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Research Article

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Low-carbon technology innovation of Chinese enterprises: Current situation and countermeasure research

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ABSTRACT

By conducting field investigation on 200 enterprises in Shenzhen, this paper finds that currently, the low-carbon technology innovation of enterprises proceeds slowly and most enterprises adopt the incremental innovation approach in innovating low-carbon technology. One of the main reasons for the slow process of enterprise low-carbon technology innovation is that enterprises invest too much in existing equipment and lack confidence in low-carbon technology which is characterized with market uncertainty and has great market risk. To accelerate the process of enterprise low-carbon technology innovation, it is crucial for the government to provide policy support and powerful guidance. The government can encourage enterprises to introduce the low-carbon project through tax incentives, increase the fund support to enterprises under transition to low carbon and assist enterprises to introduce high-quality talents in low carbon to promote the low-carbon technology innovation of enterprises.

Key words: Low-carbon technology innovation; Current situation; Countermeasure

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INTRODUCTION

Since the Rio de Janeiro Earth Summit in 1992 and the signing of the Kyoto Protocol in 1997, the problem of greenhouse gas (GHG) emission, especially the global warming induced by the emission of carbon dioxide has been viewed as a significant environmental problem[1]. To curb global warming and guarantee sustainable human development, enterprises must reduce the emission of greenhouse gas because the great amount of carbon dioxide released in the production activities of enterprises is the main source of greenhouse gas (Bernstein et al., 2007; Bradford and Fraser, 2008). And the production mode with coal being the main energy consumption material that has been long established in Chinese enterprises leads to greater pressure on reducing emissions. Thus, to reduce the emission of carbon dioxide, enterprises must carry out low-carbon technology innovation. Some scholars even point out that with the development of China's low-carbon economy; it is an inevitable trend for enterprises to conduct low-carbon technology innovation, which proves to be the key to business survival[2].

But in practice, technological innovation activities of enterprises in low carbon development are not satisfactory. When conducting an empirical analysis on the motivation source of the low-carbon technology innovation of manufacturing industries, Hua Jinyang [3] finds that enterprises lack motivation in engaging in low-carbon technology innovation (2011). The research of Yang Yuanhua[4] et al further finds that low-carbon technology innovation of enterprises proceeds slowly (2012). Then why don't enterprises conduct low-carbon technology innovation? What problems are encountered in the process of low-carbon technology innovation? This research hopes to explore the current situation of enterprise low-carbon technology innovation as well as the problems through research and analysis to provide consultation for the formulation of government policy.

LITERATURE REVIEW

2.1 Low-carbon economy and low-carbon technology innovation

With respect to the connotation of low-carbon economy, the explanation of low-carbon economy by professor Rubin

is generally recognized in academia. He points out that "on the basis of market mechanism, low-carbon economy refers to the green economy model that promotes the development and application of energy efficiency technology, energy saving and emission reduction technology and renewable energy technology to achieve low pollution, low consumption, low emission, high performance, high efficiency and high benefit by way of formulating institutional frameworks and policy measures." The low-carbon economy concept universally adopted in China is the economic model on the basis of low consumption, low emission and low pollution. Its essence is to improve energy efficiency and innovate clean energy structure and its core is technological innovation and institutional innovation, which virtually embodies the importance of technological innovation, low-carbon technology innovation in particular to the development of low-carbon economy. Being a broad concept, low-carbon technology refers to the new technology that can effectively control the emission of greenhouse gas in the sectors of electricity, transport, construction, metallurgy, chemical industry and petrochemical industry and in the aspects of the clean and efficient use of renewable energy, new energy and coal, the exploration and development of oil and gas and coal-bed gas resources and the capture and sequestration of carbon dioxide. Low-carbon technology can be divided into three types. The first type is carbon reduction technology which refers to the energy saving and emission reduction technology in high energy consumption and high emission fields as well as the technology of the clean and efficient use of coal, oil and gas resources and the exploration and development of coal-bed gas. The second type is carbon free technology, such as the renewable energy technologies of nuclear energy, solar energy, wind energy and biomass energy. The third type is de-carbonization technology. The typical example is the carbon capture and sequestration (CCS).

In the understanding of the connotation of low-carbon technology innovation, foreign literature on renewable energy and carbon emission reduction often uses vocabulary like "technological breakthroughs"" technology revolution"in illustrating low-carbon technology innovation(Barrett 2009,Barrett 2010,Hoffert,2002). This shows that foreign mainstream scholars consider low-carbon technology innovation as a kind of breakthrough innovation. For example, Hoffert el al holds that "new energy technologies are revolutionary changes on existing energy production technologies that cannot reduce the emission of carbon dioxide in a short time and stabilize the global climate[5]."

China has not had a clear definition on low-carbon technology innovation. This research assumes that technological innovation activities conducive to reducing carbon emission can all be considered as low-carbon technology innovation. According to the impact degree on enterprise management, low-carbon technology innovation can be divided into incremental innovation and radical innovation. Incremental low-carbon technology innovation refers to the innovation on the basis of established knowledge to achieve the goal of reducing carbon emission in the process of production by improving existing production technology, production process and product design. Radical low-carbon technology innovation is based on new knowledge almost completely different from existing knowledge. In other words, enterprises employ new low-carbon technology or redesign new products to replace the technology and products that are currently being used to achieve the low-carbon or carbon-free goal[6].

3. ANALYSIS OF THE CURRENT SITUATION AND PROBLEM OF ENTERPRISE LOW-CARBON TECHNOLOGY INNOVATION

To truly understand the problems arising from the process of enterprise low-carbon technology innovation, this research employs the questionnaire method and randomly selects 200 enterprises in Shenzhen for investigation. The scene investigation method is mainly adopted by which 200 enterprises are visited and senior managers (general manager and deputy general manager) and R & D supervisors are asked to fill out the questionnaire and interviewed.

3.1 Sample overview

This research selects 200 enterprises in total as the investigation object, delivers 200 questionnaire copies and collects 150 copies with 98 valid copies and the questionnaire effective rate being 65.33%. As shown in the following chart, in terms of industry classification of investigated enterprises, there are 58 manufacturing enterprises, 23 financial service enterprises, 2 retail and wholesale enterprises, 12 integrated enterprises and 3 agricultural enterprises, accounting for 59.18%, 23.47%, 2.04%, 12.24% and 3.06% of the investigated samples respectively. It can clearly be seen that manufacturing enterprises take up a large share of investigated samples.

From the scale of investigated enterprises, we can see that there are 24 enterprises with 100~500 employees, 13 enterprises with 501~1000 employees and 31 enterprises with more than 1000 employees, accounting for 24.49%, 13.27% and 31.63% of the investigated enterprises respectively. On the whole, investigated enterprises are mainly medium-sized and large enterprises. From chart 2, we can see that among investigated enterprises, there are 60 enterprises that have been set up for more than 8 years, accounting for 60% of the research sample. Through the statistical analysis of investigated samples, we can know that investigated sample enterprises are mainly manufacturing enterprises which are large in scale and have been set up for a long time.

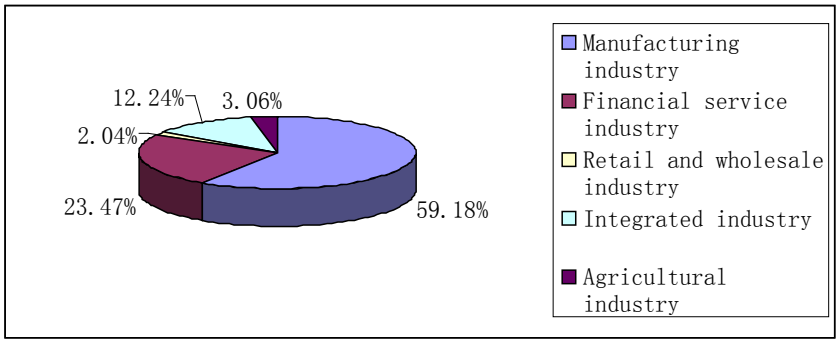

Chart 1 Statistical analysis of industry classification of investigated enterprises

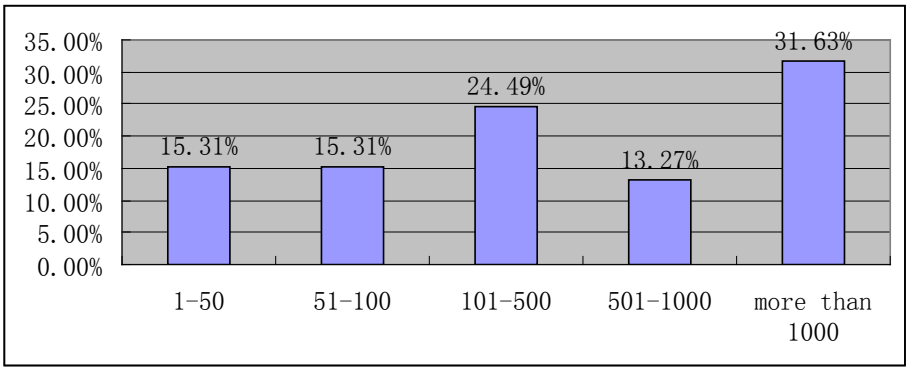

Chart 2 Statistical analysis of the scale of investigated enterprises

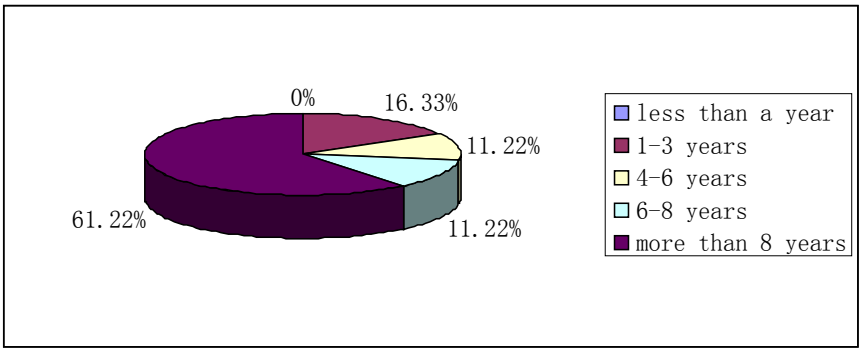

Chart 3 Chart of established year of enterprises

3.2 Investigation result and discussion

3.2.1 Current situation analysis of low-carbon technology innovation of enterprises

It goes without saying that low-carbon technology innovation is of great significance to enterprises. In terms of the current situation of enterprise's low-carbon technology innovation, only 21.43% of enterprises are implementing the strategy of low-carbon development in an all-round way; 22.45% of enterprises make an attempt to promote low-carbon technology innovation through conducting experiments inside the enterprises; 16.33% of enterprises are formulating low-carbon innovation plans; and 39.8% of enterprises, however, take a wait and see attitude, and may initiate similar innovation after an evaluation of the low-carbon technology development of counterpart enterprises. Therefore, it can be concluded that more than a half of enterprises have not implemented low-carbon innovation yet, and the proportion of enterprises which have carried out such innovation in an all-round way is still small.

Table 1 Analysis of enterprise's low-carbon technology innovation progress

option	proportion
enterprises readily implement low-carbon construction and promote low-carbon technology strategically.	21.43%
enterprises make an attempt to promote low-carbon technology innovation through conducting experiments inside the enterprises	22.45%
enterprises are planning low-carbon development but have not implemented it yet	16.33%
enterprises have not promoted low-carbon technology innovation and pay close attention to low-carbon technology development of other enterprises	39.8%

For those enterprises which have implemented low-carbon technology innovation, they focus on incremental innovation, with radical innovation supplemented. As can be seen from the Table below, 83.12% of enterprises adopt the incremental innovation: they attempt to lower carbon emission of products through improving the production technology and procedure as well as product itself. In comparison, 16.88% of enterprises, usually startup (newly emerging) enterprises [7], adopt the radical innovation: they buy in low-carbon technology directly.

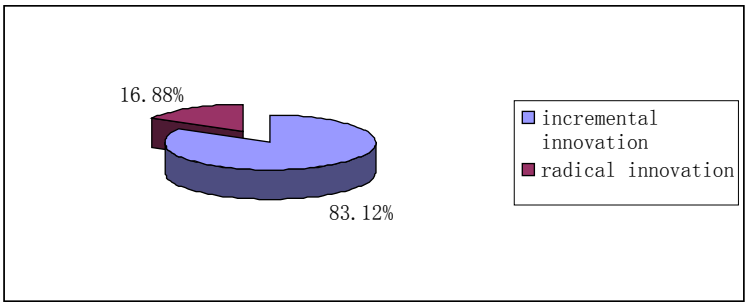

Chart 4 Classification of innovation types of enterprises which have carried out low-carbon technology innovation

In terms of the progress of low-carbon technology innovation, most enterprises hold that the current progress is relatively slow, which is shown in the figure below. Just as the investigation suggests, those enterprises which are implementing low-carbon technology innovation think the progress is very slow.

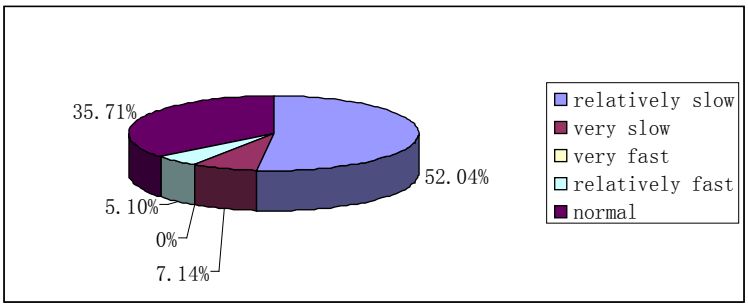

Chart 5 Analysis of the progress of enterprise's low-carbon technology innovation

3.2.2 Problem analysis

Many enterprises hold that it is quite difficult to promote low-carbon technology innovation in enterprises. To have an in-depth analysis of problems confronting enterprises when they implement low-carbon technology innovation, a further research is carried out to find the fundamental reason leading to slow progress of enterprise's low-carbon technology innovation.

When enterprises are asked whether they will retain existing technology or adopt new low-carbon technology during the process of low-carbon technology improvement or innovation, 77.5% of them say they will use the existing technology and only 22.5% say they are willing to try new low-carbon technology. Main reasons why most enterprises tend to continue using existing technology are demonstrated in the table below. But here is the most important reason: on one hand, due to a great investment of equipment, enterprises will suffer a great loss if they abandon existing production equipment and adopt new low-carbon technology; on the other hand, due to a great uncertainty of and many potential risks in the low-carbon technology market, many enterprises are not confident enough to apply new technology. Moreover, with the increasing application of technology, more experience is gained, which will stimulate the development, advancement and perfection of this technology and the realization of the increased effect of technology, investment and returns [8].

As has been noted in the research, four reasons contribute to a difficult situation when enterprises promote low-carbon technology innovation. First, domestic low-carbon technology is underdeveloped and enterprises are not possessed with existing low-carbon technology; second, there is a lack of low-carbon technology talents and research and development personnel in the enterprise have a poor understanding of low-carbon technology; in the third place, developing low-carbon technology calls for a great sum of capital investment, and there is a lack of funds for many enterprises; finally, governmental support and encouragement of promoting low-carbon technology innovation is far from sufficient. It is held by enterprises that developing low-carbon technology requires a great sum of capital investment, and the most key reasons out of these above four are a lack of funds and that technical

personnel fail to master low-carbon technology [9].

Table 2 Reason analysis of enterprise's retaining the existing technology

option	proportion
Existing technology has been applied into practice. The more the investment is, the more the income is.	32.65%
Some equipment are only available to existing technology. With low-carbon technology implemented, existing equipment and fixed investment will be of no use.	54.08%
Existing technology information and production design ideas can't be applied to low-carbon technology directly. If low-carbon technology is adopted, information sharing can't be realized.	30.61%
There is a great uncertainty and risk of the low-carbon technology market	52.04%
When enterprises decide whether to retain existing technology or make low-carbon technology innovation, there is abundant information of existing technology and little information of low-carbon technology. Therefore, the final decision is not necessarily the optimal.	35.71%

CONCLUSION

Through a field survey of 200 enterprises in Shenzhen, it is found out that current enterprise's low-carbon technology innovation develops in a slow pace and many enterprises take a wait-and-see attitude and have not carried out actual low-carbon technology innovation. For those enterprises which have implemented low-carbon technology innovation, they mainly adopt the incremental innovation model; make low-carbon transformation of existing production technology and procedure and lower carbon emission through improving the production design. One main factor contributing to the slow progress of enterprise's low-carbon technology innovation is that many enterprises have made a great investment of production equipment and they tend to retain current technology. That is to say, for fear of great economic loss, enterprises are not willing to abandon existing production technology and adopt new low-carbon technology. Besides, a great uncertainty and risk exist in the low-carbon technology market and many enterprises are thus not confident enough about the prospects of this new technology.

To accelerate the progress of enterprise's low-carbon technology innovation, first and foremost, enterprises should enhance their awareness of developing the low-carbon economy and realize that low-carbon technology innovation is vital to their survival or destruction.

In addition, enterprise's low-carbon technology innovation in our country is in the initial stage, therefore governmental policy support and strong direction is very essential. As can be noted from the investigation, in terms of the problems confronting enterprises in their low-carbon technology innovation, four solutions can be adopted by the government. To begin with, the government can provide enterprises which are implementing the low-carbon program some tax preference or relief policies to alleviate their tax burden so as to encourage more enterprises to introduce the low-carbon program [10]. Secondly, the government should increase capital support to low-carbon transformation enterprises, provide them with bank loan and find them sufficient capital sources so as to help them overcome the obstacle of a lack of funds. In the third place, the government should readily give full play of its organizing and coordinating role to assist enterprises to introduce high-quality low-carbon talents or recruit low-carbon experts so as to solve the problem of a lack of low-carbon technology talents.

REFERENCES

[1] Kimitaka Nishitani and Katsuhiko Kokubu. *The Case of Japanese Manufacturing Firms, Business Strategy and the Environment*, **2012**(08): 517–529
[2] He Jiankun. *Green Leaf*, **2009** (1): 46-50.
[3] Hua Jinyang. *Science Research Management*, **2011**,(06):43-50
[4]Yang Yanhua, Li Li, NiuGuohua, Chang Kai. *Science and Technology Management Research*, **2012**(16):1-4
[5] M. I. Hoffert,et a1, *Science*,**2002**,298 (5595):98l-987.
[6]XieHongming, Liu Changyong. *Studies in Science of Science*, **2003**:540-547
[7]Stephen Redding. Path Dependence, *International Economic Review*,**2002**,(43)
[8]Arthur W. Brain. *Economic Journal*,**1989**,(99)
[9] IPCC.Climate Change 2007:migitation.Contribution of Working GroupⅢ.To The Fourth Assessment Report of the Inter- govern- mental Panel on Climate Change [M].Cambridge University Press,New York,**2007**
[10] Li Youhua, Wang Hong. Countermeasure Research on China's Low-carbon Economy Development [J]. *Journal of Haerbin University of Commerce (Social Sciences)*, **2009**,(6)
[11]Johnson, Eric J., Steven Bellman, and Gerald L. Lohse, *Journal of Marketing*, **2003**,67 (2), 62–75.
[12]Stephen P.Robbins,DavidA.DeCenzo.Fundamentals of Management,3th ed.[M].Prentice Hall, Inc. **1997**, pp120-121
[13]Simon,H.A.Administrative Behavior - A Study of Decision Making Prvcesses in Administrative Organization

[M]. New York: Macmillan Publishing Co,lnc,**1971**
[14]Scott Barrett, Michael Toman. *Global Policy*. **2010**. 1:1, 64-74.
[15]Steve Pacala and Robert Socolow. *Science*. **2004**,305:968-972
[16]Bernstein L, Roy J, Delhotal KC, Harnisch J, Matsuhashi R, Price L, Tanaka K, Worrell E, Yamb F, Fengqi Z. **2007**. Industry.InClimate Change
[17]**2007**: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Metz B,
[18]Davidson OR, Bosch PR, Dave R, Meyer LA (eds). Cambridge University Press: Cambridge, 448–496.
[19]Bradford J, Fraser EDG. **2008**. *Corporate Social Responsibility and Environmental Management 15*(3): 156–172. DOI: 10.1002/csr.151