual flow.

1、Advantages and **challenges** confronted in commercialized shale gas exploitation of Sichuan Basin

1. Complex geological conditions and high cost

Sichuan Basin had experienced many orogeny. Its underground geological conditions are more complex than in North America. The depth of shale gas is normally deeper. Favorable shale gas areas are located in hills and low mountain areas. Surface conditions are more complex than the United States. The exploration generally is difficult and expensive.

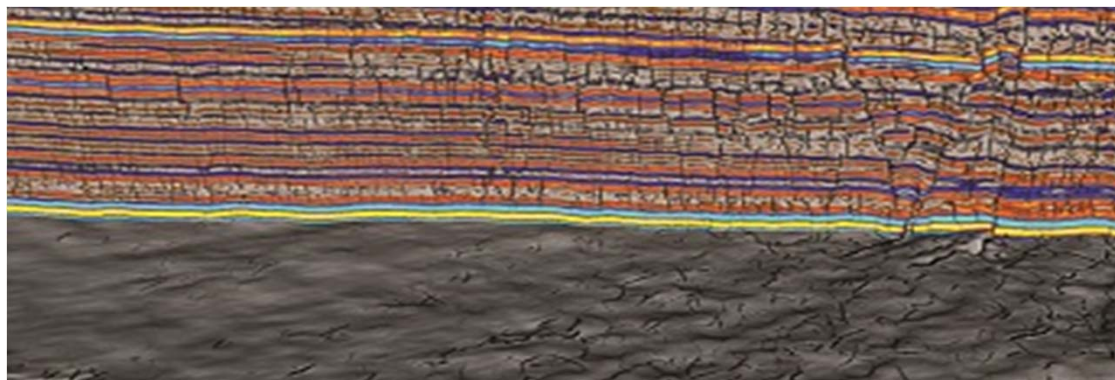
Yibin-Nanxi Seismic profile



Yibin shale gas play



UAS Geological profile



USA shale gas play



1、Advantages and **challenges** confronted in commercialized shale gas exploitation of Sichuan Basin

2. High environmental requirements

Residents resides at most of shale gas regions where desirable well sites are established. These require higher standards for environmental friendly fracturing operations taking place (especially noise control).

Yibin shale gas play

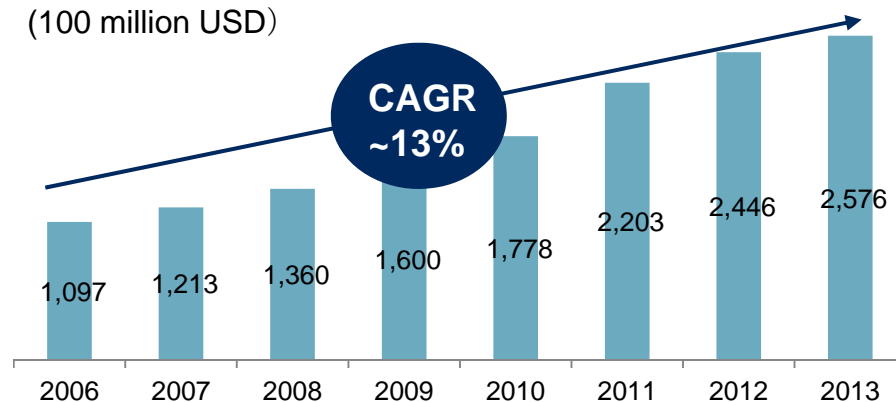


1、Advantages and challenges confronted in commercialized shale gas exploitation of Sichuan Basin

3.Weak foundation in oil-gas service industry

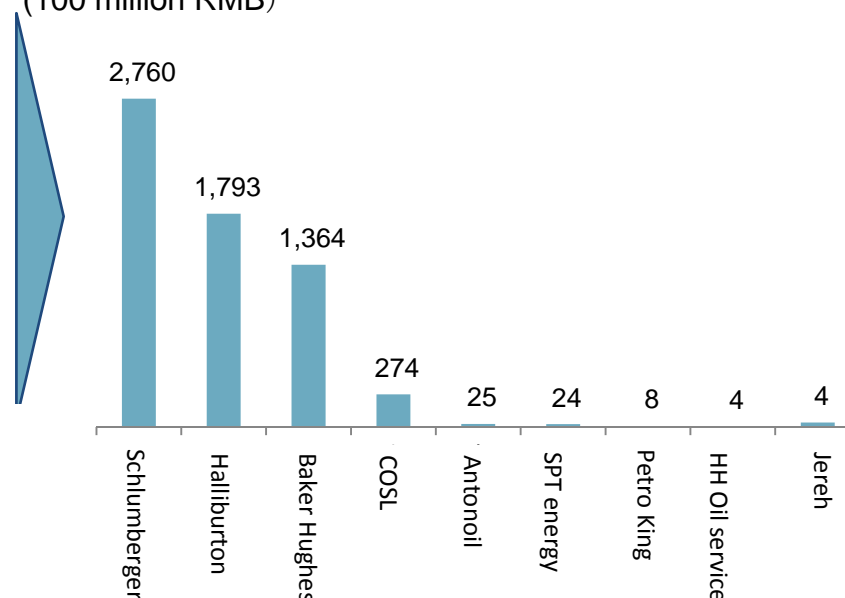
Oil-gas service in the world

(100 million USD)



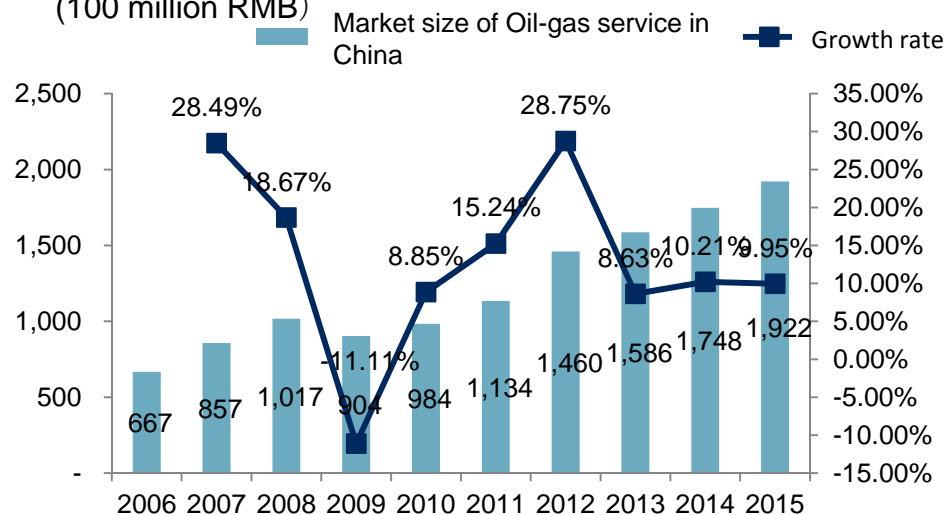
Revenues of 2013

(100 million RMB)



Oil-gas service in China

(100 million RMB)



- ◆ The oil-gas service industry hasn't scaled in China except CNPC and Sinopec.
- ◆ The oil-gas service for shale gas exploration is not enough in China

Data source : Barclays Capital

2、Effective environmental solutions of shale gas exploitation

Based on the overall requirements, effective environmental exploitation requests an integral planning with a sincere consideration of cost efficiency, paramount technology employment, possibility of utilization of well gas and optimized site map planning, etc. Therefore, HH presents below:

1. Optimized site mapping



2. Utilization of well gas



3. Integrated drilling operation

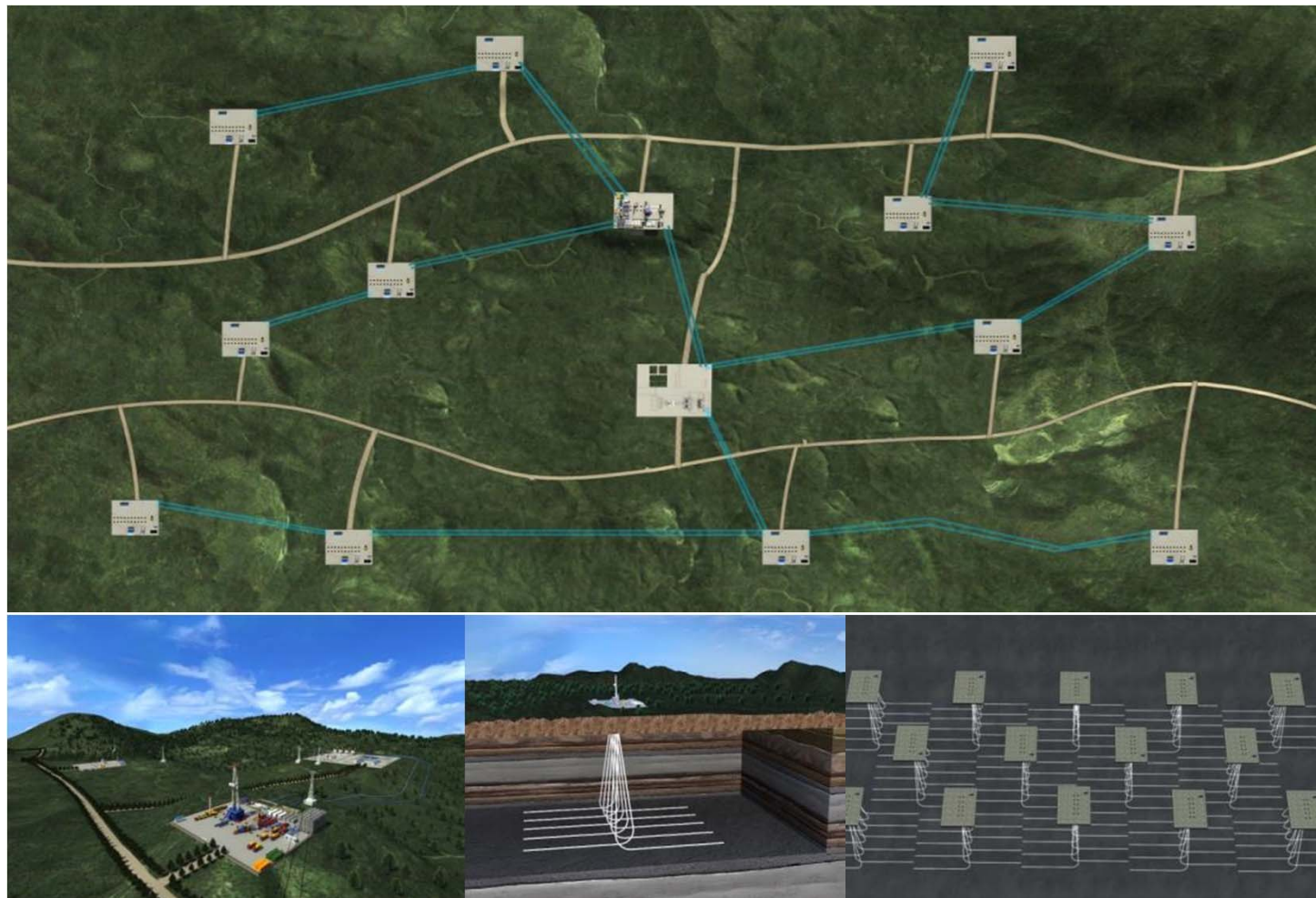


Fixed-asset investment reduced by 10%;
Land occupation reduced by 50%-65%
Numbers of operator reduced by 50%-60%;
Fuel costs reduced by 40%-80% ;
Drilling and completion cycle reduced by 30% ;
Reduce overall exploitation cost by 10%;
Diesel saving 400Tons for one well;
Diesel saving 80Tons for 2000 well;

2、Effective environmental solutions of shale gas exploitation

Optimized integral solution proposal

HH's proposal would comprise a 50,000kW power station, 10 drilling rigs , 2 sets of fracturing fleet. With these set up, operation will be able to accomplish 50 wells (drilling and completion) per year, include 15 ~ 20 rig sites and cover the size of area approx. 120 ~ 150 km².



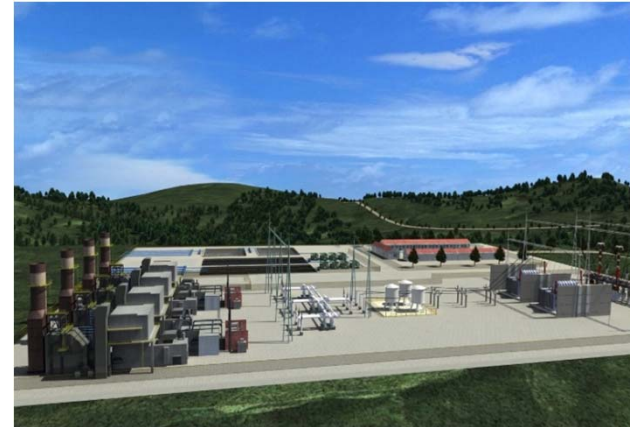
2、Effective environmental solutions of shale gas exploitation

Gas power station contributes enormous benefits

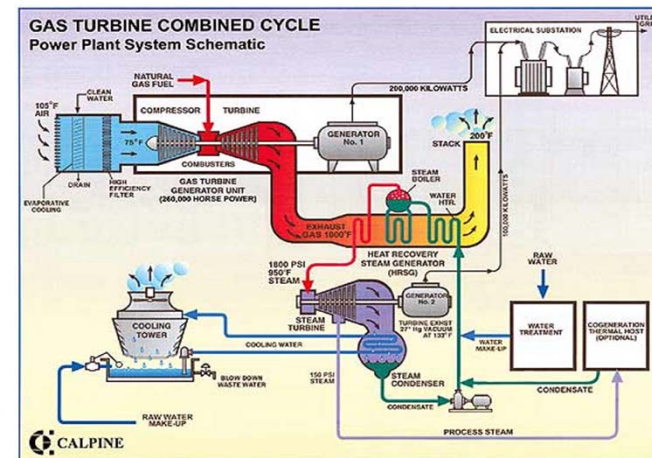
The gas power station consists of combined cycle gas turbines, through it, which provides heat efficiency up to 70%.

According to the current natural gas price in China, the total cost of electricity is approx. ¥1 RMB/ KWh.

Power stations would better be set up near residential areas to have easy access to the national power grids. It is cost-effective to use cheap hydroelectric power in Sichuan.



Centralized gas power station



Gas power generation working schematic

Drilling solutions



In recent years, HH has supplied nearly 60ea land rigs to serve in US shale gas drilling industry. Honghua is known as a prime drilling equipment manufacture with extreme rich experiences in technology innovation and supplying customized drilling packages to satisfy our customers' requirement. Honghua is competent not only to provide high efficient drilling equipment but also to integrate it along with advanced downhole technology or tools to help our customers achieve desired performance and profit in sale gas exploitation.



1500/2000HP beyond rig

Automatic AC rig
Pad drilling
Pipe handling system, 5-6 rig operators
needed only
Idrill system



2400HP Quintuple Mud Pump



Top driver



Rotary steerable system, LWD and oil-based drilling mud can realize long horizontal section

Well completion and fracturing solution

Honghua has innovated electric drive fracturing equipment including the world's biggest horse power fracturing pump. Such innovation has Effectively resolved the bottleneck of the traditional diesel fracturing equipment in shale gas drilling. It offers significant benefits in reducing the size of area that the equipment usually uses up, freeing more field hands, fuel cost savings, helping environmental concerns, etc.



6000HP AC Fracturing pump



Coiled tubing equipment

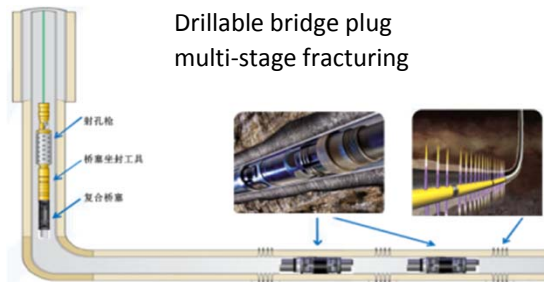
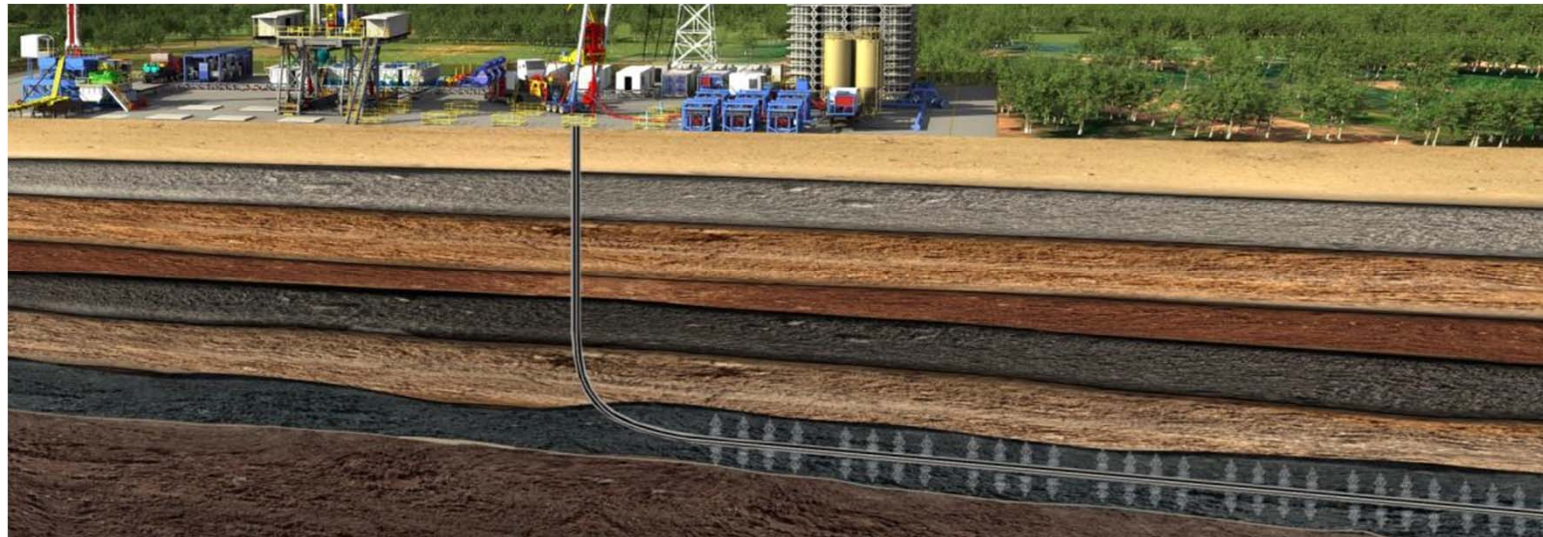


Automatic fracturing blender system

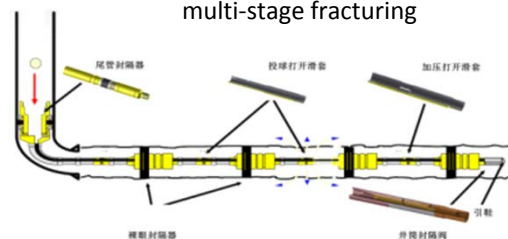


Flexible water tank

- At least Half operator
- Half land occupation



Drillable bridge plug multi-stage fracturing



The sliding sleeve packer multi-stage fracturing



Hydraulic sandblasting multi-stage fracturing

2、Effective environmental solutions of shale gas exploitation

Next generation of VFD automated drilling rigs



Integrated top drive system



Direct drive AC drawworks



Automatic catwalk



Walking system for pad drilling



Pipe handling system



Multi-function driller's cabin



Direct drive mud pump, 7500Psi

- Equipped with automated equipment, only 5-6 rig hands needed
- Walking system designed for pad drilling ;
- Notch technology and advanced features employed into major rig components to improve drilling efficiency;
- Zero discharge environment friendly
- Embraced with smart Idrill system platform

2、Effective environmental solutions of shale gas exploitation

Electric Fracturing Equipment with high horse power
helps drilling pad more compact



= 3×



there are thousands of sales gas wells being drilled in China annually. The need of fracturing equipment for such operation is getting close to 1000000 horsepower, equivalent to 4000 diesel driven fracturing units. Abide by the governmental regulation to the low carbon environmental protection requirements , the use of large power diesel engines will be significantly reduced.

6ea of HH innovated 6000HP electric fracturing pump is able to replace 18ea of conventional fracturing units, also meeting the same requirements of fracturing operation.

2、Effective environmental solutions of shale gas exploitation

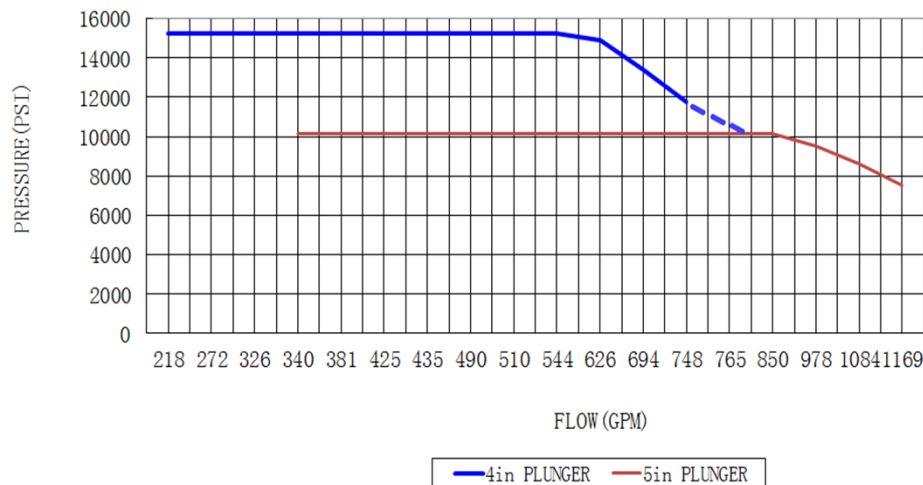
6000HP Electric Fracturing Pump



Parameters:

Max. Input Power	6000 HP (4500 kW)
Max. pump stroke	275 SPM
Stroke	254 mm
Gear ratio	4.516 : 1
Max. Force of rod	940kN(211310 lb)
Max. pressure	105Mpa(101.6mm plunger)
Max. displacement	4.42 m ³ /min (127mm plunger)
Displacement under 75Mpa	3.49m ³ /min (216SPM)
Displacement under 105Mpa	2.30 m ³ /min (225SPM)
Dimension(mm)	6175 X2990 X3030
Weight	32t

Pressure—Displacement

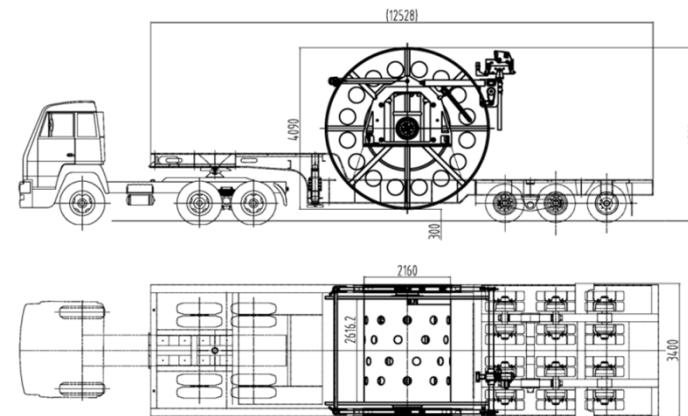


Features:

- Power rated as the largest fracturing pump in the world, the first pump is driven by medium voltage frequency AC motor
- Reduces the numbers of pump units in a fleet, compact space usage, high horse power rated, logistic efficiency.

2、Effective environmental solutions of shale gas exploitation

Specialized coiled tubing equipment for drilling deep wells



The length and diameter of coiled tubing are the essential factors to affect the total distance of horizontal section in DD. Honghua's current R&D project on 2 3/8" OD and 6000m coiled tubing unit will meet the transportation requirement in China and even more to satisfy the requirement to drill 2000m horizontal section.

2、Effective environmental solutions of shale gas exploitation

Automated Sand conveyer and storage equipment



Parameters:

Volume of the
sand storage tank

140m³

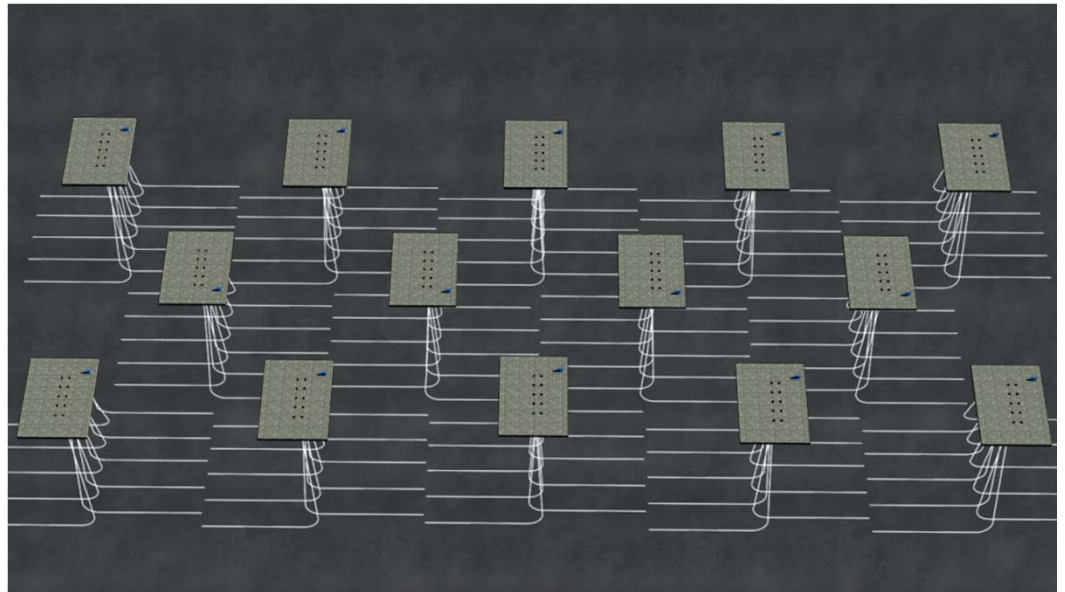
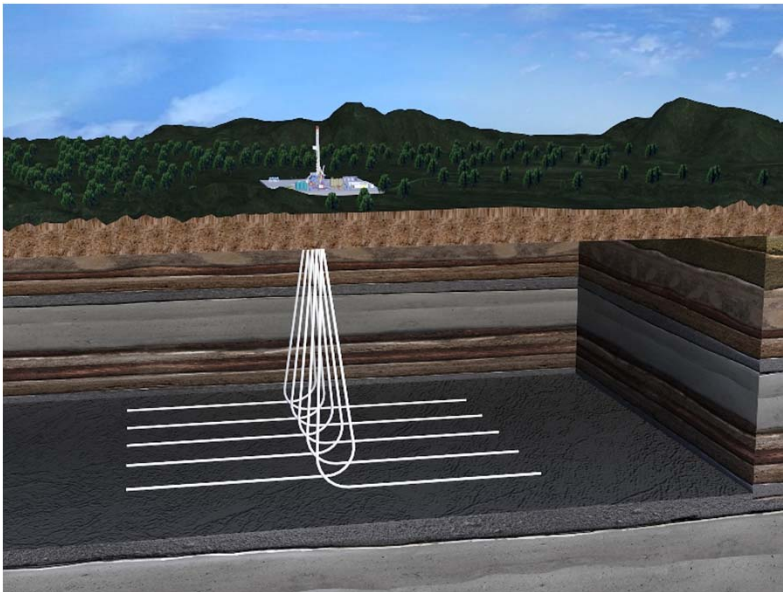
Sand mixing truck
capacity

20m³/min

Fully automated integral solution for sand storage, mixing and transportation, more hands free and safety stressed.

2、Effective environmental solutions of shale gas exploitation

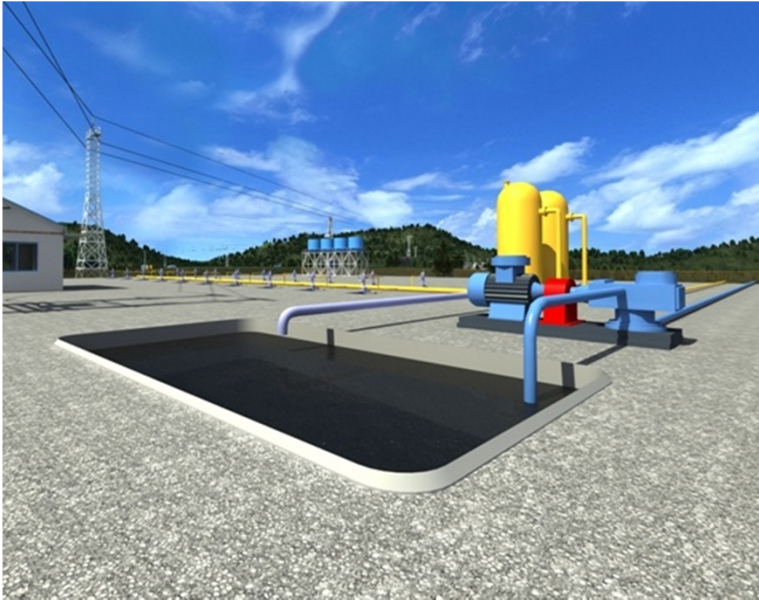
Extended Horizontal drilling brings more profit



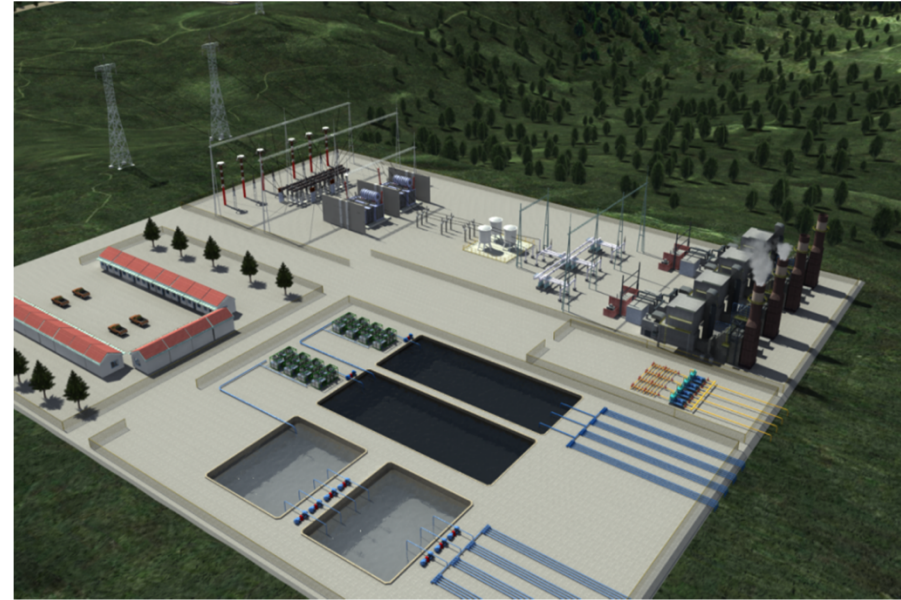
The general distance of horizontal section in Longmaxi formation is about between 1000-1500m presently. Supposedly, when the horizontal distance is extended to 2000m while drilling 10 wells in one site with well space 500m ; in this hypothesis, every well site should be able to cover the size of the area of 10-12 km², and also the land occupation will be reduced by 1/3, in consequence , production will be enhanced.

2、Effective environmental solutions of shale gas exploitation

Centralized water treatment to work environmental friendly



Return water collection and pumping



Central power station with sewage disposal system

Drilling wastewater and fracturing wastewater will be collected and transported to Central station by pipe for centralized water treatment. The treated water will be returned to well site for drilling and fracturing purpose . This water solution would possibly reduce approx. 20-30% water usage and lower the cost for waste water treatment as well.

2、Effective environmental solutions of shale gas exploitation

Zero discharge、noise pollution control



Fully Electric and sound proof equipment



Sound proof walls around shale gas play in Barnett

No diesel, zero nitride emission. Centralized waste treatment solution is meeting zero discharge requirement.

By using fully electric equipment , the sound control can be realized below 90 dB on the drilling site and below 70dB 50m distant away from the site.

Fully water cooling electric equipment , and sound proof walls can be considered when environmental requirement is even more strict. Which can realize the sound below 70dB 1m distant away from the site.

2、Effective environmental solutions of shale gas exploitation



Fixed-asset investment reduced by **10%** ;

Land occupation reduced by **50%-65%**

No. of operators reduced by **50%-60%**

fuel costs reduced by **40%-80%** ;

drilling and completion cycle reduced by **30%** ;

Reduce overall exploitation costs by **10%** ;

Saving diesel **400Tons** for one well ;

Saving diesel **80Tons** for 2000 well ;

2、Effective environmental solutions of shale gas exploitation

Honghua oil and gas service company: commit to provide turn key service

As a member of IADC, HH provides customers with turnkey service. Currently, HH service has 1,300 employee on staff composing 23 drilling teams, 30 mud teams, 10 directional drilling teams. In 2013, HH service had accomplished the very first shale gas drilling contract in China and received a sincere compliment from our customer. In 2014, we have 7 rigs are dedicated to drill shale gas at the moment in China.

We aims to become the pioneer of the rising oil-gas service company in China. If market open in China, we can achieve the ability of 200 wells per year.



HONGHUA OIL & GAS
ENGINEERING SERVICES
LIMITED

is a Contractor member
in good standing.

International Association
of Drilling Contractors
2012



HONGHUA OIL & GAS
ENGINEERING AND
TECHNOLOGY SERVICES
SICHUAN CO LTD

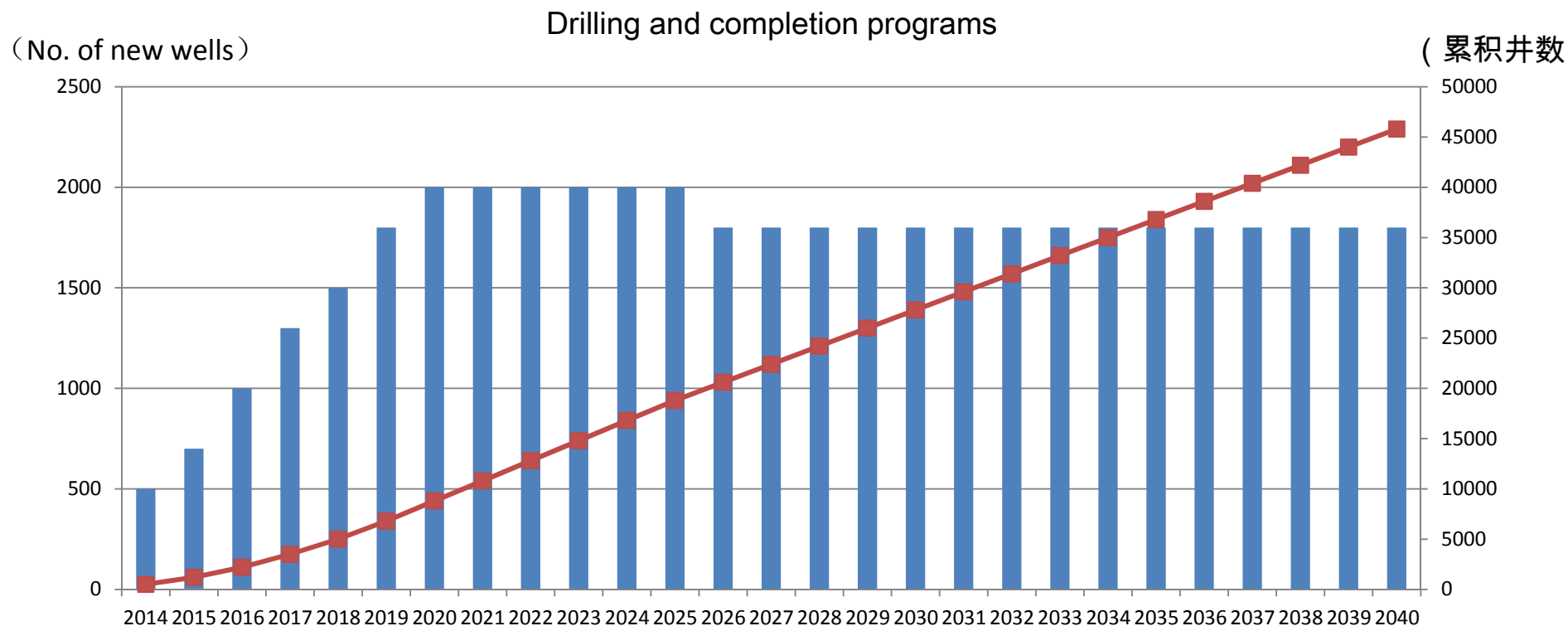
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International Association
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2011



3、 Strategic significance for China

Achieve 100 Bcm in 2020, and 200 Bcm in 2030 shale gas production



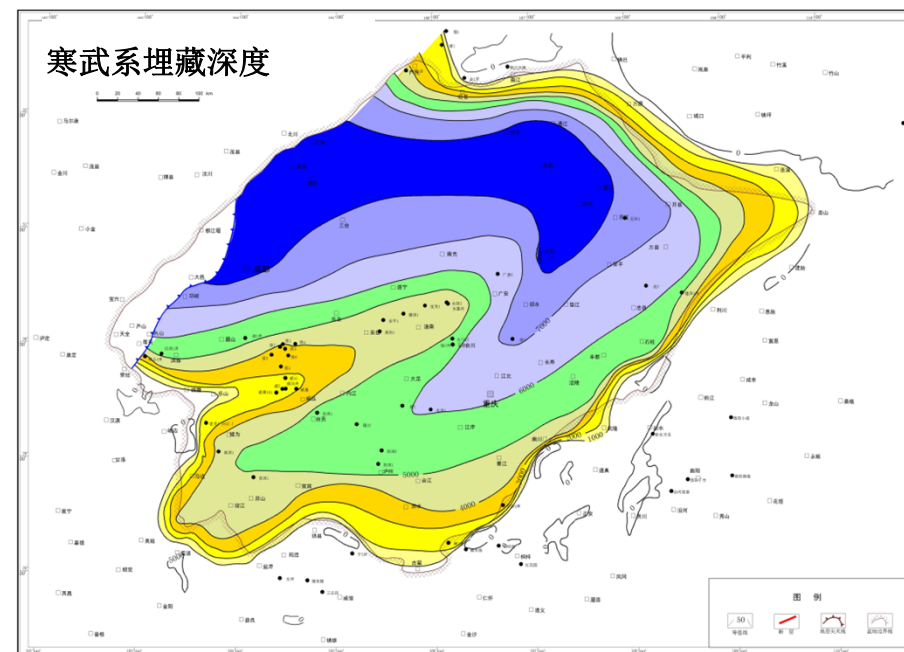
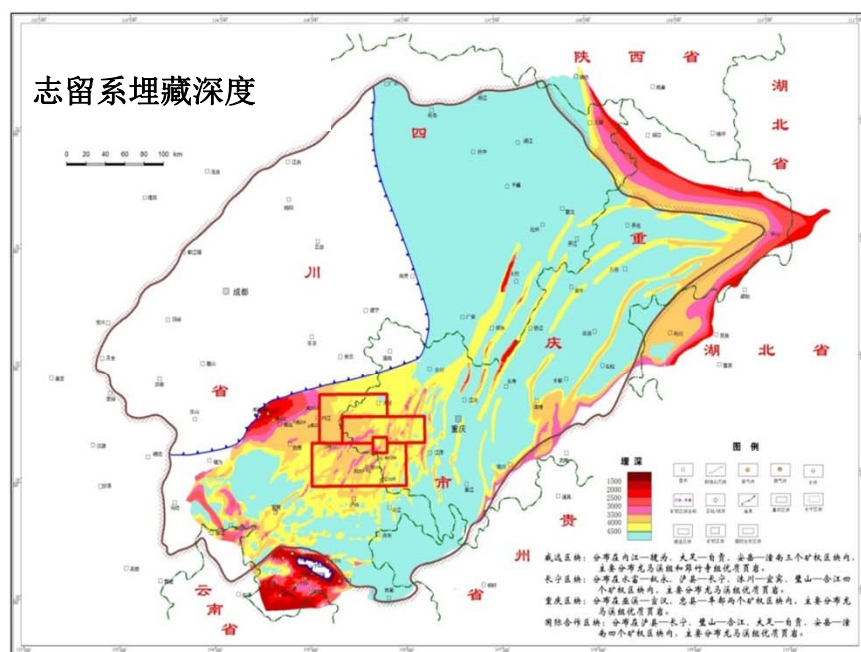
Require about 476 sets of drilling equipment and 75 sets of fracturing equipment.

- The total number of drilling wells is **8,800** between 2014-2020. If we assume the comprehensive cost is 80 million for one well, the investment of oil and gas service will be about 700 billion yuan.
- The total number of drilling wells is 19,000 between 2021-2030, the investment of oil and gas service will be about 1500 billion yuan. If we spend 140 billion yuan every year between 2014-2030, we can have 200 Bcm shale gas production in 2030.

3、 Strategic significance for China

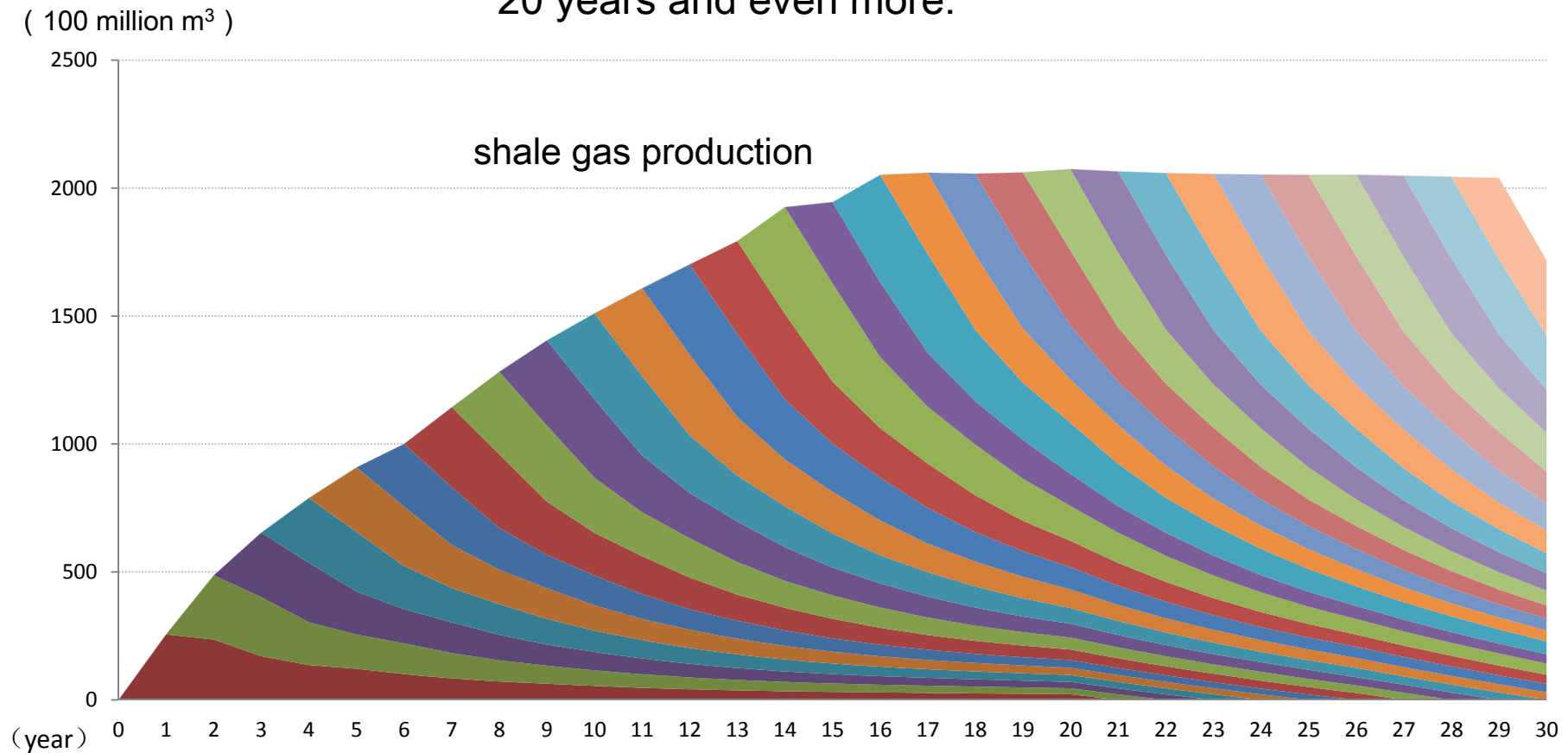
Achieve 100 Bcm in 2020, and 200 Bcm in 2030 shale gas production

- The total number of drilling wells is **8,800** between 2014-2020 , which need 10,000km² High quality shale gas resources.
- The total number of drilling wells is 19,000 between 2021-2030 , which need 20,000km² High quality shale gas resources.
- With the advances in exploration technology and the breakthrough in marine shale and marine-continental shale, we have confidence in production stable and increasing.



3、 Strategic significance for China

Strive to realize shale gas production in Sichuan Basin and the surrounding area to 100 Bcm in 2020, and 200 Bcm in 2030, hoping for stable increasing for 20 years and even more.

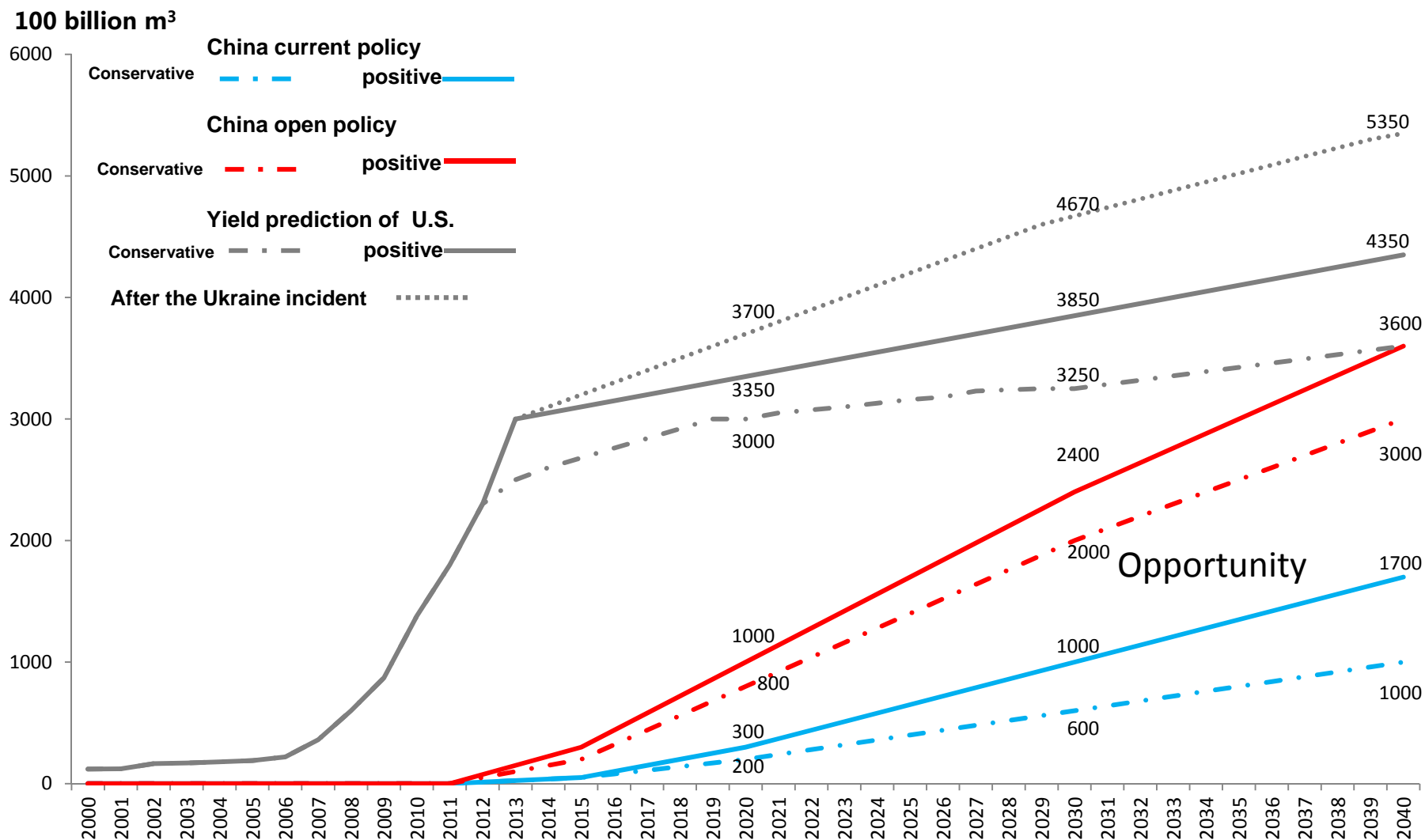


Note:

1. Estimated EUR is 110 million m³;
2. We estimate 51 thousand m³ of gas a day for every well in first year.

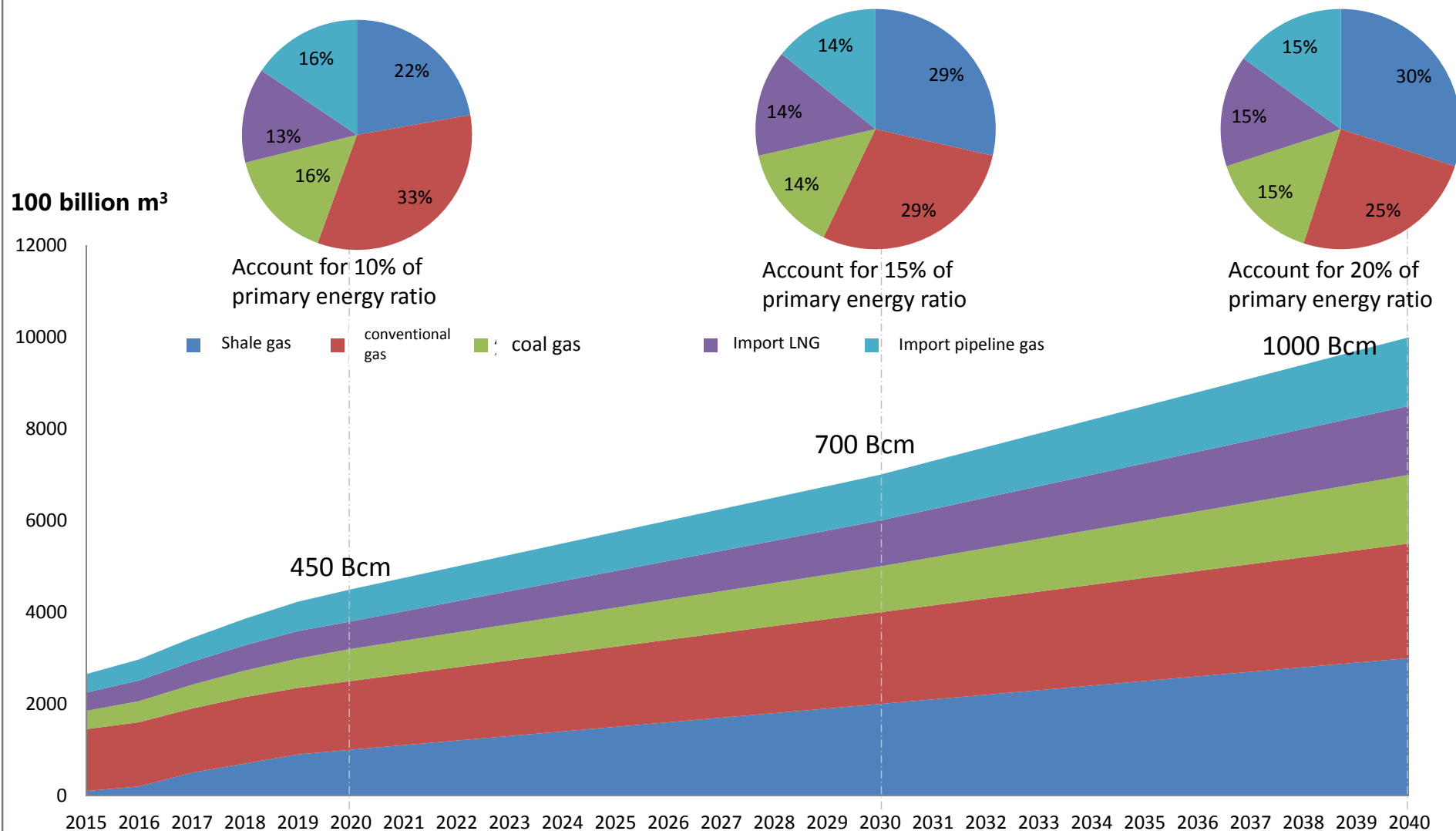
3、 Strategic significance for China

U.S. shale gas production forecast and China shale gas production imaginary map



3、 Strategic significance for China

Potential to support substantial growth of the natural gas supply of China,
increase proportion of natural gas in primary energy consumption



For blue sky!

