Northeast Asia Petroleum Forum 2009

The Study for the Development Practice and Law of Onshore Old Oil Fields in Eastern China

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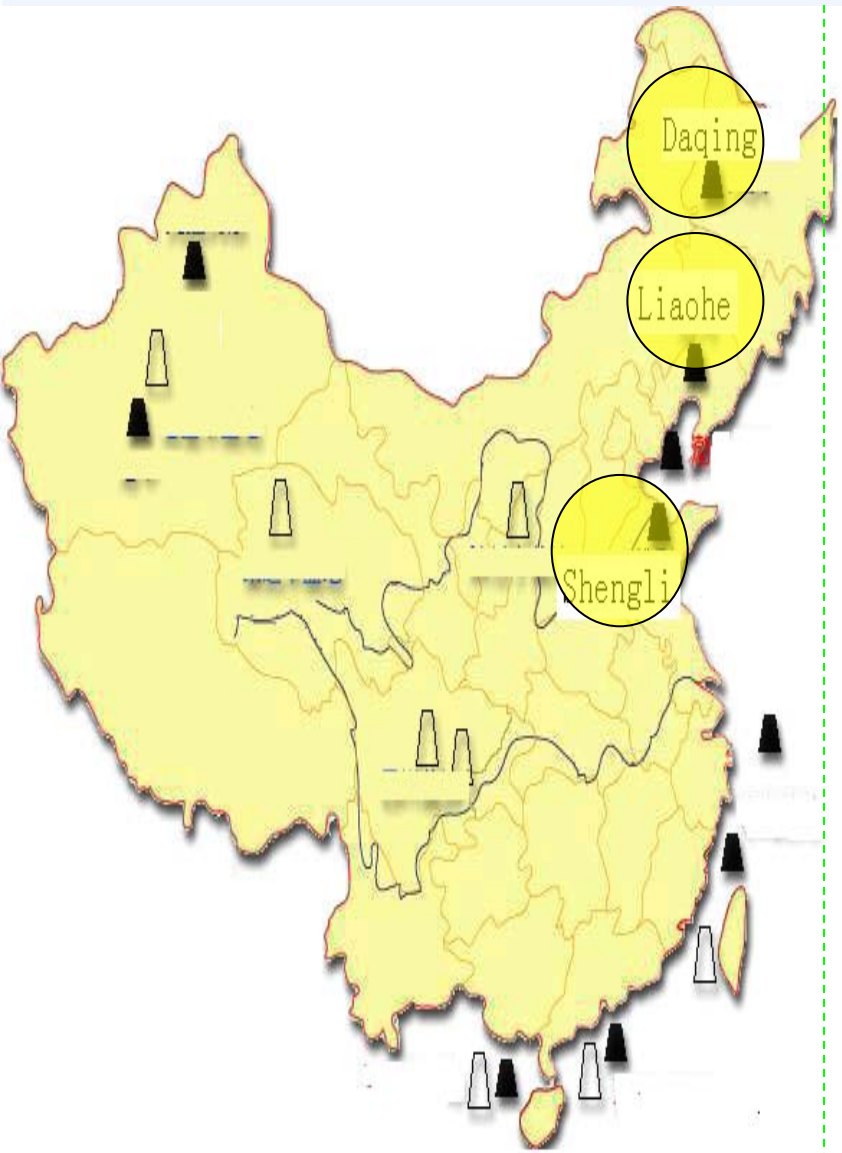
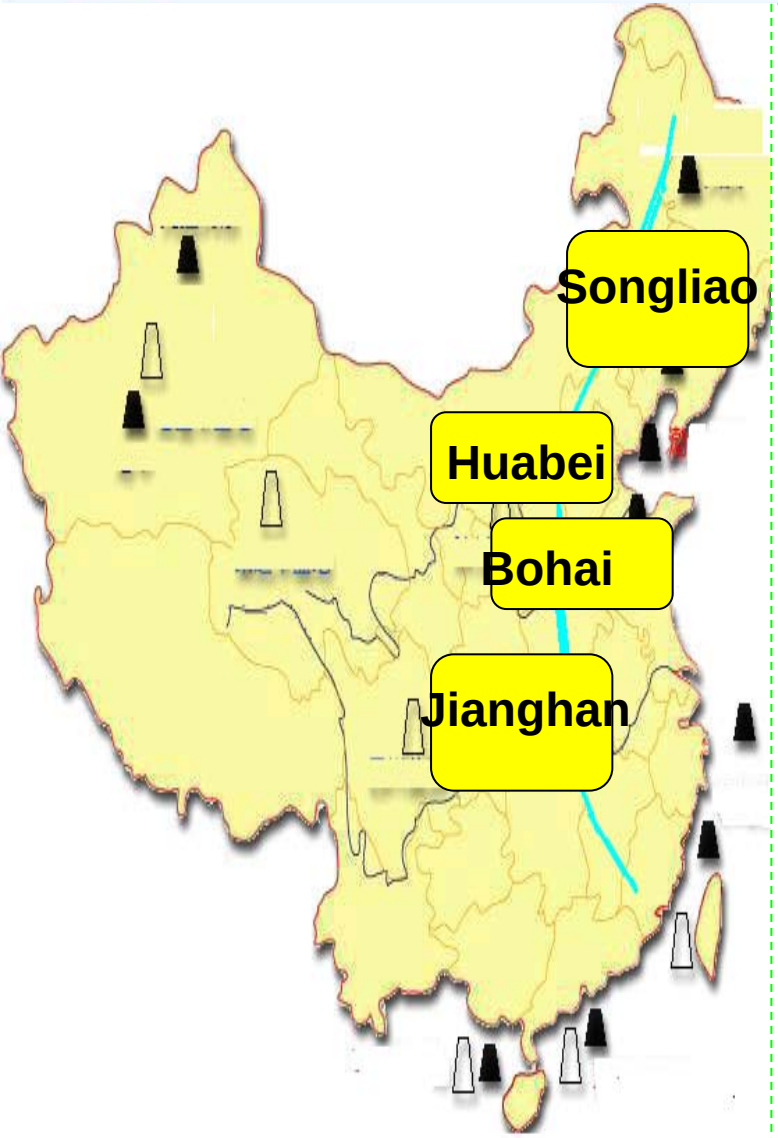


In 2008, Chinese dependency on foreign oil grew up to 50 percent for the first time. The contradiction between supply and demand has become increasingly conspicuous. Currently, steady oil production of the eastern old oil fields is still a key problem to stabilize the crude oil production of China at 0.18-0.20 billion tons annually. In 2008 the output of the crude oil of Daqing, Shengli, Liaohe Oilfield altogether accounts for more than 40 percent in China, and the oil production of all the eastern old oil fields accounts for 2/3 of China's crude oil output.



The eastern old oil fields refer to the onshore old oil fields located in the east part to the line Daxinganling-Taihang-Wulingshan, including Songliao, North China (Bohai Bay), Nanxiang, Jianghan, as well as other important hydrocarbon bearing basins, in where the proved reserve of the oil and gas accounts for 67.2 percent of china.

According to the latest round of assessment, the future resource volume of the eastern oil fields is 41.8 billion tons, accounting for 39 percent of all China's oil and gas resource volume, and their original oil in place(OOIP) is 32.4 billion tons, accounting for 47 percent.

The oil reserve of China and the eastern oil fields

Unit: Million tons

	China	Eastern oil fields	Proportion
Proved original oil in place(OOIP)	27517.05	18498.61	67.2%
Undeveloped original oil in place	7719.67	4032.73	52.2%
Technological recoverable reserve	7604.68	5656.90	74.4%
Undeveloped technological recoverable reserve	1372.94	729.60	53.1%
Remaining technological recoverable reserve	2784.22	1695.25	60.9%
Economic recoverable reserve	7851.25	5930.93	75.5%
Undeveloped economic recoverable reserve	866.80	396.37	45.7%
Remaining economic recoverable reserve	2058.10	1235.84	60.0%
Accumulated crude oil production	4820.46	3961.62	82.2%

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1. Review of the major eastern oil fields' development history

By the end of 2007 there are 10 on shore oil fields in the eastern China, among which Daqing and Shengli rank the first and second respectively in the aspect of oil production, and Liaohe oil filed is the fourth largest oil field.

Daqing oil field

1959	founded
1960	Start development
1976	Annual production 50M tons
1996	Annual production 56M tons

By the end of 2008, the annual oil production of Daqing is about 40.2 million tons, and its accumulative oil production of Daqing oil field breaks 2 billion tons, accounting for more than 40 percent of the crude oil output of the onshore oil fields at the same period. Currently the recovery factor of its major oil fields is about 50 percent.

Shengli oil field

1961	founded
1964	Start development
1978	Becoming the second largest oil field
1987	Annual production 30M tons
1991	Annual production 33.53M tons

By the end of 2008, the annual oil production of Shengli is about 27.7.2 million tons, the average recovery factor of Shengli oil field is about 28.9 percent, and its accumulative oil output is 936 million tons. Until now its accumulative proved original oil in place(OOIP) is 4824 million tons, the proved gas geology reserve is 50 billion cubic meters, and its annual three stages of oil reserve volume exceeded 100 million tons in past 6 consecutive years.

Liaohe oil field

Liaohe oil field, founded in 1970, reached its production summit 15.52 million tons in 1995.From 1996 Liaohe oil field entered into the stages of production shrinking. As of the end of 2007 its annual production is 12 million tons and its accumulative proved original oil in place(OOIP) is 2587 million tons, its accumulative oil production is 354 million tons, and its average recovery fator is 22.6 percent.

Basic situation of the three eastern oil fields *Unit: million tons*

Oil field	Founded	Accumulative proved original oil in place	Accumulative production of crude oil	Average recovery factor(%)	Present annual production
Daqing	1959	6000	2000	50	40.2
Shengli	1961	4824	936	28.9	27.7
Liaohe	1970	2587	354	22.6	12

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2.1 Lacking substitute resource reserve and being difficult in employing the newly added reserve.

All of the three major old fields presently are facing the same problem of difficulty in finding the replaceable resource. As the deepening of the oil exploration, the condition of the remaining oil resource is becoming more and more complicated, it is more and more difficult to explore, and geological targets are becoming more and more complex, the abundance of the oil are becoming lower and lower, and the quality of the reserve is becoming worse and worse, which leads to the increasingly growing up in the hydrocarbon exploration cost and it is more and more difficult to employ the newly added reserve.

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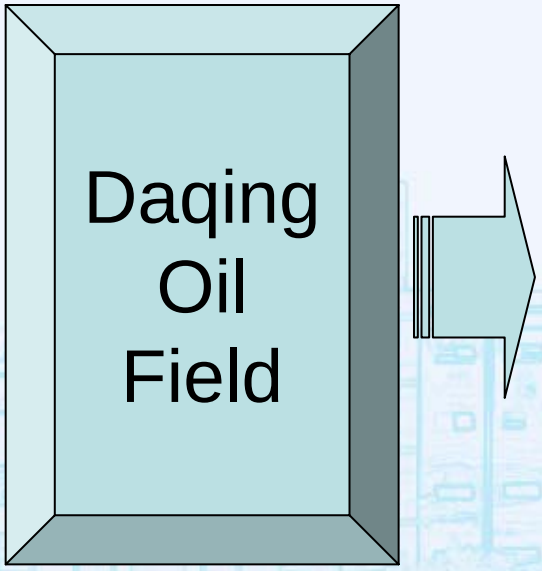

Most of its newly added reserve has the characteristics of low abundance, low production, difficult optimization and high technology demand, and approximately 60 percent of the reserve belongs to hard extracting reserve with low perforation, low permeability, and low flow ratio. Therefore there are only a few objectives that can be applied as the strategic replacement basins.

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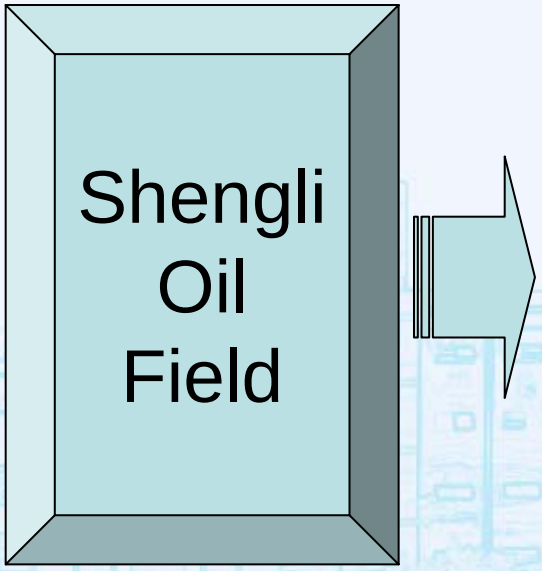

From the point of the composition of newly added proved reserve, the proportion of the low quality reserve with low permeability, heavy oil, under complicated diving mountain and sea beach is rising from 47.3 percent in the "eighth five years" to 69 percent of "tenth five years". Currently, the low quality reserve with deep locating, low permeability accounts for 75 percent, in which the reserve in the deep layer with low and ultra-low permeability has accounted for 60 percent.

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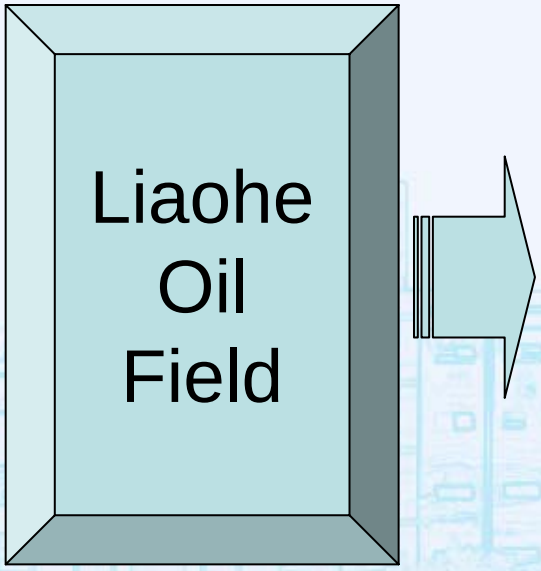

From 1996 Liaohe oil field has entered into the stage of production declining, and in 2008 its rank lowered down from 3rd to 4th. The exploration of onshore oil fields of Liaohe oil field has entered into highly mature period with annual resource discovered becoming less and less, and its resource quality is lowering, reserve replacement rate and reserve to production balance coefficient are under 1.

2.2 The exploration difficulty is rising in the extra-high water content period and the casing damage is becoming more and more severe.

After decades of development the three major oil fields have entered into high water content stage, the contradiction between unbalanced reserve and production is conspicuous, the pressure of increase in the water content and decrease in oil production is rising. With the growth of the number of the extra-high water content wells, the low efficient or inefficient circulation of the water injected under the ground is becoming more and more serious, which results in the increase of the casing damaged wells.

2. Main problems in the late development stage in the major eastern oil fields

The comprehensive water content rate of Daqing oil field reaches 87.71 percent and most of its major oil fields enter into extra-high water content period. The number of the casing damaged wells is increasing. The casing damage affects the production of oil field and results in more than 1 billion Yuan's economic damage annually.

The major oil fields of Shengli oil field have entered into "three high" stage prevalently, with the water content rate up to 90 percent and natural decline rate 20 percent. By the end of 2006 there are about 4 thousand casing damaged wells in Shengli oil field and there will be another 400 casing damaged wells added annually

The present natural decline rate of Liaohe oil field is 28.92 percent. Currently there are approximately 2800 wells without producing and the figure is rising by 10 percent every year. Among the wells the casing damaged wells account for 35 percent.

2.3 The infrastructure is aging and the ground engineering system as well as the load of different areas is imbalanced.

The old oil fields are generally operated in heavy load, parts of the infrastructures are aging. Some storage tanks haven't been repaired for many years and the pipes for transporting the oil eroded seriously. According to the investigation in the pumps, heating stoves, containers, and kinds of tanks as well as pipes, generally problems such as low efficiency, erosion, aging, thinning and perforation of the pipe wall will occur after ten years of operation. These wounded facilities possess safety problems in production. Moreover, as declination of the crude oil production, water contented in the oil is increasing, and the unit energy consumption showed an upward trend year after year, the problems of the ground oil gathering and transporting system are becoming more and more prominent, the original designed capability of part of the stations, pipes, and equipments can't fit practical production.

2.4 The contradiction among investment, production, and cost is becoming more and more prominent.

It is more and more difficult for the old oil fields to explore, which leads to the continuous uprising in exploration and development cost. In order to stabilize the production the three large old fields took the measure of secondary or third oil recovery, which made their oil cost keep on increasing. From 2001 to 2006, the unit exploration cost and unit development cost of the three oil fields rose in different extent.

Comparison of the discovery cost *Unit:$/barrel*

Unit discovery cost	2001	2002	2003	2004	2005	2006
Shengli oil field	**2.49**	**2.37**	**2.57**	**2.65**	**3.21**	**2.38**
Liaohe oil field	**1.69**	**1.74**	**4.85**	**5.21**	**5.24**	**3.31**
Daqing oil field	**1.73**	**1.89**	**2.46**	**2.38**	**0.95**	**3.27**

2.5 There are still lots of bottle-neck technologies of oil exploration and development in the old oil fields

As the condition of the old oil reservoir are becoming more and more complicated, hard developing marginal reserve increases, the production potentiality of the old areas is becoming smaller and smaller. With the third oil recovery changing to subsequent water flood, the exploratory technologies are facing new challenges, for example, the exploratory technology suitable for complicated objectives should be enhanced, technology of describing remaining oil reserve of the old oil field should be improved, and the technology of enhancing oil recovery factor and chemical compound drive technology should be improved. In Daqing oil field the seismic technology to identify river channel in Fuyang oil zone should be improved, and in Shengli oil field there's still lack of the technology definitely describing the structure and reservoir of diving mountains.

2.6 Disposal of the contaminated matters can't meet requirement, the environment problem is still prominent.

The oil enterprises belong to the high polluting industry. Oil exploration and development will bring pollution to the environment. The soil will also be contaminated by the fallen oil, polluted water, sewage, and chemicals discharged during the operation of downhole service. Therefore the task to control industrial pollution is still very hard.

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3.1 To strengthen exploration, ensure increase of reserve, and accomplish the balance between reserve and production.

Daqing Oil Field

Since 2004 Daqing oil field has accomplished its proved original oil in place(OOIP) over 100 million tons annually in 5 consecutive years. Thanks to using new technologies, in 2008 Daqing oil field accomplished its newly added three stages of oil reserves over 600 million tons and newly added gas reserve 50.7 billion cubic meters

The proved oil and gas reserve of Daqing oil field in the resent years

Newly added proved original oil in place	2004	2005	2006	2007	2008
Oil (million tons)	104	102	106	105	267
Gas (billion cubic meters)		102.4	100	101.5	50.7

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Shengli Oil Field

Shengli oil field has its characteristic rolling exploration technology. The theories of hidden reservoir and beach sand reservoir technology have been improved rapidly, and the new round of high and fine seismic technology in development has achieved a lot, which raises the proportion of finding new proved reserve.

The basic condition of oil and gas proved reserve in Shengli oil field

Newly added proved original oil in place	2004	2005	2006	2007	2008
Oil (million tons)	103	100	92	102	104
Gas (billion cubic meters)	6.26		1.58		0.45

3. The study for the development practice and law of the eastern old oil fields

Liaohe Oil Field

From 2005 after the secondary recovery strategy was taken, there's a breakthrough in special lithological reservoir technology, which leads to its newly added proved original oil in place growing up to 56.63 million tons and lays a solid foundation for stabilizing the annual production to 12 million tons.

The basic condition of oil and gas proved reserve in Liaohe oil field

Newly added proved original oil in place	2004	2005	2006	2007	2008
Oil (million tons)	30	25	33	54	54
Gas (billion cubic meters)			0.55	0.33	

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3.2 To strengthen the innovation of production technology and try to enhance the recovery factor

Present recovery factor

Daqing	Shengli	Liaohe(2005)
50	28.9	24.4

Daqing Oil Field

From 1960s Daqing oil field began to research and develop the third production technology. Presently its production by third recovery accounts for 25 percent of its whole oil production, the production by third recovery stabilized at 10 million tons for 7 consecutive years, and its accumulative incremental reserve would be equal to a newly founded oil field with its reserve over 100 million tons.

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Shengli Oil Field

Currently with the development of the technology for increasing the recovery factor, the annual third recovery production in Shengli oil field stabilizes at 1.7 million tons. Since 2008 after the dual-scale polymer flooding technology was applied extensively, the anticipated recovery factor will be increased by 11.1 percent.

Liaohe Oil Field

In liaohe oil field, due to application of secondary development theory, new development means and technologies, the recovery factor has been increased drastically. The oil recovery factor of Xinhai 27 area which is regarded as the demonstration project of the secondary development will be expected to increase to 50 percent from 15.3 percent after application of the secondary recovery technology.

3.3 To optimize and adjust the grounding engineering, complement the injection and production well network, and prolong the casing life.

After the old oil fields entering into high water content period, part of the facilities of the old oil fields will be left unused, and energy consumption will rise. Coupled with the aging of facilities, the workload of renewing and maintaining increases drastically.

Through optimization and adjustment of the ground system, reducing the excessive capability, and stopping or lowering the lower load as well as aging stations and facilities, the investment of renewing and alternating facilities as well as the operation energy consumption are reduced. Meanwhile by strengthening investment to the grounding system, applying advanced guiding technology conducting technology innovation to the grounding facilities, the water content rate and natural declining rate can be controlled effectively.

Moreover, by enhancing cementing quality and protecting the casing, the life of the casing was prolonged effectively.

3.4 To increase management efficiency through management innovation and fine management

Through management innovation and fine management, in 2008 in Daqing oil field, 68 stations of vary kinds has been canceled during designing the productivity engineering, which saves grounding engineering investment about 1366 million Yuan.

In Shengli oil field through strengthening cost, investment and cash management, in 2008 it fulfilled several thousands of cost control task entitled by SINOPEC.

In Liaohe oil field the secondary development system has been formed, which provides strong support for its production stabilizing at 12 million tons, and now its secondary development technology has been used widely in CNPC.

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4.1 To strengthen research on the theory and technology of oil exploration and development

Presently there are still a lot of theory and technology problems needed to be solved urgently, such as the theory of gathering the remaining oil in the old fields, exploration technology of the hidden oil, production of the low permeability oil and recovery factor increasing technology. In order to solve the above problems the following measures should be taken: Firstly, the investment to the oil exploration and development scientific research should be increased to the international standard with the investment accounting for 3 percent of overall sale's revenue. Secondly, the scientific research cooperation should be strengthened among different sections and firms.

4.2 To strengthen the popularization and application of the key oil exploration and development technology

Each of the three oil fields has its comparatively advanced technologies, such as the third development technology of Daqing oil field, the heavy oil production technology of Liaohe oil field and complicated well technologies. The state should break the monopoly of the three state owned companies including CNPC, SIPEC, and CNOOC in the name of funding provider, in the principle of minimum profit, encourage intellectual transaction among them and popularize the key mature exploration and development technologies, so that these technologies can be used widely and the exploration and development cost will be decreased drastically.

4.3 To optimize the grounding engineering system as well as injection and production well network, to promote the application of energy saving and environment protecting technology

As the development of science and technology, together with the requirement of implementation of national energy saving and discharge reducing policies and laws, the eastern old oil fields should optimize grounding engineering system and injection and production well network by abandoning the original well network, rebuilding well networks, choosing new development approaches to promote energy saving and environment protection. The optimization of the grounding system should be coupled with the design and implementation of the development plan. persist the optimization principal of integrating geology, technology, and grounding engineering.

4.4To endeavor to push the management innovation and make profit through strengthening management

Through constructing and complementing varies of systems, strengthening inner management, the oil fields should try to promote management innovation, complete budget, inner control, assessment, and supervision system, and strengthen information system construction and promote scientific management level.

(1) To strengthen budget management.

(2) To strengthen fine management.

(3) To strengthen supervision management.

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