



China's Shale Gas Industry -Current Policy

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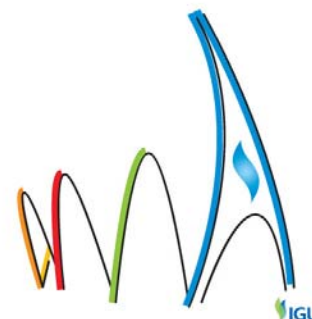


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Background

The successful development of shale gas in U.S. has changed the pattern of energy supply. Shale gas will play an important role in countries such as China, Australia, India, Canada, Indonesia and Poland. China is now actively committed to shale gas operations. Until now, 300 wells have been drilled. A lot of organizations made shale gas resources assessment of China. The result shows the geological resources are about 100-130Tcm (3500-4700Tcf) (MLR, IHS), the recoverable resources are about 10-36Tcm(350-1270Tcf) (CAE, EIA). Marine shale gas development in Sichuan basin has gotten a big success, and the recoverable resources are 8.82Tcm (Zou etal)

Tab. 1 Shale gas resource assessment results of different organizations

Organizations	Geological resource ($\times 10^{12} \text{m}^3$) (Tcf)	Recoverable resource ($\times 10^{12} \text{m}^3$) (Tcf)	Year
IHS	100(3500)	--	2008
EIA	--	36(1270)	2011
Ministry of Land and Resources(MLR)	134(4700)	25.08(880)	2012
China Academy Engineering	—	10-15(350-530)	2012



Shale gas recoverable resources in U.S. are about 18.8Tcm, and 370 Bcm gas were produced in 2014. 170 Bcm gas should be produced in marine shale per annul, with about 8.82Tcm recoverable shale gas. Considering the lower degree of prospecting and the complexity of reservoir, at least 80Bcm shale gas should be produced per annul.

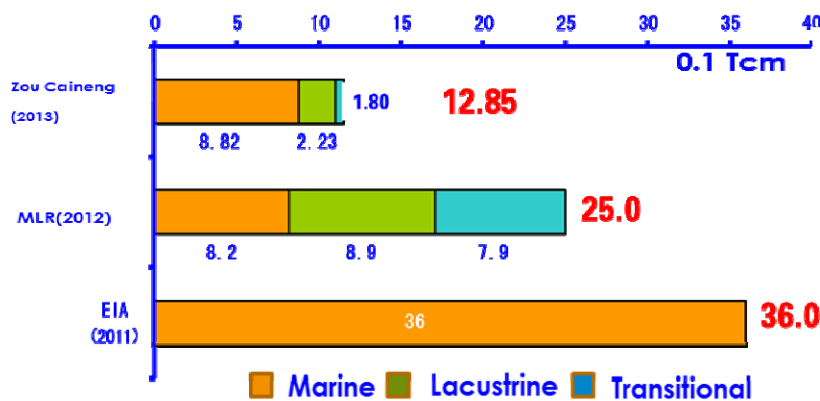
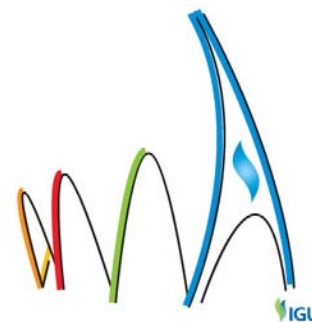


Fig.1 China shale gas assessment results of different organizations

Until now, over 300 wells have been drilled in Jiaoshiba block and in Shunan area. CNPC (Petrochina) is developing the shale gas resources in Shunan area, the southern Sichuan basin, including two national pilot areas of Changning-Weiyuan and Zhaotong. SINOPEC puts emphasis on the surrounding of Sichuan Basin and is developing the shale gas in Jiaoshiba block, Fuling national pilot. CNOOC has carried out shale gas evaluation in Wuhu, Anhui Province and is now evaluating the shale gas in coal-bearing formations with CUCBM. Yanchang Petroleum Group is conducting the experiments for exploring and developing the continental shale gas, such as Yan'an national pilot.

Aims

The main shale gas policies and their effort for China's shale gas industry will be introduced in this paper. Different cases for typical shale gas well will be analysed to show the effort. The policies have made a very important effect on shale gas production. It's estimated that the shale gas production will increase to 1.5 Bcm in 2014 and 5.5 Bcm in 2015. Based on present cost of shale gas exploration and development, we think the China government will continually give a shale gas production subsidies in 2016-2020, in order to promote the rapid growth of shale gas production.



Shale gas policies and the effort

To increase gas supply, alleviate the contradiction between supply and demand, the Chinese government actively promotes the development of shale gas resources. So the government introduced a series of industrial policies.

"*Notice about shale gas development and utilization of subsidy policy*" was issued by Ministry of Finance and National Energy Administration. "*Shale gas industrial policy*" was issued by National Energy Administration. "*Notice about the work of strengthening shale gas resources prospecting & exploitation and supervision*" was issued by Ministry of Land and Resources. The Ministry of Science and Technology has established technology research projects.

(1) Exploration and extraction rights policy

Shale gas is appointed as a separate mineral species. In December 2011, the MLR formally approved shale gas as one of the 172 minerals. Its investment will be managed and regulated as an Individual mineral. Shale gas can be prospected and produced in oil & gas blocks, but additional shale gas exploration or extraction rights should be applied for.

Since 2011, two rounds of shale gas exploration right bidding have been carried out, and in some conventional oil and gas blocks shale gas exploration right have been added.

Tab. 2 Shale gas exploration blocks in China

Shale gas mining right	No.	Area (km ²)	Location
Apply for additional shale gas mining right	33	146258.38	The sichuan basin and its peripheral ordos basin
The first round of bidding	2	4236.81	Chongqing, Guizhou, Hunan
The second round of bidding	19	19504.81	Chongqing, Guizhou, Hunan, Hubei, Jiangxi, Zhejiang
Total	54	170000	Chongqing, Hunan, Hubei, Guizhou, Jiangxi, Zhejiang, Shanxi, Sichuan

(2) Financial subsidies policy

"*Notice about shale gas development and utilization of subsidy policy*" releases 0.4 RMB/m³ financial subsidies for shale gas produced in 2012-2015 by Ministry of Finance and NEA, in Nov. of 2012. If a shale gas company want to get the subsidies, the next five conditions must be met: (1) Gas Produced from shale reservoir with TOC>1.0%;(2) Interbedded formation



ratio <20%;(3) Single interbedded formation (such as sandstone or limestone) < 1 m;(4) The shale gas should have been produced and utilized;(5) The shale gas should have been metered accurately.

A series of shale gas policy, promoted the Chinese shale gas development pace. 1.2 Bcm shale gas was produced in 2014 and the production will reach 5.8 BCM in 2015. 77.4 Million dollars subsidies will be received for shale gas produced in 2014, and the subsidies will reach 0.37 Billion dollars in 2015.

In Jiaoshiba block, over 1 Bcm shale gases were produced in 2014, and the production will reach 3.2 Bcm in 2015. And about 0.28 billion dollars will be received till 2015. In Shunan area, about 0.15 billion shale gas were produced in 2014, and the production will reach 2.6 Bcm in 2015. And about 0.2 billion dollars will be received till 2015.

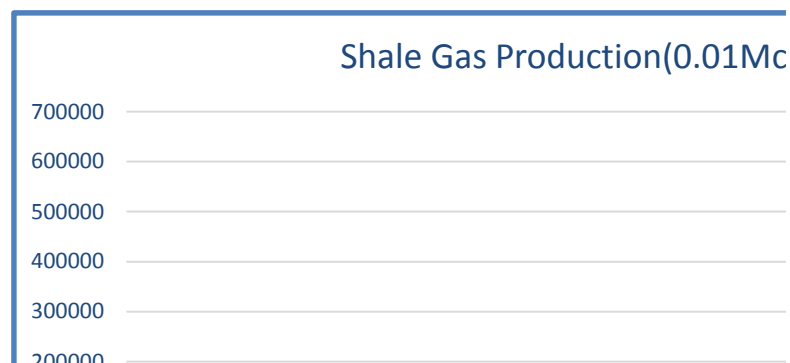


Fig.2 China shale gas production

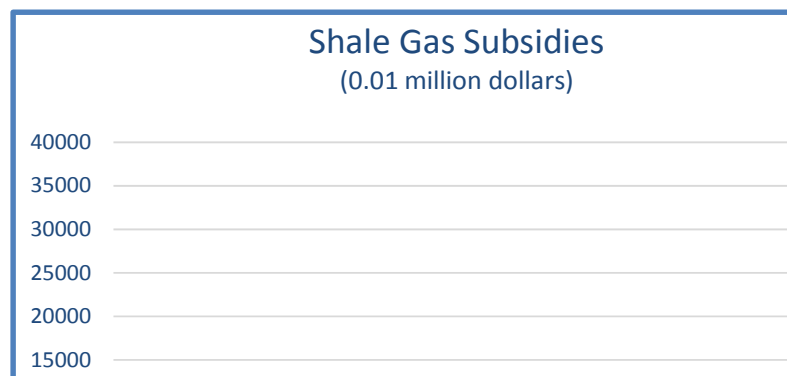


Fig.3 China shale gas Subsidies

(3)Technology research projects

Ministry of Science and Technology established the project "critical techniques for shale gas exploration and development" in 2010. Two projects in "973" project found, have been set up,



which are "Southern Paleozoic shale gas resource potential accumulation mechanism and evaluation", "Basic research on Southern marine shale gas development".

Most horizontal wells got a promising initial gas producing rate. In Jiaoshiba block, the average test initial gas producing rate is about 0.33 Mcm/d, and the max test rate is 0.55 Mcm/d. In Shunan area, the average test initial gas producing rate is about 0.125 Mcm/d, and the max test rate is 0.24 Mcm/d.

Drilling cycle of horizontal wells reduced by a big margin. Changning: reduced from 140 days to 60 days. Weiyuan: reduced from 150 days to 90 days. Zhaotong: reduced from 140 days to 70 days. Jiaoshiba: reduced from 83 days to 60 days.

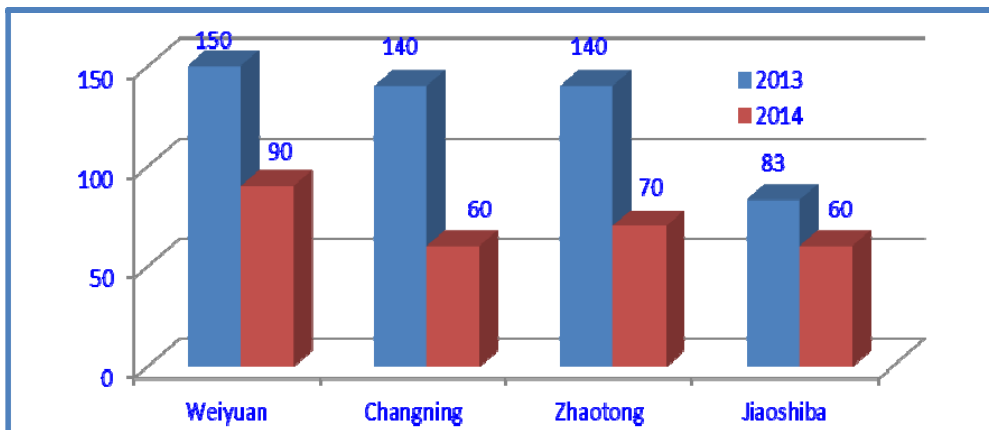


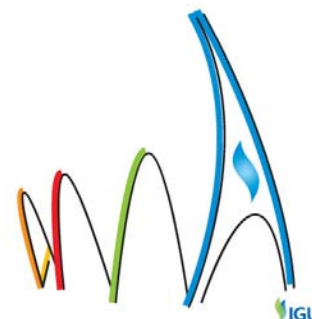
Fig.4 2013-2014 Drilling cycle of horizontal wells (Days)

Case study of typical shale gas well

According to the geological characteristics, three types of well with different initial gas producing rate were chosen as typical wells. The initial gas producing rates of the three type wells are 20 Mcm/d, 15 Mcm/d and 10 Mcm/d, and the EUR are 0.139Bcm, 0.11Bcm and 0.089Bcm.

(1) Typical well without subsidies

If with a 0.2 Mcm/d initial test producing rate, the IRR is 22.75%. If with a 0.15 Mcm/d initial test producing rate, the IRR is 12.13%. If with a 0.1 Mcm/d initial test producing rate, the IRR is 4.42%.



Tab3. Economic analysis of typical well with well cost 70 million RMB

Parameters	Economic analysis		
Initial gas producing rate(Mcm/d)	20	15	10
EUR(Bcm)	0.139	0.11	0.089
horizontal segment(m)	1500	1500	1500
Well cost(million RMB)	70	70	70
Price(RMB/m ³)	1.6	1.6	1.6
NPV(million RMB)	24.87	1.01	-7.89
IRR(%)	22.75	12.13	4.42

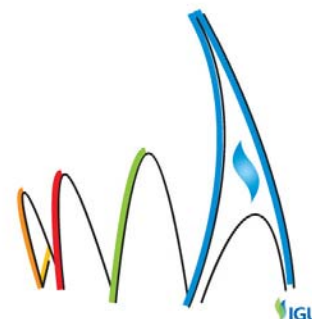
If well cost can reduce to 60 million RMB, the IRR will increase by a big margin. If with a 0.2 Mcm/d initial test producing rate, the IRR is 34.51%. If with a 0.15 Mcm/d initial test producing rate, the IRR is 19.57%. If with a 0.1 Mcm/d initial test producing rate, the IRR is 9.28%.

Tab4. Economic analysis of typical well with well cost 60 million RMB

Parameters	Economic analysis		
Initial gas producing rate(Mcm/d)	20	15	10
EUR(Bcm)	0.139	0.11	0.089
horizontal segment(m)	1500	1500	1500
Well cost(million RMB)	60	60	60
Price(RMB/m ³)	1.6	1.6	1.6
NPV(million RMB)	24.87	16.68	1.71
IRR(%)	34.51	19.57	9.28

(2) Typical well with 0.4RMB/m³ subsidies in 2014-2015

Considering the 0.4 RMB/m³ subsidies in 2014-2015, the IRR will increase sharply. If with a 0.2 Mcm/d initial test producing rate, the IRR is 41.62%. If with a 0.15 Mcm/d initial test producing rate, the IRR is 21.61%. If with a 0.1 Mcm/d initial test producing rate, the IRR is 8.93%.



Tab5. Economic analysis of typical well with 0.4RMB/m³ subsidies in 2014-2015

Parameters	Economic analysis		
	20	15	10
Initial gas producing rate(Mcm/d)	20	15	10
EUR(Bcm)	0.139	0.11	0.089
horizontal segment(m)	1500	1500	1500
Well cost(million RMB)	700	700	700
Price(RMB/m ³)	1.6	1.6	1.6
NPV(million RMB)	39.46	19.22	1.24
IRR(%)	41.62	21.61	8.93

Conclusions

China government is full of confidence with shale gas development. The National Energy Administration has issued an "Action Plan for Accelerating exploration & Development of Shale Gas", in which 30-50 Bcm shale gas will be produced in 2020 and 80-100Bcm in 2030.

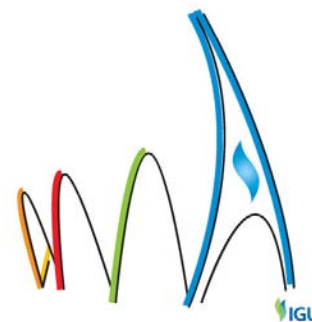
Most companies cannot enjoy the subsidies policy in 2012-2015. According to the shale gas current situation, only PetroChina and SINOPEC can obtain some subsidies of shale gas production in 2012-2015. Other companies can't realize the effect development of shale gas, and cannot enjoy the subsidy in 2012-2015. If the single well cost can achieve the expected value is still need to practice. Single well cost is 600 million RMB in the process of the economic evaluation of typical block, but the single well cost is about 700-800 million RMB. Though we think the single well cost is very probably less than 600 million RMB after 2016, it is still has some. China's shale gas resource conditions are worse than that of the US. Every shale gas reservoir is different, so different shale reservoir need different suitable technology to develop effectively. We need reduce the cost gradually and we think 2 to 3 years is necessary to have a big cut of the cost in a new shale gas block. Shale gas development has impact on the residents' living environment.

Based on present cost of shale gas exploration and development, the subsidy is necessary in order to promote the rapid growth of shale gas production in 2016-2020. Considering technological progress, single well cost has a big possibility to decrease to less than 60 million RMB. We advise government giving 0.3 RMB/m³ subsidies during 2016 to 2020, so that IRR of shale gas development project can reach 10% or higher. Considering the environmental impact of shale gas development, safety and environmental protection supervision system need to be strengthened by government. China government issued a new Environmental Protection Law on January 1, 2015. If there is a possibility of

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environmental pollution, precautionary measure must be done to protect against it. How to eliminate environment pollution from the source is a top priority. We advise strengthening the recycling of drilling fluid, fracturing flowback fluid, and strengthening water drilling fluid research for horizontal well, to gradually replace oil-base drilling fluidt68

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