中国生物质能转换技术发展与评价

Biomass Energy Conversion Technologies in China: Development and Assessment

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MOA/DOE Project Expert Team

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This book is written and edited based on the output of joint research project "Evaluation of Commercialization of Biomass Energy Conversion Technologies and Their Market Oriented Development Strategy" between Ministry of Agriculture of China and Department of Energy of US. The project has been supported and helped by both governments.

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With Mr. LOU Zhentao and Mr. Ralph Overend going over the text; and Mr. LIU Xiaofeng laying out the pictures,tables, and articles.

CONTENTS

CHAPTER 6 Biogas Supply and Comprehensive Utilization —Economic Evaluation of Biogas Project in Xinghuo Breeding Farm[1]

6.1 Case selection

6.1.1 Location of the site

The demand of meat, livestock, and eggs increases greatly as people's income increases, which is the result of China's economic reform policy. In order to meet the need China government promotes the development of the Vegetable Basket Project (Cai Lanzi Gongcheng), which encourage the development of livestock and vegetable plantation to provide the need in cities.

Large-scale livestock development has also aroused environmental pollution issues. The biogas project is one of the technical feasibility options to deal with the discharge from livestock farms. It is not only a project for biogas production for energy consumption but also produces organic fertilizer and fodder at the same time.

As one of the big cities in China, Shanghai's suburb is the base for Vegetable Basket Project. Xinghuo Farm biogas project is one of the good practice in China for biogas project and for biomass comprehensive utilization. Therefore it is selected as the point for case study.

Located in Fengxian County of Shanghai City, the Xinghuo Farm covers an area of 21.67 km^2 with employees of more than 6,600 and residents of 3,900 household (see Figure 6.1). There are three cow farms in it.

6.1.2 Social and economic development and environmental situation

The farm was established in 1959 as a beach-cultivated farm. The farm has become a comprehensive company with agriculture, livestock, industry and trade.

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[1] This report is a technology assessment report. It is not a post evaluation report. The date used in this case are based on the case of Xinghuo Farm but are not restricted to it.

Table 6.5 Benefit of the biogas station-economic analysis (1000 *Yuan*)

Biogas	1,441
Fertilizer	67
Feeder	269
Avoided environmental cost	967
total	2,744

Note: As for avoided cost see ITEESA's report to IDRC for more detail.

Table 6.6 Baseline for CO2 abatement cost analysis

Total investment requirement	1,810,000 *Yuan*
Life cycle for analysis	20 years
Annual LPG consumption	339 ton
Annual operation cost	903,000 *Yuan*

Table 6.7 Benefit of the biogas station-financial analysis form perspective of farmer (1,000 *Yuan*)

	LPG substitution price	Farm regulated price
Farm benefit in baseline case	1,980	1,067
Farm benefit without comprehensive utilization	1,644	731
Farm benefit without environmental fee	1,826	913
Farm benefit without environmental fee and without comprehensive utilization	1,441	528

Table 6.8 Benefit of the biogas station-financial analysis from perspective of farmer (1000 *Yuan*)

	LPG substitution price	Farm regulated price
Biogas station benefit in baseline case	1,777	864
Biogas station benefit without comprehensive utilization	1,441	528

6.5 Financial and Economic Assessment

The result of economic assessment is shown in Table 6.9. The NPV of baseline is 760,000 *Yuan* while the IRR was 13%.

Sensitive analysis showed that the project is sensitive to initial investment and benefit. If the initial investment increased by 10% or the benefit decreased by 10%

the IRR of the project will become 12%. On the other hand, if the investment decreased by 10% or the benefit increased by 10% the IRR of the project will become 15%, which is higher than 12% of the investment criteria.

As the development of biogas technology the initial investment will be decreased which has been demonstrated by the biogas project practice in China. If the investment decreased by 10% the IRR of the project will become 15%. This means the project may well become a good project.

Table 6.9 Economic assessment and sensitive analysis

		NPV (1,000 *Yuan*)	IRR (%)
Baseline case		755	13
Initial investment	increase by 10%	−470	11
	decrease by 10%	1,980	15
Operation cost	increase by 10%	251	12
	decrease by 10%	1,259	14
Benefit	increase by 10%	2,560	15
	decrease by 10%	−1,049	11
1.1 million subsidy from international society		1,740	14

Result of financial assessment showed that the NPV of the project will be 78,000 *Yuan* in baseline case while the IRR will be 12%, as shown in Table 6.10. This means that in case the farmed has surplus investment resource the return of investment in biogas station will be slightly higher than the return from deposit the same amount of money in the commercial bank.

We further analyzed the impact of different policy measures. The results showed that

1) Initial investment subsidy is helpful for the farms to adopt the biogas technology to treat discharge from livestock farms (Scheme of 2 and 4);

2) If farm regulated price is applied, the financial benefit from the biogas station is not high. As a result it will be encourage the farms to invest in the biogas technology.

3) Result showed that comprehensive utilization is not the key factor for the financial and economic performance while it affect the financial performance of biogas station.

4) Farm will have less incentive if the regulation on environmental fee is not fully implemented.

5) If China can get initial investment subsidy from outside at a amount based on the CO_2 abatement cost of biogas station the farms and China government will have the incentive to promote and to do the biogas station.

Table 6.10 Financial assessment and sensitivity analysis

	NPV (1,000 *Yuan*)	IRR (%)
Base case: no government subsidy,LPG substitution Price, environment fee	78	12
Scheme 1: no government subsidy, farmed regulated price, environment fee	−5,920	−3
Scheme 2: with government subsidy,LPG substitution price, environment fee, with comprehensive utilization	3,420	23
Scheme 3: with government subsidy, farmed regulated price, with environment fee, with comprehensive utilization	−2,590	2
Scheme 4: with government subsidy,LPG substitution price, environment fee, without comprehensive utilization	2,460	21
Scheme 5: with government subsidy, farmed regulated price, with environment fee, without comprehensive utilization	−3,540	
Scheme 6: without government subsidy,LPG substitution price, without environment fee, with comprehensive utilization	−940	10
Scheme 7: without government subsidy, farmed regulated price, without environment fee, with comprehensive utilization	−6,940	
Scheme 8: with international subsidy,LPG substitution price, environment fee, with comprehensive utilization	1,060	14

From the perspective of a biogas station, the financial performance is shown mainly from the annual balance between cost and benefit. The calculation shows that if use the LPG substitution price the biogas station have surplus. If applying the farmed regulated price the biogas station will has limited surplus with comprehensive utilization and did not have surplus in the case of without comprehensive utilization.

Table 6.11 Financial analysis from the perspective of biogas station

Scheme 1: LPG substitution price and with comprehensive utilization	7,709
Scheme 2: Farm regulated price and with comprehensive utilization	986
Scheme 3: LPG substitution price and without comprehensive utilization	6,079
Scheme 4: Farm regulated price and with comprehensive utilization	−644

6.6 Social Environmental Benefit

6.6.1 Environmental benefit and GHG abatement

The construction of biogas station improve the environmental quality off farm. After the establishment of the biogas station the discharge from the farms reach the nation environment standard.

The biogas station not only treats the dung of the farm itself, but also the residual discharged by Shanghai Haixing livestock farm. As a result it avoids the environment treatment cost.

The biogas station has the benefit of substitution of fossil fuel, such as coal, LPG, electricity.

The biogas station also have positive global environmental benefit. Using the LPG as the baseline the CO_2 abatement from biogas technology will be 3,753 tons of carbon in the life cycle of the biogas station.

6.6.2 Social benefit

Biogas project has many social benefits. It reduces the time needed for cooking, so provides more leisure time for a household. On the other hand, since coal stove is substitute in the case of Xinghuo Farm household does not have to store the coal cake in the corridor of the building, which results in good environmental quality in the corridor and in good neighborhood relationship.

The biogas station also improves the air quality of the farm, so avoids the cost of disease treatment fee and cost from labor loss.

6.6.3 Benefit to women working and health conditions

Since biogas replaces coal, the emission from coal combustion is avoided. It is estimated that the avoided discharge of coal dust is about 10 ton annually, with an avoided cost of 29,000 *Yuan* to move it to place government regulated.

Biogas stove to substitution coal stove also reduce the working intensive of the women on cooking.

Annex

Annex Table 1. Cash flow of economic assessment for biogas project (1000*Yuan*, 1995)

Year	Initial Investment	Operation cost	Benefit	Net benefit
1	13,720			-13,720
2		767	2,744	1,978
3		767	2,744	1,978
4		767	2,744	1,978
5		767	2,744	1,978
6		767	2,744	1,978
7		767	2,744	1,978
8		767	2,744	1,978
9		767	2,744	1,978
10		767	2,744	1,978
11		767	2,744	1,978
12		767	2,744	1,978
13		767	2,744	1,978
14		767	2,744	1,978
15		767	2,744	1,978
16		767	2,744	1,978
17		767	2,744	1,978
18		767	2,744	1,978
19		767	2,744	1,978
20		767	2,744	1,978
NPV(12%)				755
IRR				13%

8.4.2 Benefit

In the project the recovered methane-rich gas is used for power generation connected to grid directly. There are two prices of electricity, peak price and valley price. The prearranged electricity prices are shown below:

Peak price for 14 peak hours:	0.63 *Yuan*/kWh
Non-peak price for 10 hours:	0.17 *Yuan*/kWh
Average price:	0.438 *Yuan*/kWh
Annual electricity sale income:	5,106,900 *Yuan*
Economic analysis price(long-term projection price):	0.80 *Yuan*/kWh

8.5 Financial and Economic Analysis

8.5.1 Financial and economic analysis

Table 8.6 shows the results of financial and economic analysis of the landfill gas utilization project under basic condition. If taking inflation into account, the FIRR is 12.5%, indicating that the project can bring a little benefit. However, without considering inflation, the FIRR is only 8.3%, which is lower than the standard IRR of 12%.

Table 8.6 Results of financial and economic analysis of project

	Financial		Economic	
	NPV(1,000 *Yuan*)	IRR (%)	NPV (1,000 *Yuan*)	IRR (%)
Without inflation	-3,745	8.37	2,523	31.42
With inflation considered *	633.2	12.5	4,216	36.38

*: Inflation rate of operation cost and electricity price is set as 5%.

8.5.2 Sensitivity analysis

Table 8.7 shows the sensitivity analysis of the project. The result indicates that the project is not particularly sensitive for the changes of the investment and operation cost, but comparatively, it is sensitive for the changes of the benefit. Hence the changes of electricity sale and the electricity price will have relatively important influence on the benefit of the project. But it should be noticed that without inflation FIRR is still lower than the standard IRR, even the electricity sale is 10% higher.