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Corporations Response to the Energy Saving and Pollution Abatement Policy

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ABSTRACT: As the main actor of implementing energy saving and pollution abatement, corporations and their response to the policy are studied in this paper. We find that corporate properties as scale, ownership, current environmental performance on energy using and pollution, target market and listed situation have impact on the corporate responding conduct and progress. Especially, current environmental performance has strong relationship with corporate policy responding performance, corporations with low energy efficiency performed poorly to energy saving and those with heavy pollution level performed below average for pollution abatement. It implicates that the national policy could contribute a lot to outdating production facilities less environment-friendly under strict implementation.

Key words: Energy saving, pollution abatement, corporation, environmental performance, Qingdao, China

INTRODUCTION

Making benefit of opportunities for sustainable development through optimization in energy use has been considered in lots of studies during recent years (Ataei and Yoo, 2010; Atabi, 2006; Rehman et al., 2009; Saffarinia and Dellavar, 2009; Lau et al., 2008; Karbassi et al., 2008; Shafie-Pour et al., 2007; Masnavi, 2007; Mehrdadi et al., 2007; Shafie-Pour Motlagh and Farsiabi, 2007). In the three decades after China's opening, remarkable economic growth has helped China to be one of the most important emerging powers in the world. However, it has not come without prices. For example, as the world largest emitter of wastewater, all the seven major watersheds in China were medially polluted in 2007, 50.1% of which contained water deemed unsafe for human consumption. China is now the second largest energy-consuming country in the world after the USA, consuming in total 26.5 billion tons of standard coal equivalent in 2007 (Zhang et al, 2009; National Bureau of Statistics of China, 2008) with high energy intensity, that's 3 times more than that of US, and about 7 times as that of Japanese (Hong, 2009). Due to the coal-dominated energy consumption, China becomes the second source of global CO_2 emission (Guan et al, 2009) as well as the largest contributor to global SO_2 emission, which makes China one of the three major acid rain polluted area in the world (Larssen et al., 1999; Shi et al, 2008).

Therefore, to reduce pollutants emission and improve energy efficiency is inevitable course for China to achieve sustainable development. "Energy saving and pollution abatement policy" was approved as two legal-bounding targets for the 11th Five Year planning (2006-2010) in 2006: (1) energy saving- energy intensity per GDP needs to be reduced by 20% at the end of the 11th Five-Year Plan; (2) pollution abatement- both the emission of SO_2 and COD needs to be abated by 10% at the end of the 11th Five-Year Plan.

China's energy saving and pollution abatement have been investigated by a number of decomposition studies (Ma et al., 2009; Lin and Cao, 2008; Shi, 2008; Cornelius and Story, 2007; McMichael, 2007; Crompton and Wu, 2005; Karen et al., 2004; Wang, 2002). Besides literatures from engineering perspective, many studies are mainly focused on analysis and evaluation of related management and policies. Philip (2009) introduced China's energy-saving targets and evaluated related energy policies

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at national level; Shi et al (2008) evaluated the potential SO_2 abatement at provincial level in China from 1990-2005 by data envelopment analysis; Wang et al (2008) and Zhang et al (2008) analyzed the implementation effect of energy saving and pollution reduction based on economics model; Fang and Zeng (2007) analyzed effect and perspective of management instruments in China for energy saving and pollution reduction and then provided suggestions; Yang (2007) also analyzed main barriers to energy saving in China from government's perspective; Ma et al (2007) presented a lasting effect mechanisms for China's implementing policy of pollution abatement at central government level. However, existing literatures are mainly from the perspective of government, few are about analysis of other stakeholders. Moreover, little literature focuses on corporation, which is the real power that plays an important role in achieving the targets of energy saving and pollution abatement.

In this study, 120 corporations were surveyed in Qingdao at the end of 2008 to analyze corporations' awareness, attitude and actions to the policy of energy saving and pollution abatement. Sample analysis was in Sector 2 of this paper. Sector 3 discussed how these corporations thought about the importance and impact of the policy, and to what extent they did for it. In Sector 4, the relationships between policy performance and corporate properties such as scale and ownership were discussed. Conclusion and policy suggestion were proposed in Sector 5 based on former results.

MATERIALS & METHODS

Qingdao is selected as target city in our study. As one of the fourteen coastal cities of open economy endorsed by State Council in China, Qingdao is the production base of electronic equipment in China, and petro chemistry and machinery production are other two dominant industries of this city. Advantageous geographic factors together with preferential policies attract abundant foreign investment, especially from Japan and South Korea, in food and textile wearing apparel manufacture.With the assistance of Qingdao Bureau of Environmental Protection (QBEP), 200 corporations were randomly selected from database. Except for those newly closing down and rejecting the interview, 120 samples were finally collected by face to face interview with managers and staff in charge of environment related issues in surveyed corporations. Table 1 is a classification of samples, according to their industrial categories, scales and ownerships.

RESULTS & DISCUSSION

The 120 corporations cover 24 industries according to the secondary industrial classification in China (since some food manufacturers also produce beverages, the two industries "manufacture of foods" and "manufacture of beverages" were combined). They consist of 25 Chinese state-owned corporations, 32 Chinese private corporations, 35 foreign corporations and 28 joint ventures. 98 corporations belong to small scaled corporation, mainly because their capital asserts are lower than 40 million Yuan. Large corporations with capital assert over 400 million, employment over 2000 and annual sale over 300 million Yuan account 7.5%. Other 13 corporations in between are medium sized. The proportion of medium scaled corporation is very consistent with the statistics from Qingdao Statistic Book 2007; while the proportion of large corporation is somewhat higher, mainly because none of those selected large corporations rejected interview.

From the economic perspective, energy saving and pollution abatement have different impact on business cost. However, it is hard to say which costs more-reducing energy intensity by 20% or abating SO_2 and COD emissions by 10%. It may depend on the investment required and marginal reduction cost to each corporation. In this research, on one hand, the policy was considered as a whole in the interview of corporate awareness and attitude to it; on the other hand, the authors considered their performance on energy-saving and pollution abatement separately to make their current situation and policy response more accurate.

79 corporations thought it was hindering or very hindering to their business, in which 24 thought the negative impact was serious. Only 18 corporations considered the policy was good to the long-term development of business. See fig. 1.

Among the 18 corporations which welcomed the stricter environmental requirement, 9 are foreign corporations (3 from US, 5 from EU and 1 from Japan); 6 are joint ventures, 5 of which are dominated by American, German and Japanese investment, 1 is Sino-South Korean corporation; the other 3 are all large scaled Chinese state-owned corporations. Significant gap is shown between foreign and domestic investment. These 18 corporations also do well in energy using and polluting control: 12 of them have world advanced energy using efficiency and the other 6 are leading in China; 15 corporations are slightly polluting and the other 3 are polluting averagely.

In contrast, the most discouraged 24 corporations are mainly small sized private ones, see fig. 1. They performed poorly on energy using and pollution control. Half of these corporations have energy efficiency at or below national average, 9 of them said they had no idea of what level they were. According to the staff from QBEP, they are mainly poor at it. Except

Table 1. Industrial category, ownership and scale of samples

Industrial Category	Number of samples	Ownership		Scale[c]	
Processing of Food from Agricultural Products	7	S (state-owned) [a]	1	L (large)	0
		P (Chinese private)	1	M (medium)	0
		F (foreign invested)[b]	2	S (small)	7
		J (joint venture)	3		
Manufacture of Foods and Beverages	12	S	4		
		P	2	L	1
		F	5	S	11
		J	1		
Manufacture of Textile Wearing Apparel, Footware and Caps	14	S	3		
		P	2	L	1
		F	7	S	13
		J	2		
Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	2	S	1	S	2
		P	1		
Manufacture of Paper and Paper Products	1	P	1	S	1
Manufacture of Articles For Culture, Education and Sport Activities	3	F	2	S	3
		J	1		
Processing of Petroleum, Coking, Processing of Nuclear Fuel	2	S	2	L	2
Manufacture of Raw Chemical Materials and Chemical Products	18	S	3		
		P	5	M	8
		F	5	S	10
		J	5		
Manufacture of Medicines	1	P	1	S	1
Manufacture of Chemical Fibers	9	P	4	S	9
		F	2		
		J	3		
Manufacture of Rubber	4	P	2	S	4
		F	1		
		J	1		
Manufacture of Plastics	3	P	1	S	3
		F	1		
		J	1		
Manufacture of Non-metallic Mineral Products	1	J	1	S	1
Smelting and Pressing of Ferrous Metals	1	S	1	L	1
Smelting and Pressing of Non-ferrous Metals	2	S	1	M	1
		J	1	S	1
Manufacture of Metal Products	1	J	1	S	1
Manufacture of General Purpose Machinery	3	P	3	M	1
				S	2
Manufacture of Special Purpose Machinery	9	S	2	S	9
		P	2		
		F	2		
		J	3		
Manufacture of Transport Equipment	1	S	1	L	1
Manufacture of Electrical Machinery and Equipment	8	S	1	M	1
		P	4	S	7
		F	2		
		J	1		
Manufacture of Communication Equipment, Computers and Other Electronic Equipment	14	S	3	L	2
		P	3	M	2
		F	5	S	10
		J	3		
Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	1	S	1	S	1
Manufacture of Artwork and Other Manufacturing	2	F	1	S	2
		J	1		
Production and Supply of Electric Power and Heat Power	1	S	1	L	1
Total	**120**				

[a] State-owned corporation in China is fully invested and controlled by the national or local government.

[b] Foreign corporation here only refers to that wholly owned by foreign capital.

[c] Classification of scale answers to the classification of corporations published by National Statistic Bureau in 2003, that is: large corporation- total asserts >= 400 million Yuan, employees >= 2000, and annual sells >= 300 million Yuan (they are all necessary conditions); medium- total asserts from 40 to 400 million Yuan, employees from 300 to 2000 and annual sells between 30 to 300 million (all necessary conditions); others are all small corporations. If any of the 3 condition can not achieve the required standard for Large or Medium, the corporation will be classified as small one.

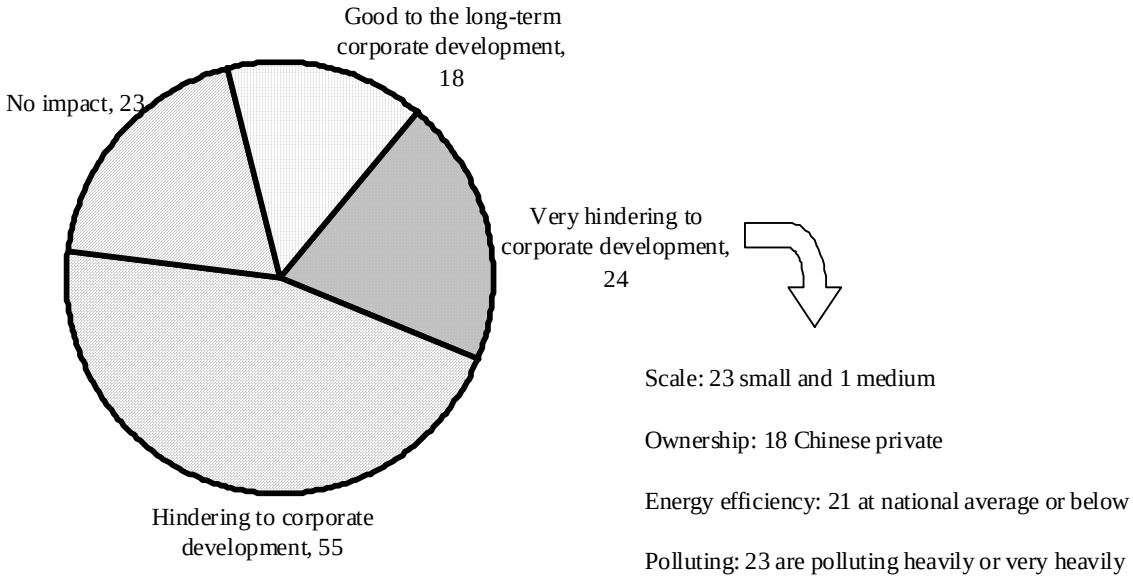

Fig. 1. How will the policy impact my business?

Table 2. Correlation matrix of four variables

	Impact	Importance	Energy efficiency	Pollution level
Impact	1.00	0.70	0.73	0.76
Importance	0.70	1.00	0.80	0.76
Energy efficiency	0.73	0.80	1.00	0.68
Pollution level	0.76	0.76	0.68	1.00

***, **, * refer to significant level at 1%, 5% and 10%; - indicates the nonzero coefficient is denied by z-test.

for one corporation, all other 23 corporations admitted that they were polluting heavily or very heavily. All of them have to pay the pollution discharging fee, 23 of them has been fined for environmental pollution.

More than 75% of surveyed corporations said the energy saving and pollution abatement policy was very important or important to them. For the 29 corporations ignoring the policy importance, they all considered the policy was hindering or very hindering to their business. Similar to the result above, these 29 corporations are all small sized: 6 of them are state-owned, 20 ones are Chinese private, 2 are South Korean corporations and 1 is a Taiwan corporation. Also, their performances on energy using and pollution control are mainly at or below the national average.

Since the factors of policy impact, policy importance, current energy using efficiency and polluting level seem to have close relationships with each other, we present the correlation matrix in table 2 to show their correlation.

High and positive correlation exists amongst these four variables. One reasonable hypothesis is that the higher current environmental performance a corporation has, the more possible it will consider the policy positive and important to its business, as the environmental performance would contribute to its competition advantage. Another hypothesis is based on the correlation between energy efficiency and pollution level- corporations having high energy efficiency is more likely to have lower pollution emission. It is acceptable because they share many determinants, such as technical level, investment, managing level and environmental awareness. Besides, scale has little correlation with them.

Among 120 surveyed corporations, 40 corporations had not taken any actions for energy saving, and 22.5% of surveyed corporations were no-responding to pollution abatement. One reason might explain the lower responding rate for energy saving is, national and local Development and Reform Commissions (DRCs), who are in charge of monitoring energy saving process, are a sort of comprehensive decision-making administration without enforcement power. While pollution emission is regularly monitored

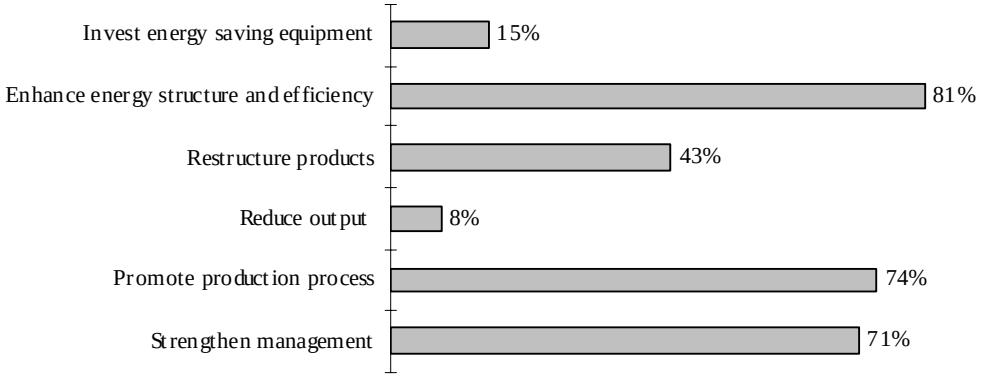

Fig. 2. Energy saving approaches and adoption rate

by local Environmental Protection Administration and discharge fee is periodically charged. Early actions to abate pollution can get more return from environmental fee or penalty. Further more, national programs to promote desulfurization in power generation sector and wastewater treatment in key industries, as well as decreasing international petroleum price may have opposite influences on their responses.

Fig. 2 illustrated how the other 80 corporations respond to energy saving. Most of them take more than one measures, and the most used one is to enhance energy structure and efficiency in the internal energy supply system. The other two popular approaches are to save energy through production process and management. They almost have no impact on regular production and little investment is required.

It is a surprise to find that 43% surveyed corporations restructured their products. Actually, from our experience, energy saving is not the unique or primary reason for it. Export reduction and market decline made it the time to update products structure with lower energy intensity. And for some corporations in tougher situation, they chose to reduce their output to suffer through the global economic crunch.

Extra investment is unsurprisingly not popular. 12 corporations having invested in energy saving equipment achieved an average energy efficiency improvement of 8.0%, compared with a growth rate of 7.1% by others (those taking actions exclusive of investment in energy saving equipment). For these corporations, whose energy efficiency is higher than national average, extra investment seems to be necessary to achieve the energy saving target, and they all adopt at least two other approaches.

93 surveyed corporations had answered to the pollution abatement. They mainly took more than two approaches, see fig. 3. The most popular one is to invest treatment, it is very different from that in energy saving. An important reason is that end-of-pipe treatment is able to reduce or eliminate pollutants directly and greatly without impact on production process and output. For SO_2 emission (as well as other pollutants exclusive in the current pollution abatement target, like industrial solid waste), 59% corporations are benefit from energy saving approaches. It seems that the energy saving and pollution abatement target could be combined and achieved together, and corporations are capable of organizing them economically. Among 27 surveyed corporations which had not started to abate pollution discharge, 26 surveyed corporations had not acted to energy saving, either. And these 26 corporations are all small sized and performed at or below national average in environment. All of them considered the energy saving and pollution abatement policy would restrict the corporation development even badly.

The authors discussed some topics as awareness, attitude and actions in the section above, in this section focus will move to how much these corporations had done to answer to the policy, and how the corporate properties impacted their performance.

There are two steps to assess how corporations answer to the energy saving and pollution abatement policy. Step 1- to ask the corporations whether they had taken actions to respond; if yes, asked next which measures they took and how much they had achieved in energy saving and pollution reduction; if no, went to Step 2- to ask whether they had any intending plan for it. At Step 1, corporations are classified by three grades- active, to-be active and passive. At Step 2, all active corporations are valued by their growth rate of energy efficiency and abatement rate of SO_2 and COD emissions.

Most corporations are actively involved in the policy, constitution at Step 1 see fig. 4. The reason

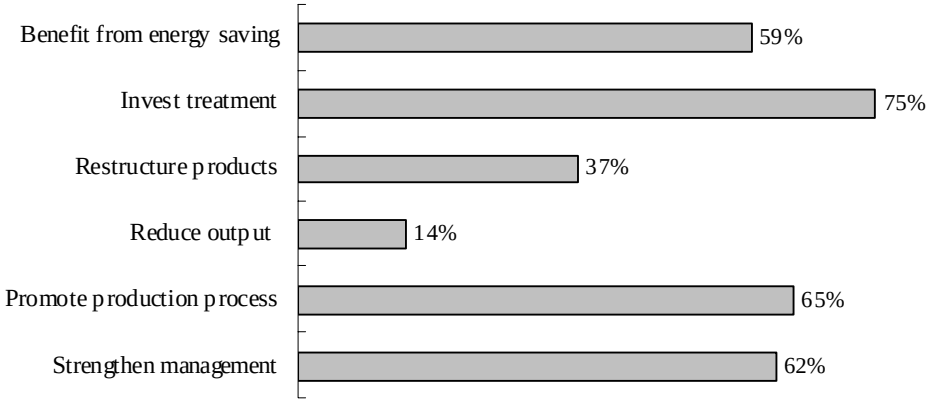

Fig. 3. Pollution abatement approaches and adoption rate

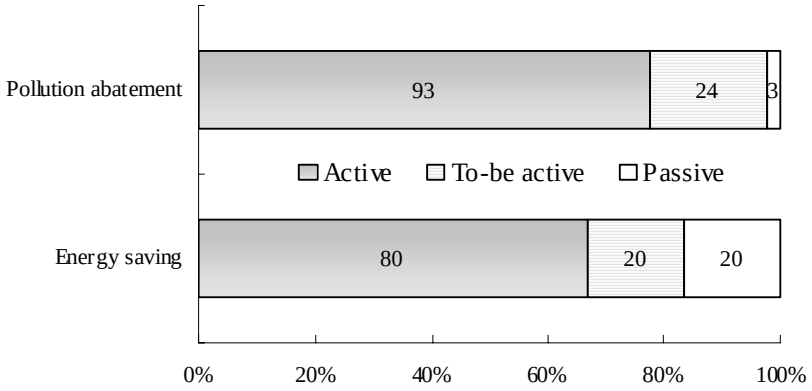

Fig. 4. How corporations acted for the policy

more corporations acted in pollution abatement than in energy saving has been explained in subsection 3.3. For those active corporations, the average improvement of energy efficiency is 7.2% and average reduction rate of targeted pollutants is 8.5%. It seems that pollution abatement achieved more in both policy responding rate and improvement. Considering the reduction targets, for energy intensity is 20% and for pollutants discharge is 10%, the implementation of energy saving needs to be strengthened. Comparing with pollution abatement targeting on volume control, energy saving is an indicator of efficiency, and is closely relative to gross production. Taken the total sale of last year as weight, the energy saving rate of 7.03% for all the 120 corporations far lagged behind, in contrast with the 25% equivalent requirement (namely 20% reduction of energy intensity).

In the section 3, the authors have already mentioned some factors may impact corporations on their response to the energy saving and pollution abatement policy. They are scale, ownership, awareness, attitude, current environmental performance-energy using efficiency and pollution level. Following we will discuss more on these potential impact factors, and their influences on corporate performance to the policy, including but not limited to them. Scale is an important factor affecting corporation conduct in industrial organization theories, and our research confirms it once more. All the 9 large corporations have taken actions to both energy saving and pollution abatement, with average improvement of 8.3% and 9.1% respectively. So did all the 13 medium scaled corporations, with slightly lower improvement rate of 7.5% and 7.2%. In the other 98 small corporations, active rate is 67.8% in energy saving and 77.5% in pollution abatement; average energy efficiency growth is 7.0% for active corporations and 4.1% for all; pollution reduction rate is 9.7% for active ones and 6.3% for all. Generally, corporate performance rises with scale. According to our classification of ownership, Chinese state-owned corporations performed top in both energy saving and pollution abatement progress, see figure 5. Second is joint venture, and foreign corporations performed better than local Chinese private corporations. Chinese state-owned corporation shows best policy

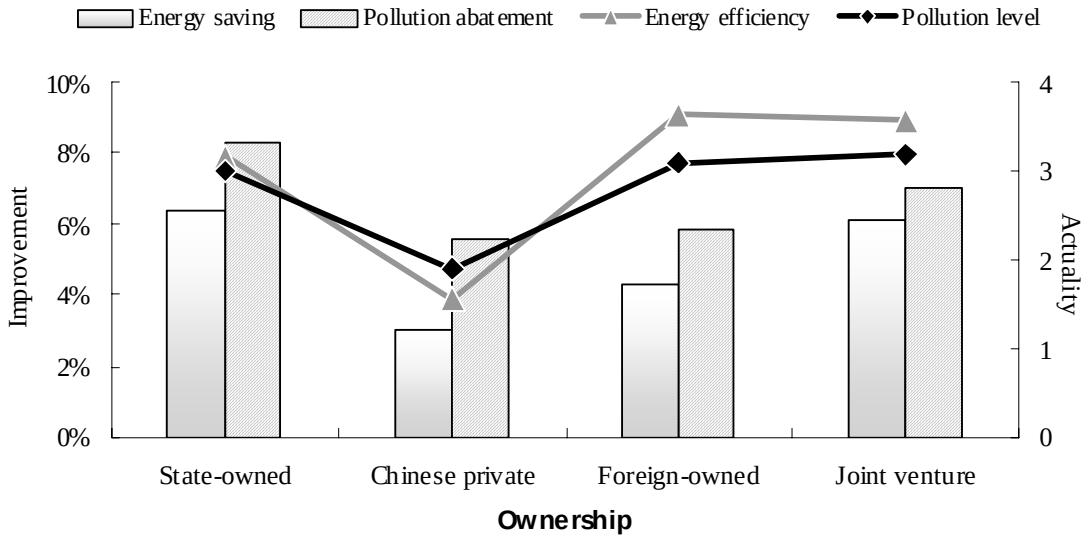

Fig. 5. Ownership and corporate performance

compliance than others due to the institutional arrangement. Joint ventures did better than wholly foreign corporations, may because they have characters both of foreign companies, from technology and management aspects, and Chinese state-owned companies, from the policy acceptance and compliance aspects.

The authors classify Grade 1-5 of energy efficiency and pollution level, and Grade 0 refers to the situation in which manager is not clear about the answer. It is found that corporations with energy efficiency at or below average did less to save energy with their efficiency going down; so did corporations polluting averagely or below. See fig. 6.

All the corporations with energy efficiency of Grade 1 and Grade 0 did not take any actions to energy saving. It is likely that corporation uncertain of its energy efficiency did not do well in energy using, as mentioned by the staff from QBEP.

The authors classified corporations into three categories according to the target market: domestic market- all products are sold in China mainland (34 corporations); mixed domestic and foreign market- products are sold partly in domestic market and partly in foreign market (78 corporations); foreign market- all products are sold outside of China mainland (11 corporations). Figure 7 indicates their gaps clearly.

Firstly, line charts show that corporations targeting for foreign market are of better energy using efficiency and pollution control, and corporations orientated at complete foreign market are better than those at mixed market. (Axis on the right; energy efficiency and pollution level are divided into five grades, the higher the better.) Secondly, the bars in figure 7 reflect the similar situation in energy saving and pollution abatement. (Axis on the left; % means the energy efficiency growth rate and pollution abatement rate). Corporations targeted at foreign market performed better than those for domestic market. Some corporations in our survey said that pollution caused foreign market entry barriers for them, especially for export to USA, EU and Japan.

Samples are classified into three groups according to their listed status: listed, to be listed, not listed. And results show that listed and to be listed corporations did significantly better than those not listed; listed corporations performed slightly better than those to be listed. Environmental information exposure required by listing regulation seems to work well.

From analysis in Section 2 and 4.2, the authors find that:

" How a corporation thinks about the impact and importance of the policy closely related to its actuality of energy using and pollution emission, so are impact factors of ownership, market and listed effect. They affect corporate response to the sustainable policy as well as their current energy efficiency and pollution level.

" Scale and current energy efficiency/ pollution level have significant influence on corporate policy response, and they are relatively independent. Correlation coefficient between them is less than 0.3. To avoid multi-linear problem, the authors only take current energy efficiency/ pollution level and scale as impact factors of policy performance. Since corporate performance varied in energy saving and pollution abatement, we establish their relational expressions separately:

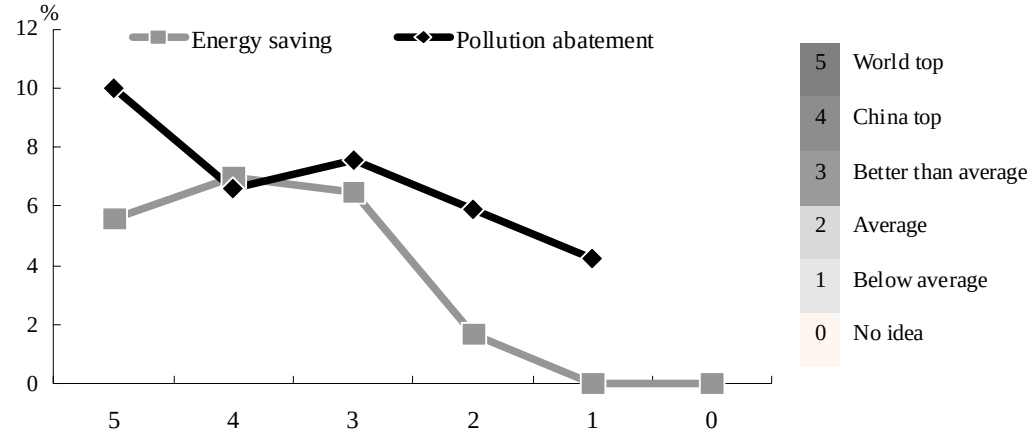

Fig. 6. Relationship between environmental performance and policy response

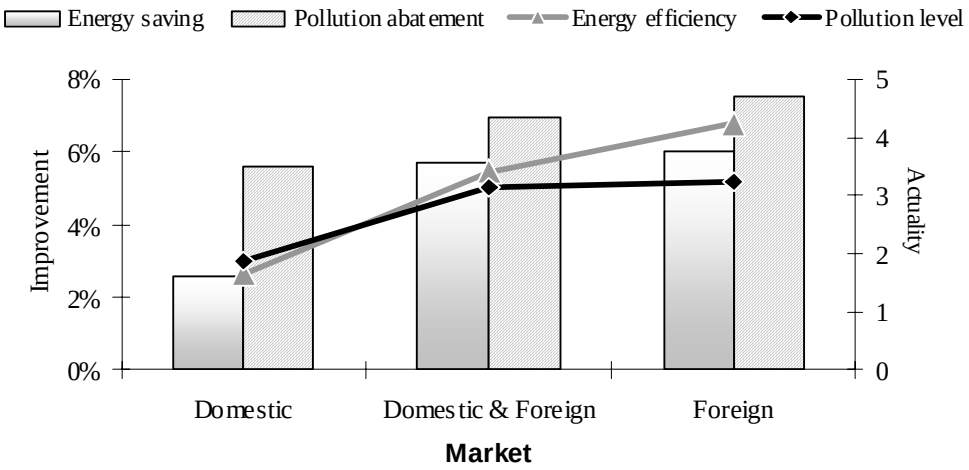

Fig. 7. Target market and environmental performance

$$Pe = c(1)*S + c(2)*Ce_1 + c(3)*Ce_2 + c(4) \quad (1)$$

$$Pp = c(5)*S + c(6)*Cp_1 + c(7)*Cp_2 + c(8) \quad (2)$$

Pe: performance of energy saving; measured by the growth rate of energy efficiency caused by energy saving actions, in case of no action had been taken, it is 0.

Pp: performance of pollution abatement; measured by the reduction rate of dominant targeted pollutants (SO_2/COD), in case of no action had been taken, it is 0.

S: scale; mark large=1, medium=2 and small=3.

C_e: current energy efficiency; dummy variables C_{e1}-energy efficiency higher than average, C_{e2}-energy efficiency lower than average.

C_p: current pollution level; dummy variables C_{p1}-pollution level better than average, C_{e2}- pollution level worse than average. As P_e and P_p are both assumed to be nonnegative and our survey can only cover limited growth rates and abatement rates, we adopt censored regression model with left point of zero. Applying Eviews 6.0, results showed in Table 3.

For energy saving performance, scale has positive influence on it. With corporate scale rise, higher energy efficiency increment is achieved. Compared with corporations at average energy using level, corporations below average are likely to get much less improvement in energy efficiency. Adjusted R^2 shows that corporate energy efficiency actuality and scale can explain 42% of its energy saving performance.

For pollution abatement, adjusted R^2 of 2% means current pollution level can only explain a small part of the performance, we lack information from other impact factors or even those not being taken into consideration in this research. However, the coefficient of C_{p2} still provides information that compared with those at average pollution level, corporations polluting heavily

Table 3. Regression results for equation (1) and (2)

Dependent variable	Coefficients of parameters				Adjusted R^2
P_e	c(1)- S	$c(2)$- C_{e1}	$c(3)$- C_{e2}	$C(4)$- C	0.42
	1.17*	-	-11.58***	4.77***	
P_p	$c(5)$- S	$c(6)$- C_{p1}	c(7)- C_{p2}	$C(8)$- C	0.02
	-	-	-2.86**	5.45***	

***, **, * refer to significant level at 1%, 5% and 10%; - indicates the nonzero coefficient is denied by z-test.

achieve less pollution abatement in average. The conclusion is similar to that of energy saving.

In spite of some missing information for wholly explaining corporate performance, the regression results implicate assuredly that the energy saving and pollution abatement policy and its allocation to corporations will help to outdate production facilities of low energy efficiency and high pollution level, since these manufacturers are more likely to fail to implement their required targets.

CONCLUSION

This paper analyzed corporate response to the energy saving and pollution abatement policy by sampling. The authors firstly analyzed awareness, attitude and actions of the 120 surveyed corporations to the energy saving and pollution abatement policy, and found that:

" More than half corporations thought the policy would constrain their development, especially those small corporations performing poorly in environment; only a few Chinese state-owned and foreign corporations with good environmental performance considered it was good to long-term development.

" In general, corporations responded to pollution abatement more actively than energy saving due to different monitoring authorities. And 26 in 27 corporations taking no action were small corporations with poor environmental performance.

" Environmental performance and how corporations thought about the policy impact and importance are highly correlated with each other. It seems foreign investment from USA, EU and Japan has better environmental awareness generally. Small sized Chinese corporations as well as a few small foreign corporations from South Korea and Taiwan consist of the most passive part answering to the policy. No significant difference appears among industrial categories.

" Most corporations took more than two measures in action, and measures in promoting production process and management are commonly adopted. Investing in equipment is the most popular approach for pollution abatement while not for energy saving. The policy meanwhile provides drive and environmental direction for adjusting products structure and outdating disadvantaged production facilities.

Further research found that corporate properties as scale, ownership, current environmental performance on energy using and pollution, target market and listed situation have impact on the corporate responding conduct and progress. Summarize these impact factors, we found that current environmental performance has strong relationship with their policy responding performance. Corporations with low energy efficiency performed poorly to energy saving, while those with high pollution level performed below average for pollution abatement.

It implicates that the national policy of energy saving and pollution abatement and its task allocation to corporations could contribute to outdating production facilities less environment-friendly significantly under the condition of strict implementation. And the given environmental requirements also drive corporations to achieve targets by various approaches, with which also help corporations to gain other benefits, such as updating and adjusting product structures, lowering pollution discharge fee. That may be the co-benefit for China's economic transformation.

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