

Pros and cons of centralized and decentralized biomass-to-energy system in China

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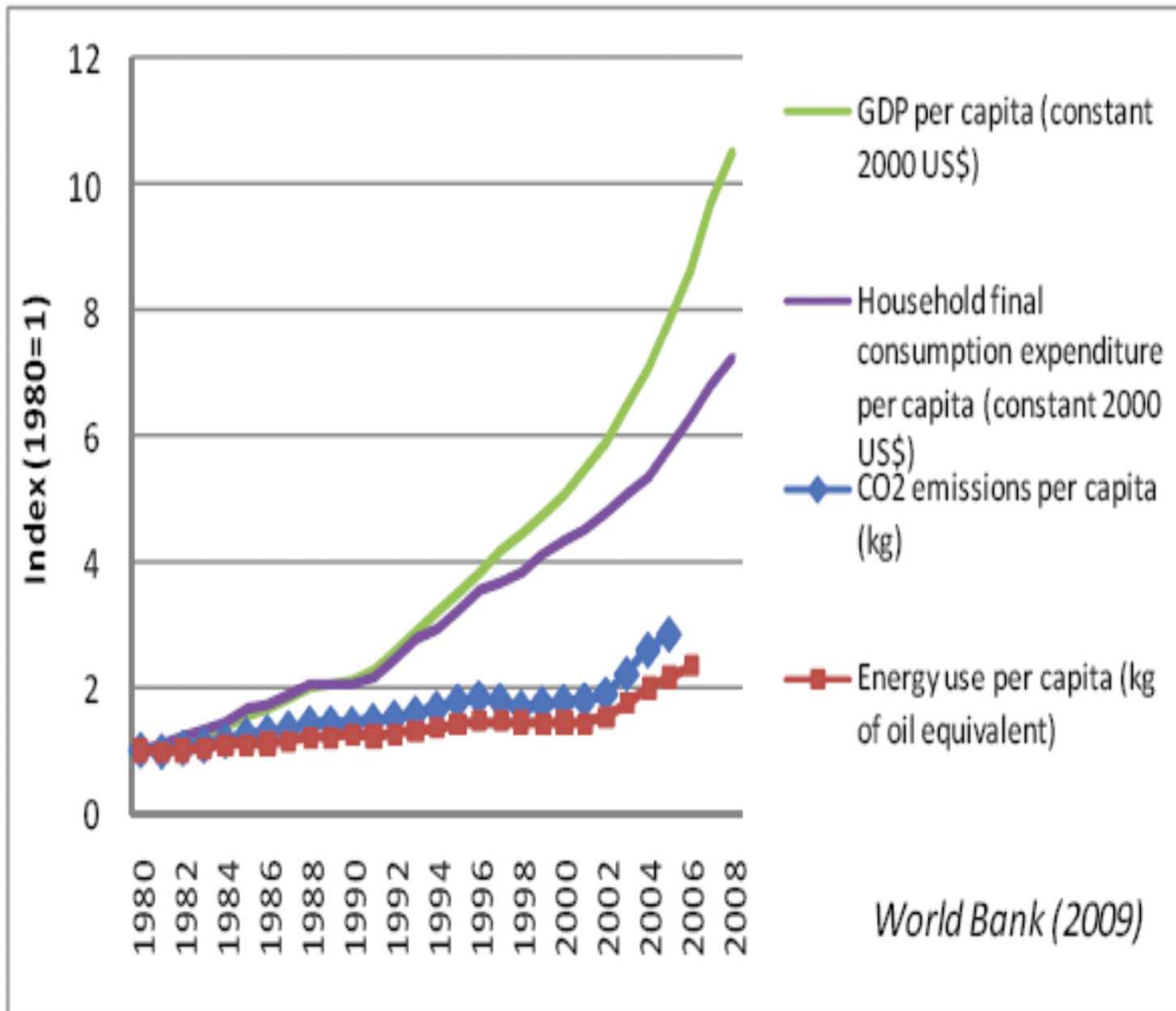
Research Center for Eco-Environmental Sciences, CAS



What will we talk.....

- ☯ Background of energy transition
- ☯ Research question and method
- ☯ Evaluation on the two bioenergy systems in rural China
- ☯ Conclusion

Urgency of the Energy Transition



China's GDP per capita jumped from US\$186.4* to US\$1,963.3 in 2008, with an annual growth rate of 8.8 percent.

Energy use per capita climbed from 25.5 GJ to 60.0 GJ, with an annual growth rate of 3.3 percent between 1980 and 2005.

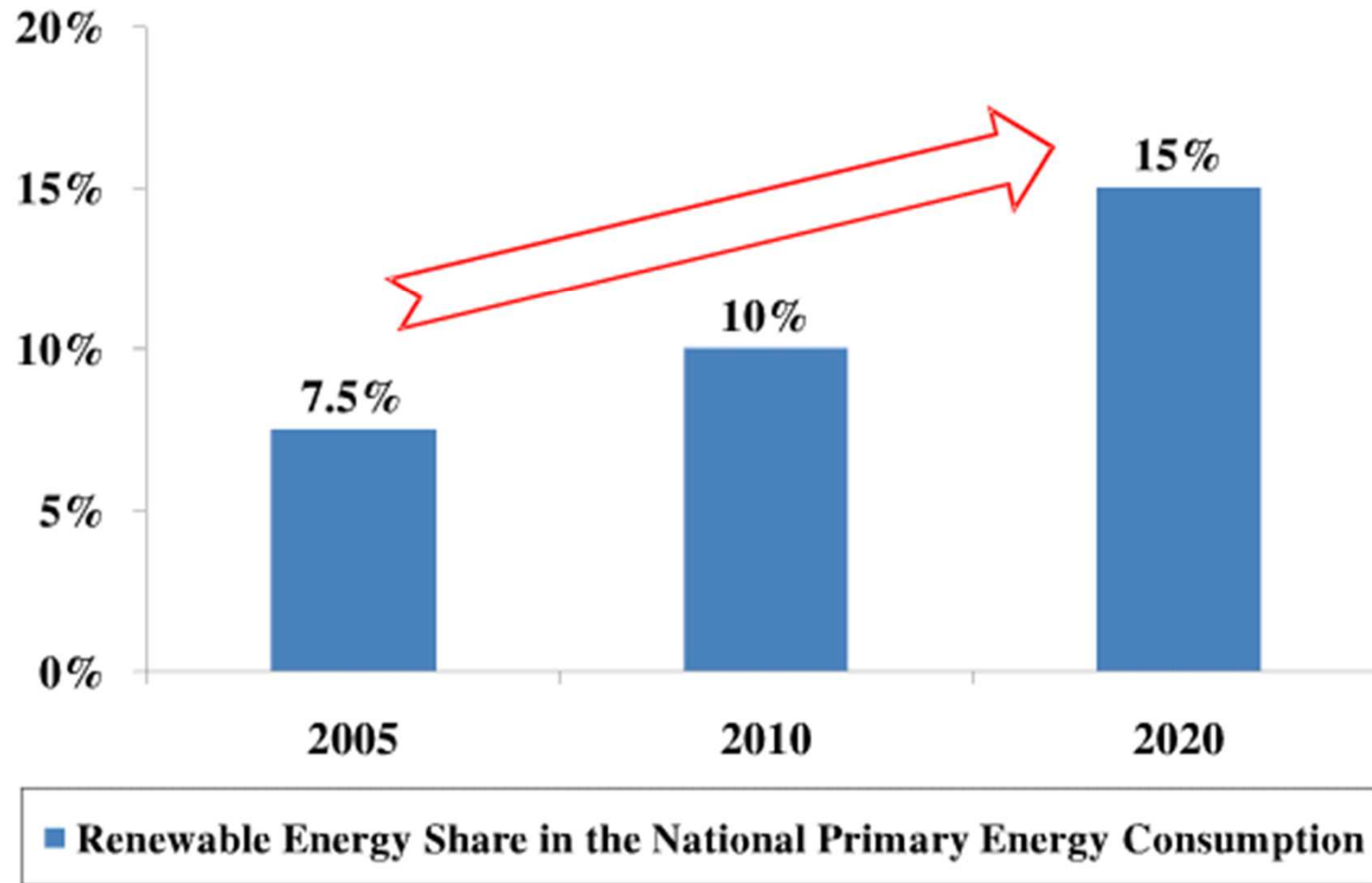
CO₂ emissions per capita rose from 1.51 ton to 4.26 tons between 1980 and 2006, with an annual growth rate of 4.2 percent.

* In constant 2000 US\$

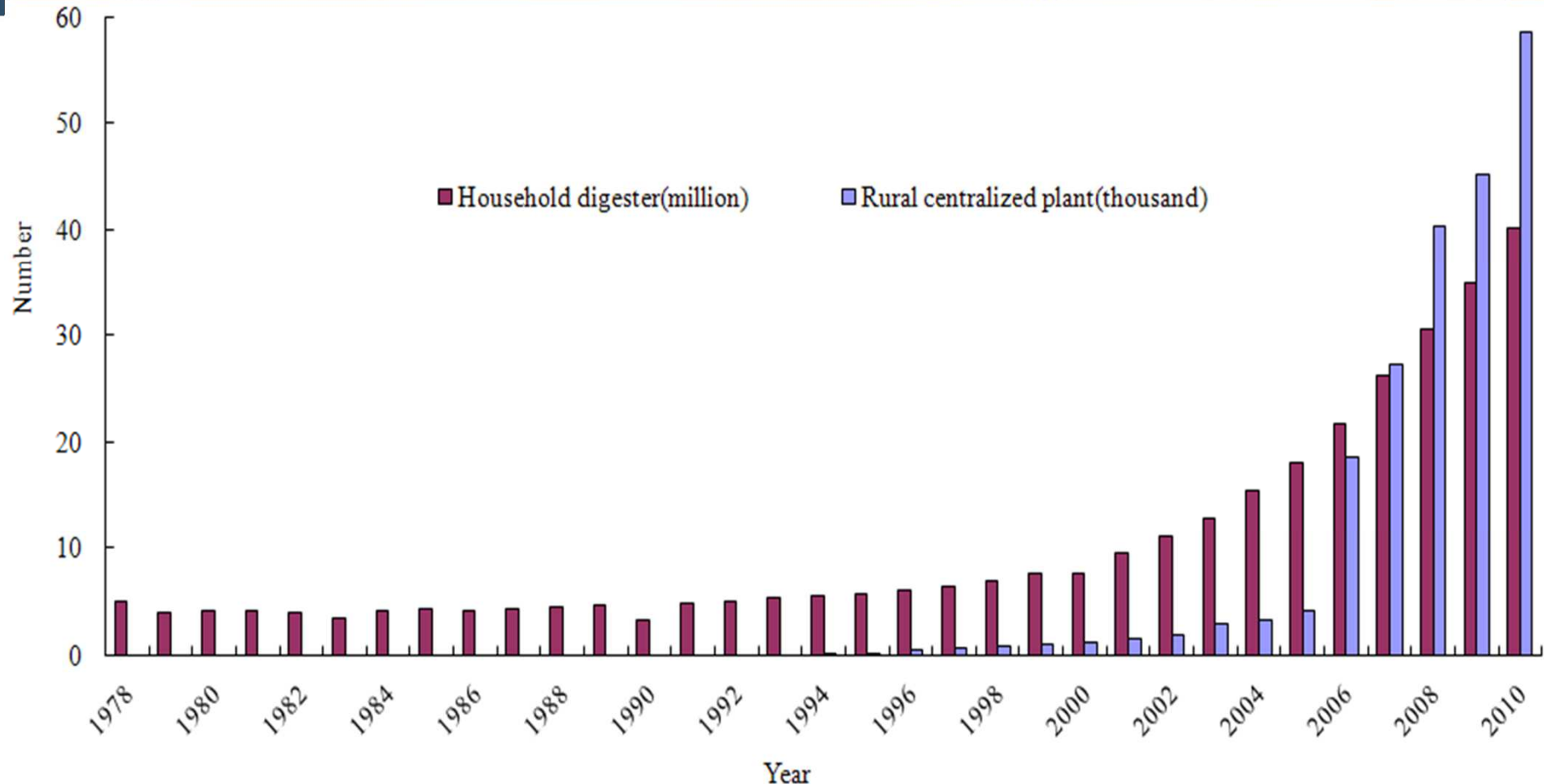
Milestones of the RE policy

- 2003年6月全国人大将可再生能源立法纳入立法议程
- 2004年6月中国政府代表团出席波恩国际可再生能源大会，向世界宣布中国政府将制定可再生能源法和国家可再生能源发展规划
- 2005年2月全国人大常委会通过，胡锦涛主席签发颁布了《**中华人民共和国可再生能源法**》，奠定了可再生能源发展的法律基础
- 2006年1月1日，《**中华人民共和国可再生能源法**》生效，有关部门陆续出台了10多个实施细则，保证了可再生能源法的实施
- 2007年6月，中国政府颁布《**中国应对气候变化国家方案**》，将风能、太阳能生物质能等可再生能源发展纳入其中
- 2007年9月7日，中国政府颁布了《**中国可再生能源中长期发展规划**》，正式提出了国家可再生能源发展目标
- 2007年12月，中国政府颁布了《**中国的能源状况与政策白皮书**》，将可再生能源发展作为国家能源发展战略的重要组成部分
- 2007年12月巴厘岛气候变化峰会，联合国秘书长潘基文高度评价中国的可再生能源发展
- Incorporated into the legislation list at June 2003
- 2004 Jun. Bonn Conference, declaration of the RE law and the planning work
- 2005 Feb. release of the China RE Law (CRL)
- 2006 Jan. 1st CRL came into force, 10+ regulations afterwards released
- 2007 Jun. China National strategy on the Climate Change, Wind, solar and biomass were prioritized
- 2007 Sep. China RE Medium- and Long-term Planning, targets identified
- 2007 Dec. White Book on Energy Situation and Policy, RE identified as significant part
- 2007 Dec., Secretary General of UN highly appraised the efforts China did on RE development during the Bali Climate Change summit

Targets of REs Development in China



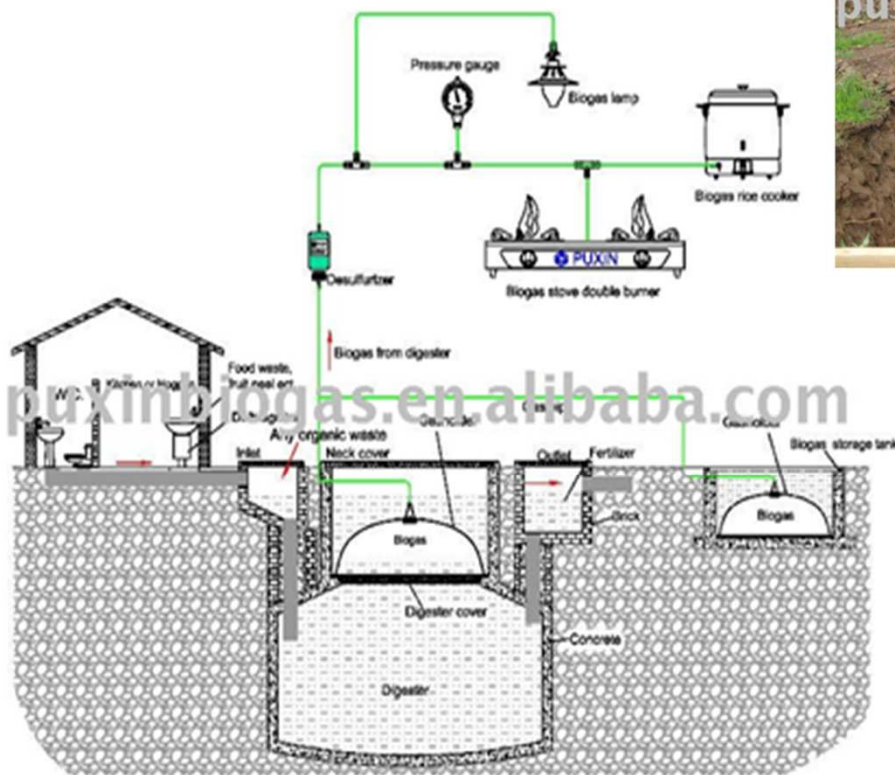
Bioenergy Project in China



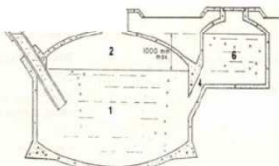
- Last decade has witnessed a high wave of biodigester promotion of both centralized and decentralized projects in rural China
- A strong preference by the governments to centralized (village-based) bioenergy projects in recent years

Two types of bioenergy project

Household digester



A 10M³ Family size PUXIN biogas system for two family



Chinese Fixed Dome



Two types of bioenergy project

Centralized bioenergy plant



Using biogas to cook and boil water





Government-driven Projects

- A total of 61 billion Yuan in rural biogas programs 2003-2010
- “One Digester with Three Transforms” -- 1500, 1200, 1000 yuan for the western, middle, and eastern farmers
- The central government shares 25%, 35%, and 45% of the investment of the medium- and large-scale bioenergy plant



Research Aim

- Government-driven projects have not worked without problems.
- This study aims to shed light on the performances of these two systems in terms of project arrangement, social goal, economic, and environmental effectiveness for successes.

Case study area and method



- Twelve villages in Dezhou, Zibo, Weifang, Shandong Province, China

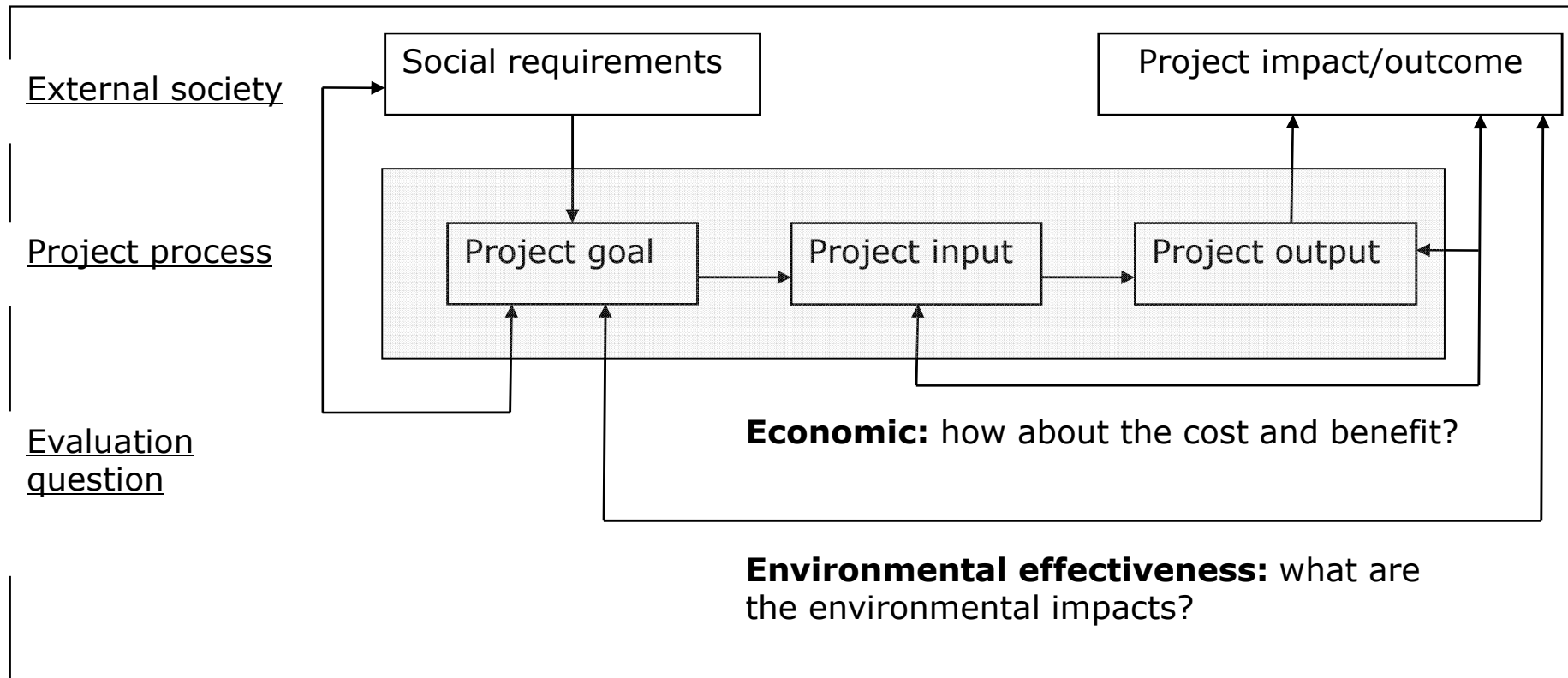
Two methods : **interviews** and a **questionnaire** survey on farmers and village leaders

Characteristics of the villages

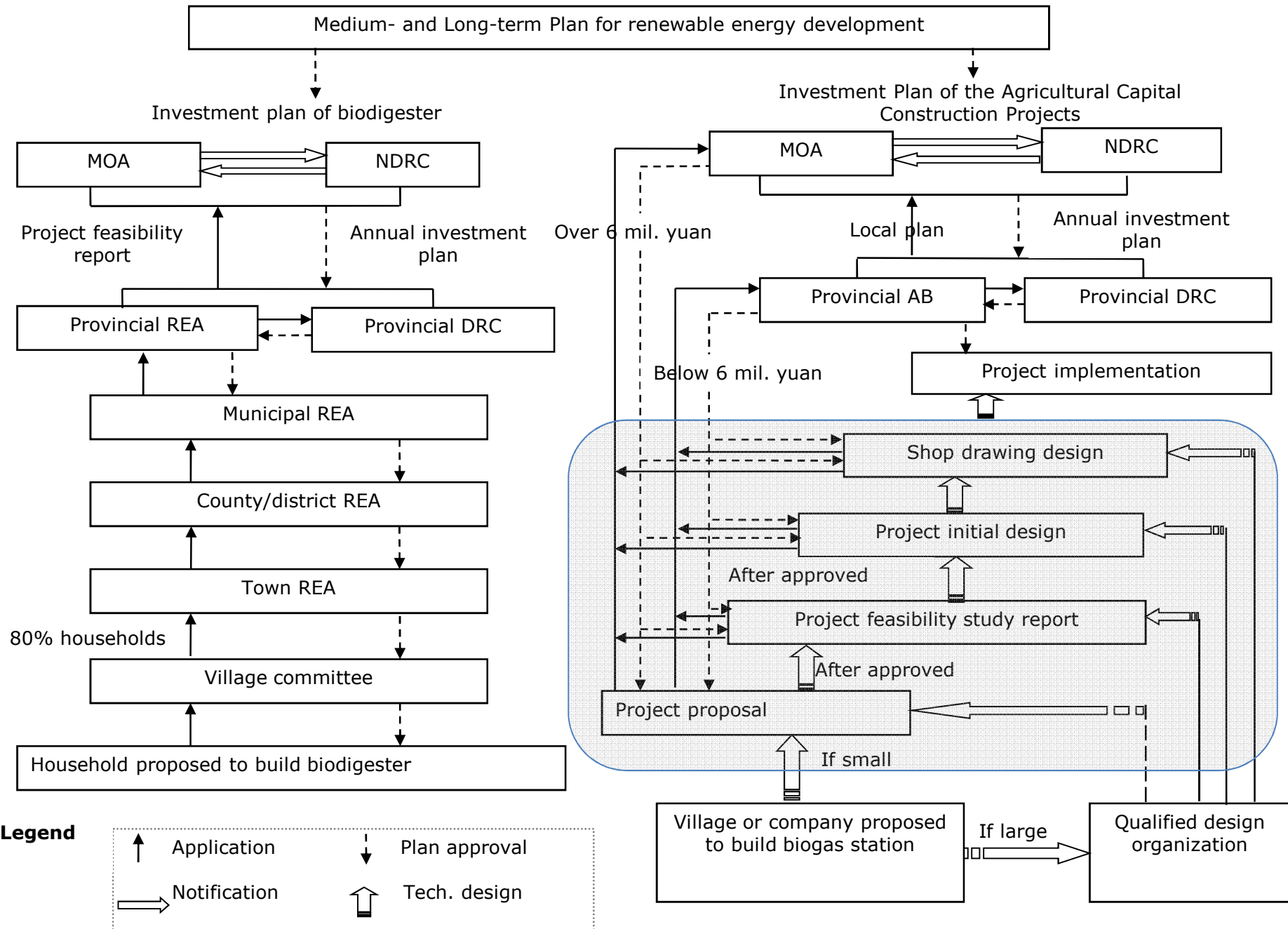
	DC	ML	CJ	DZ	MT	SW	SB	CW	JZ	HC	XS	HX
Total Household	110	240	580	520	262	236	158	230	407	270	330	145
Villagers	350	862	2200	2020	1072	856	580	760	1500	610	1172	520
Net income per capita (yuan)	8000	7200	6000	8100	6000	5000	7000	7600	4500	7700	8500	8000
Electricity use rate (%)	100	100	100	100	100	100	100	100	100	100	100	100
Land (km ²)	580	1450	1600	900	1948	2140	1360	860	2400	1090	1655	600
Poultry farm	No	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes
Bioenergy system	H	H	H	H	H	H	H	C	H	C	C	C
No. of household using biogas	110	110	290	129	134	138	10	200	10	189	308	145

(1 Yuan is appr. 0.147 US\$)

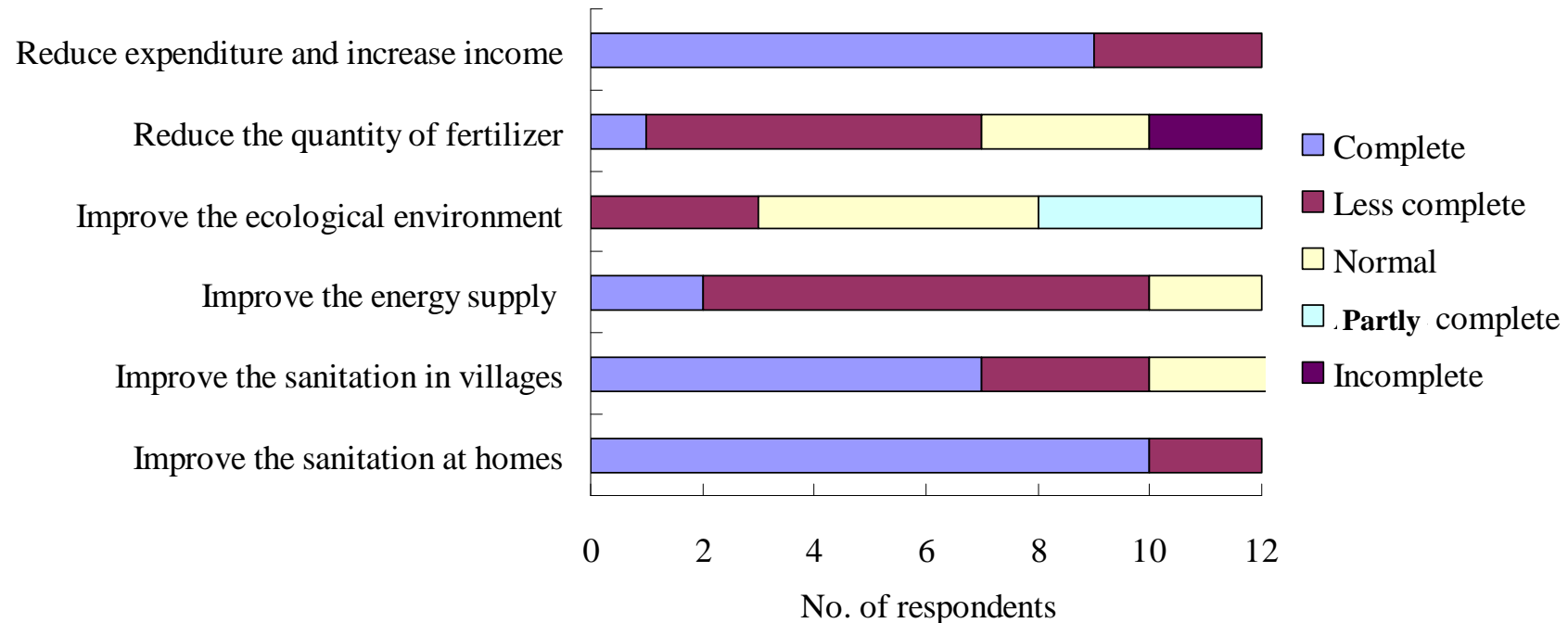
Evaluation framework and criteria



Application and approval of the bioenergy project



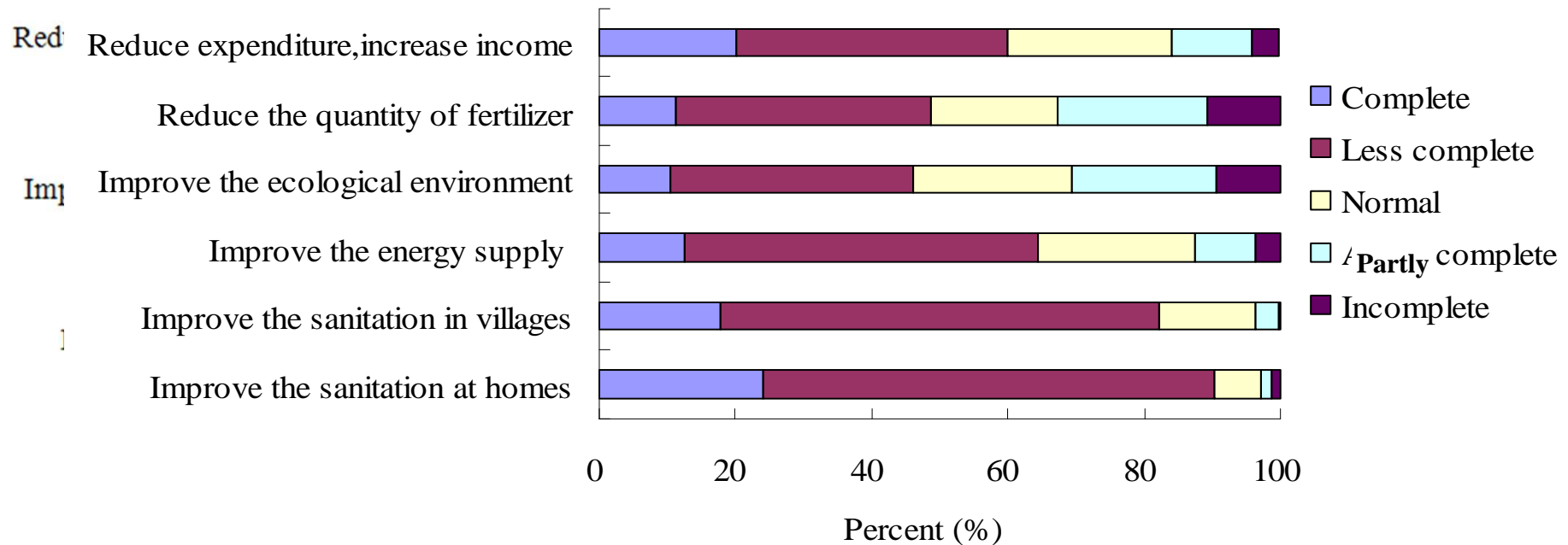
Attainments of the project goals



village leaders' attitudes towards the goals of the bioenergy projects

- Completely achieve: Improving the sanitation, Reducing expenditure and increasing
- Incomplete achievement goals: Reducing the quantity of the fertilizer, improving the ecological environment

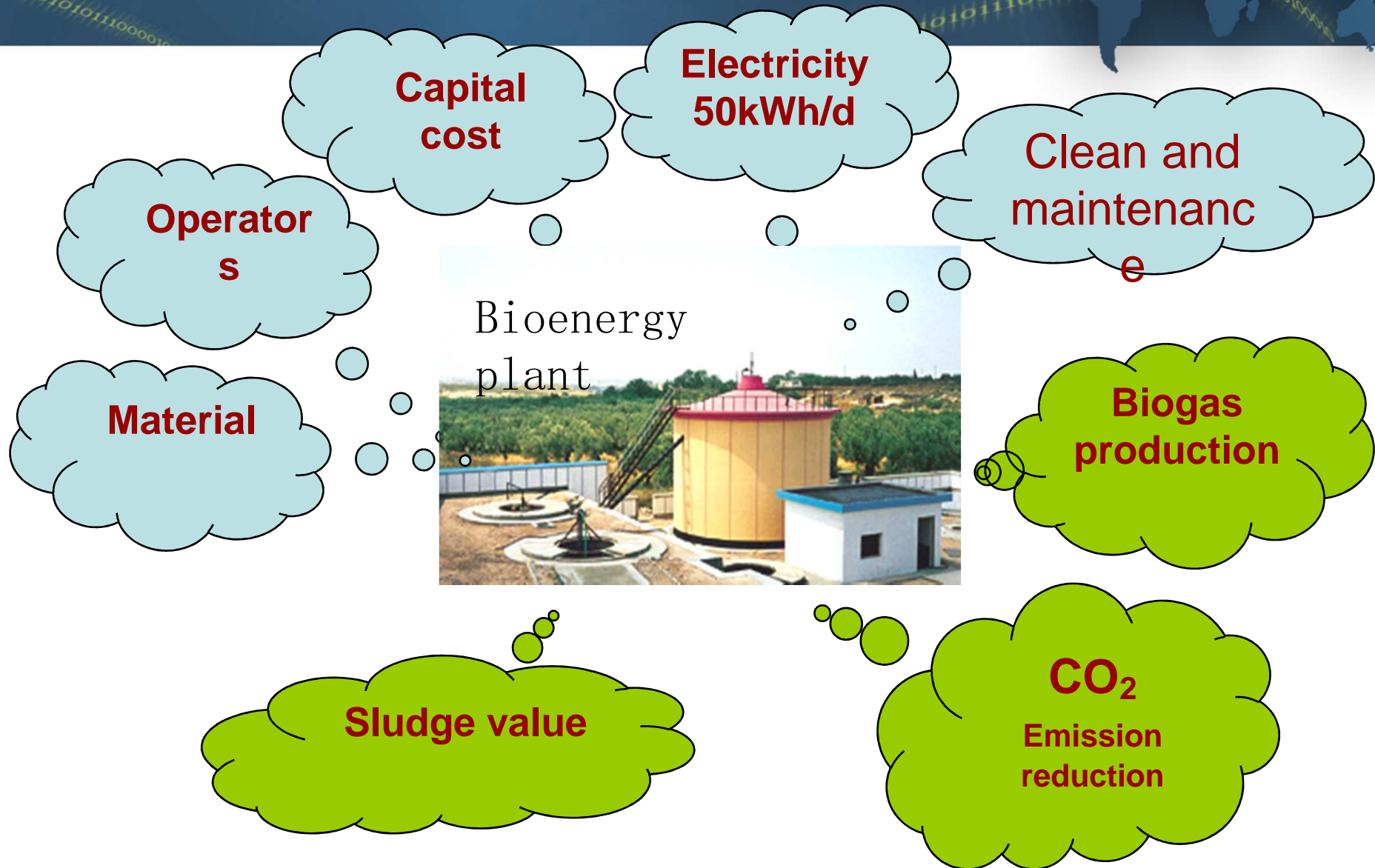
Attainments of the project goals



Farmers' attitudes towards the goals of the bioenergy projects

- Excellent: improving the sanitation in villages and improving the energy supply
- Not well: reducing the quantity of the fertilizer and improving the ecological environment

The Centralized Bioenergy Project



Economic Evaluation-

Centralized project

Village		HC	CW	XS	HX	Average
Items						
Capital cost	Total fixed cost	727900	672000	2070000	1890000	1340000
(yuan)	From government	189000	203000	800000	1000000	548000
	From village/company	520000	446000	1240000	876000	770500
	From household	18900	23000	30000	14000	21475
Operational cost	Labor cost	16000	16000	18000	40000	22500
(yuan/a)	Material	38000	39000	21000	0	24500
	Electricity, water, transportation	23500	25000	30000	35000	28375
	Clean and maintenance	2000	2000	5000	5000	3500
Revenue	Sale of gas	65000	68000	50000	40000	55750
(yuan/a)	Sale of sludge	0	0	0	30000	7500
	Town subsidy	15000	15000	0	0	7500
Total cost (yuan/m3 gas)		0.80	0.72	1.08	1.60	1.05
Operational cost (yuan/m3 gas)		0.54	0.50	0.45	0.73	0.56
Benefit (yuan/m3 gas)		0.45	0.42	0.30	0.64	0.46

(1 Yuan is appr. 0.147 USD)

Economic evaluation on the household digester

Village		DC	ML	CJ	DZ	MT	SW	SB	JZ	Average
Capital cost	Total fixed cost	2620	2704	2459	2678	2742	2693	2834	2653	2760
(yuan)	From government	1560	1182	1196	1506	1771	1708	1304	1320	1380
	From village		100		500	300				110
	From household	1060	1422	1263	672	671	985	1530	1333	1270
Operational cost (yuan/a)	Material	95	155	98	73	224	187	238	222	178
	Transportation	25	30	20	30	15	25	15	15	20
	Clean and maintenance	65	70	80	45	53	78	75	68	60
Revenue (yuan/a)	Use of gas	195	207	205	218	215	176	173	166	189
	Use of sludge	318	305	313	356	296	282	245	258	280
Total cost (yuan/m ³ gas)		0.48	0.41	0.49	0.38	0.43	0.40	0.47	0.42	0.44
Operational cost (yuan/m ³ gas)		0.27	0.29	0.33	0.25	0.28	0.26	0.32	0.35	0.28
Benefit (yuan/m ³ gas)		0.58	0.57	0.57	0.60	0.51	0.44	0.48	0.46	0.52

(1 Yuan is appr. 0.147 USD)

Effectiveness of the two bioenergy systems

Respondents attitudes toward the effectiveness of the bioenergy projects

	Centralized project (%)	Decentralized digester (%)
Distinctly reduce the workload of housewife	67.4	48.1
Improve the sanitation condition	88.0	85.3
Protect the forest and reduce the water and soil erosion	14.0	25.5
Reduce the expenditure	43.2	59.1
Improve the energy supply	63.1	64.5
Save the fertilizer	1.7	54.1
Reduce the maintenance workload for each household	31.0	N/A
Guarantee the steady materials	9.8	N/A
Dispose the waste	2.6	N/A

Energy transition--Annually average consumption of various fuels

		Household digester		Centralized	Prov. Ave. consumption
Fuel type	unit	Non-user of biogas	User of biogas	User of biogas	User of biogas
Coal	kg	894	1,095	1132	290
Elec.	kWh	432	348	361	1,277
LPG	kg	36	20	18	33
Biogas	m ³	0	228	276	191
Fuel wood	kg	384	273	165	371
Crop stalks	kg	1,728	1,538	867	1,706

The amount of the electricity, liquid petroleum gas (LPG), fuel wood, and crop stalks reduced in different degrees



GHG Reduction

- ☯ Reduce greenhouse gas emissions :
preventing CH₄ emissions through manure treatment; reducing CO₂ emissions by fuel replace
- ☯ Total GHG reduction
 - Household biodigester: 251 kg CO₂-eq
 - The centralized bioenergy project: about 600 kg CO₂-eq per household each year

A dark blue banner at the top of the slide features a stylized world map in a lighter blue shade. Overlaid on the map are several lines of yellow binary code (0s and 1s) that appear to be flowing or radiating across the globe.

Conclusions

- ☯ Diversity in purpose and process
- ☯ Gave the positive evaluation on the goals of sanitation improvement, the farmers' expenditure reduction and their income increase
- ☯ High perceived difficulty was the initial investment of the centralized bioenergy project, financial support from the government was thought as a viable option
- ☯ The positive economic benefit for the household digester
- ☯ Effectiveness: clean, convenience and energy supply
 - **HB could save more fertilizer and pesticides than CB**
 - **CB had more impacts on fuel alternative and GHG reduction**



Suggestions

Removal of such identified barriers is essential for successful implementation

- ☯ Innovating the investment mechanism
- ☯ Balance the long-term and short-term benefits
- ☯ Extending the production chain of CB
- ☯ Selection of the different systems depends on the local circumstances

Any Comments!