



Government Interventions in Developing a Circular Economy

---What Can China Learn from Sweden?

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Master dissertation International business program May 2005

Preface

With this dissertation we will conclude one year of public administration and international business studies at Kristianstad University. We appreciate all the knowledge and experience received here. We cherish our solidarity and cohesion in the process of dissertation research.

We want to express our special thanks to Hakan Pihl for his support. The dissertation is completed under his wholehearted guide and help. We would like to thank Annika Fjelkner for her sincere English tutoring. We also thank Christer Ekelund, and Lisa Nilsson for their help.

We want to show our thanks to Lennart Erfors, a counselor of local investment program in Kristianstad, for his efforts. Furthermore, we would like to thank all the interviewees' participation. Without them this dissertation would have been impossible.

Finally we will express a special thanks to the Karpalund Biogas Plant, C4 Energy Company and Snararp Recycling Park which we visited and which participated in the interviews.

Kristianstad, May 2005

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Abstract

If it took England the exploitation of half the globe to be what it is today, how many globes will it take India? -----Gandhi

This dissertation focuses on the roles of government intervention in developing circular economy. We start with a pre-study of the theories and literature related to circular economy in the developed countries around world. Several case studies are adopted to illustrate the different measures in developing circular economy. Case studies concerning the environmental taxation, the tradable permits and the green certificate system put an emphasis on the economic role of government intervention. A case study of a circular economy in the city of Kristianstad including C4 Energy Company and waste management covers all the measures in harmonization. At last a framework of government interventions and eight proposals based on Swedish experience are tested and supported. Then a comparison between Sweden and China is carried on under a Chinese context through a case study of Chinese Eco-park. The framework is categorized into three aspects: state regulation, economic instruments and social balance mechanism. After the comparison, some modifications are done. We develop a framework and eight proposals in developing a circular economy in China.

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Chapter 1: Introduction

In this chapter the background of the dissertation is presented as well as research questions. Its purpose and limitation are also explained.

1.1 Background

The idea to this dissertation comes from the big campaign of promotion of circular economy in our home city Ningbo in China. Circular Economy is a kind of economic growth pattern which fits the thought of sustainable development. Sustainable development is a world-widely concerned issue nowadays. Economic growth in many fast-developing countries is attained at the cost of environmental degradation. Circular economy is a good idea and solution to this problem. Basically Circular Economy means turning the traditional economic process "resource –production –waste (recycling resource)" from a "line" into a "circle ". At its simplest it can be described like this: a maximization of resources and a minimization of pollution. (Zhang Sifeng, Zhou Hua, 2004) "Increasing the circularity of the economy is one of the key goals of environmental-economic policy. If all wastes could be returned to the economy in these various loop; both resource depletion and long-term pollution could be eliminated altogether."(Jacobs, 1990)

Our city Ningbo has pledged to an ambitious blueprint on development of circular economy. We think this topic will be helpful in our future work and this topic is concerned with public administration and economics which will conform to our study requirement.

In a developed society, such as Sweden, Denmark, Germany, or the USA, the circular economy has been brought forth and put into practice for decades. A lot of experience accumulated will be helpful for a developing country. But it should be rectified under a different social, economic, political context. For China, the

situation is different when it comes to political arrangement; stage of industrialization and economic institution. The government has been launching the program of developing circular economy just in recent years. As a fact in China government plays a stronger role in economic sector comparing to the above countries. Hence the role of government in facilitating circular economy and the extent to which the government intervenes in economy are different.

1.2 Research Questions

- What is the concept of a circular economy (CE)?
- Why should government play an important role in developing circular economy?
- What are the effective measures in facilitating a circular economy in developed countries (focusing on Sweden)?
- What can an emerging economy learn from a developed industry nation in developing a circular economy and what are the differences?

1.3 Purpose

The purpose of this dissertation is to develop a model of interactions among government, economy and society in developing a circular economy. At first, the core elements of the concept "circular economy" are described. Then a model that synthesizes different opinions for government intervention is developed based on the Swedish experience. At last, we will study the differences between Sweden and China and develop proposals about the use of these interventions in China.

1.4 Limitations

Since the idea of circular economy has been put forward for decades the relating material is abundant. And measures to fulfill it are diversified around the world. So it is impossible to cover every aspect of a circular economy in a short time. We just focus on some big issues. In addition, most of our interviews and the main case study in our dissertation are carried out in Kristianstad, which is a

middle-sized city in Sweden. To some extent the difficulty of developing a circular economy will be less comparing to a bigger city. Our empirical study is suspicious to be narrow with respect to the broad idea of a circular economy. Furthermore, the time limitation of five months is the main constraint of our research in observing the development and change of a circular economy process.

1.5 Outline of Dissertation

Chapter 2: The methodology and the research approach are presented.

Chapter 3: At first, the chapter illustrates the theories and practice of circular economy in the world. Then the reason for government intervention is explained. Furthermore different kinds of government intervention are described. Finally the preliminary framework of government intervention and eight proposals are presented.

Chapter 4: The overall analyses on government intervention in Circular Economy are made in four Swedish cases. Finally the framework of Swedish government intervention is summed up and six proposals are proved.

Chapter 5: A Chinese case is introduced and analyzed. The framework of Chinese government intervention is generalized. Meanwhile six proposals supported in Swedish cases are also proved in the Chinese case.

Chapter 6: The comparison of government intervention between Sweden and China is made. Meanwhile the two extra proposals are proved and Swedish Experience is concluded.

Chapter 7: We make a summary of dissertation. The findings of research are given. The applicability of the model is also shown. Finally the opinions about future research are recommended.

Chapter 2: Methodology

In the second chapter the methodology is discussed. The dissertation's research approach is presented.

2.1 General Approach

Our key aim is to set up a framework of CE development in China among the government, economy and the society. The concept of circular economy has emerged for decades. There is a vast of literature discussing this issue and there are several good examples in Sweden. We will list some proposals from a theory analysis and test them in our case studies. This is the deductive approach. At the same time some conclusions (framework) will be drawn from the case studies. This is the inductive approach. The conclusions will be refined to a framework. Then the framework will be analyzed under a Chinese context. The framework can be modified and some aspects will be accentuated through a case study of China.

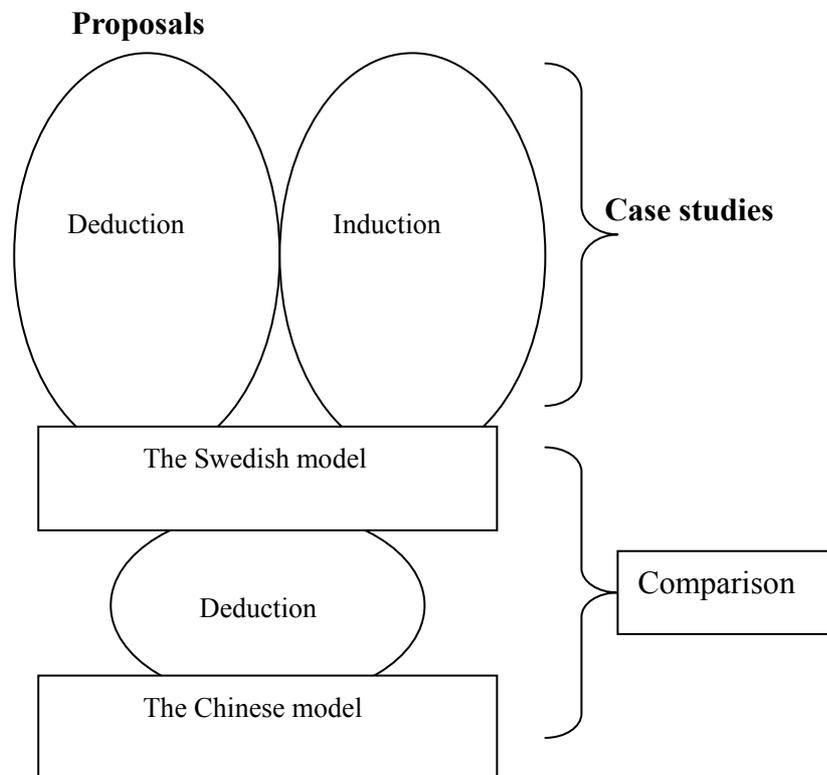


Figure 1.1 the structure of dissertation

2.2 Research Strategies

Research strategy is about how you answer the research questions. (Thornhill, 2003, pp 90) We will use the survey and case study strategies. Several empirical investigations are carried out in Sweden. We also interview the staffs who are involved in circular economy.

2.3 Criticisms of Data

Most of our data in case studies comes from interviews, government reports and some secondary data of other people's thesis. There are three main threats which may question this issue: reliability, validity and generalizability. We try to lessen the influence of the threats by some measures.

2.3.1 Reliability

How reliable is the data that we have collected? There are four threats to the reliability of data: subject or participant error; subject or participant bias; observer error and observer bias.

Subject or participant error

When we interviewed different people of different companies three of us put forward the same important question from different perspectives respectfully. So it is very hopeful the interviewees will really understand questions and give us meaningful answers.

Subject or participant bias

The interviewees employed by government are suspicious to exaggerate their proactive roles in government function. To avoid this to some extent we made a comparison between interviewing data with publicized material in some specific details.

Observer error

The observers may misunderstand the answers. So we confirmed some unclear

answers through e-mail. And most of conversation was recorded to avoid language barrier.

Observer bias

It is prone to make mistakes by interpreting the unclear answer on your own base. We try to avoid guessing meaning or expressing our conclusions without evident data.

2.3.2 Validity

“Validity is concerned with whether the findings are really about what they appear to be about. Is the relationship between two variables a causal relationship?”(Saunders, Lewis and Thornhill, 2003) There are six threats to validity: history; testing; instrumentation; mortality; maturation; ambiguity about causal direction (Saunders, 2003).

History

The interviewees' past uncomfortable experience may influence answers to some extent. But for our case studies the interviewing organizations have acquired many awards of their jobs. It is easy for them to be fair on both positive and negative aspects.

Testing

If the interviewees think that the question will have a negative effect on their works you are inclined to receive a biased answer. We are prudent to use the conclusion obviously embodying personal feeling.

Instrumentation

Changes may happen as time goes by. New technology or reform of organization will be carried on. This will affect the results of interview in a time span. We do not worry about this because our investigations are finished within a short time.

Mortality

This refers to participants dropping out of studies. Hopefully our studies are finished within a short time.

Maturation

Gradually the participant will become mature in the thought of circular economy. It will be a problem when we experience a long research process. But most of our interviews are based on the past programs of government. This threat has little to do with our results.

Ambiguity about causal direction

Sometimes it is difficult to be clear the cause-effect relationship. Which one is decisive factor? In our dissertation it is clear to discern the differences and the different roles are just interactive.

2.3.3 Generalisability

Generalisability is sometimes called external validity, which means the research result can be applicable in a big scope. It is important to draw a right conclusion but also the conclusions can be applicable in other settings. This is a very important issue in our dissertation. After a framework is obtained from case studies we test it by deductive approach in other surroundings. Some modifications are made in a certain specific setting. In our dissertation we conclude some ways through learning Swedish experience of sustainable development to be helpful in developing circular economy in China. So the applicability of conclusions is the key point of this dissertation. Because the situation of developing circular economy vary the focus on the framework will shift accordingly.

Chapter 3: Theoretical Framework

In this chapter the theories are presented. First the chapter illustrates the theories and practice of circular economy in the world. Then the relative basic theories are explained in detail. Afterwards the reason for government intervention is explained. Furthermore different kinds of government intervention are described. Finally the preliminary framework of government intervention and eight proposals are presented.

3.1 The Theories and Practice of Circular Economy

3.1.1 Retrospect of Global Circular Economy

The ultimate goal of human development is to improve living standards and fulfill overall development of human beings. For this end, human society has to deal with the relation between human beings and nature, with two sides being interdependent and interactive. The essence of the contradiction between human being and nature lies in the conflict between infinity of demand of economic activity with growth mechanism and the limitation of supply of ecological system with stable mechanism (Wang Yuqing, 2004).

Human society can be classified into three stages as follows: primary development, industrialization and post-industrialization stage. Correspondently, the economic development patterns are primeval circular type, linear predatory type and high-grade circular type of development pattern (Wang Yuqing, 2004) .

3.1.1.1 Primeval Circular Type of Economic Development Model

Primeval circular type existed in the society with agriculture and handicraft industry is the main economic support under natural and semi-natural economy. In this era, economic activity was integrated into a natural food chain in which nature could fundamentally maintain the spontaneous ecological equilibrium by means of self-purification. Meanwhile, human beings also encountered extreme

situation of ecological degradation such as soil loss by flushing which eroded much fertile farming land into barren deserts due to over-farming and over-felling of forest. (Wang Y., 2004).

3.1.1.2 Linear Predatory Type of Economic Development Model

Linear predatory type exists in the industrial society with large consumption of fossil fuel. Its technical paradigm is the combination of labor force, machines and whole natural ecological system with large material linear flow from resource to products, last to the emission of waste (see figure 3.1). In this era, exploitation of resource and emission of waste by social and economic activity have transcended the supply capacity and self-purification ability of the ecological system. Thus, the contradiction between human beings and the nature becomes more severe (Wang Yuqing, 2004) . The characteristics of this stage are:

A Great Imbalance of Material Consumption among Different Nations

Industrial nations with 15% of the global population consume 56% petroleum of the total consumption, 60% natural gas and 50% of other important deposit resource of globally total consumption. 20% of the global population, who live in the rich countries, makes up 86% of private consumption expenditure, while the other 20% living in the poor countries, occupies only 1.3% of the total consumption (Pan Yue, 2004)(Report of the Secretary-General, 2001).

A Rapid Decrease of Material Resources and Ecological Resources

Coal can be exploited and used no more than another 100 years. Petroleum can be used within 100 years. Aluminum, copper and lead will last for another 100 years, 40years and 40 years of production respectively (Oleg, 1999). As for natural resources, about half wetlands have been disappearing; pasture has been reduced by 90%; forest area per capita globally is reduced to 7.3 square kilometers from 11.4 square kilometers in 1970; a large number of species have disappeared or suffered from threats (Report of the Secretary-General, 2001).

A Worsening of Ecological Environment

Some kinds of pollution such as air pollution, water pollution, the destruction of the ozone layer, acid rain, and disasters such as desertification, drought, flood and soil flow loss etc follow the ever-increasing industrialization. Many environmental disruption and ecological disasters such as the London Smog Accident are being staged one by one.

A More Turbulent World from Resource Exhaustion and Environment Devastation

International conflicts have frequently happened in order to acquire resources and environmental rights which sometimes become the last straw to form local wars (Pan Yue, 2004).

In conclusion, human beings finally realize that natural resources are not inexhaustible and the purification capacity of the ecological environment is not unlimited. If the human society wants to proceed and develop persistently, it should change its growth pattern, and explore new development patterns. (Wang Y.Q, 2004) .

3.1.1.3 The Origin of Circular Economy

In last century many scientists call the economy the Cowboy Economy which means that the exploitation of natural resource is irregular and without any consideration of the nature just like a cowboy pastures in the immense green land. Experiencing a series of ecological disasters, many scholars begin to think about the insurmountable contradiction and adverse effect from traditional development patterns and delved into new development patterns (Wang Y., 2004).

In 1962, Rachel Carson, an American biologist, published the famous book, *Silent Spring*, which tells us about the harmful effects of insect-killing chemicals

such as DDT. She illustrates many typical cases and strikes the alarm bell for environmental crisis brought by industrialization (Xie Zhenhua, 2004).

In 1966, American economist Kenneth Boulding, firstly, put forward the concept of Circular Economy in his *the economics of the coming spaceship earth*. Boulding's conception was of planet Earth as a 'spaceship'. If we think of a spaceship going on a long journey it will have only one external source of solar energy. It will have a stock of resources depending on whatever was put aboard before take-off. But as that stock is reduced, so the expected lives of the spacemen are reduced unless they can find ways to recycle water and materials and generate their own food. Boulding is pointing to the need to contemplate Earth as a closed economic system: one in which the economy and environment are not characterized by linear interlinkages, but by a circular relationship. (Xie Zhenhua, 2004).

In the 1970s, two energy crises happened and the contradiction between economic growth and resource shortage became more severe. In 1972, Rome Club delivered its research report which warned the world: "the growth utmost will happen in 100 years if the population, industrialization, pollution, food production and consumption of resource in the world go on with present rising trend". In the same year, the United Nations delivered *Manifesto of the Human Development* which further appealed to each nation to undertake responsibility for protecting the nature (Ma Kai, 2004).

In the 1980s, human beings began to explore the road to a sustainable development. In 1987, Madam Brundtland put forward the concept of sustainable development in her report named *Our Joint Future*. In 1989 American Robert Frosch proposed the concept of industrial ecology in his article *The Strategy for Processing Industry*. Frosch suggested a framework of industrial ecological system similar to a natural ecological system in which the waste and

side-products in the upstream stage could be used as raw materials in the downward stage (Ma Kai, 2004).

In 1992, the UNED Conference held in Rio de Janeiro of Brazil, officially put forward the strategy of sustainable development by two important documents, *manifesto of Rio* and *Agenda 21*. The UN called on each nation to pay more attention to the quality and sustainability of development besides rate and quantity. Afterwards, most countries began to explore a strategy of sustainable development (Ma Kai, 2004).

3.1.1.4 The Present Situation of Circular Economy in the World

Some developed countries such as Germany, Japan and the USA, are to some different degree engaged in legislation related to Circular Economy. Germany is the first country to enact this kind of law. In 1986, Germany revised its *Law on The Waste Disposal* regulated in 1972 and promulgated *Law on Limitation Disposal of The Waste*. In 1991, Germany enacted *The Law on Disposal of Waste Packing Material*. And in 1994 Germany enacted *The Law on Circular Economy and Disposal of the Waste* which defined the application scope of Circular Economy (Ma Kai, 2004, Chi Guanqun, 2005).

Japan has perfect law system on Circular Economy which covers each field of production and life. There are eight laws in the system among which the *Law on Formation and Promotion of Circular economy* enacted in 2000 is the most typical. This law makes Japan stand out in Circular Economy (Ma Kai, 2004).

Though the USA has no comprehensive law on Circular Economy, its law on resource protection and reclamation, and pollution prevention, has embodied the thought of Circular Economy. Since mid-1980, over half the states in the USA have successively enacted laws to promote a circular use of resources (Chi Guanqun, 2005).

The Nordic countries engaged in sustainable development exploration very early. Though these countries have no special law on Circular Economy, other environmental laws include the requirements for cleaner production and recycling of secondary resource. France, the United Kingdom, Italy, Spain and Holland have all enacted special resource utilization laws (Chi Guanqun, 2005).

In Sweden, some laws such as *the Law on the Waste Collection and Disposal* and *the Law on Reclamation of Aluminum-made Containers* have been promulgated. Although Sweden does not emphasize the concept of Circular Economy, its achievements made in the sustainable development actually show us a society where Circular Economy and green consumption are core contents. According to Chi Guanqun (2005), there are three characteristics of the Swedish circular economy as follows:

First, sophisticated cleaner production has been carried out in the enterprises and industry sector for over thirty years which forms the foundation for energy and resource saving production; Second, for the country and regions, “three Rs (reducing, reusing and recycling) principle” is carried out for the circulation of resource in whole society; Third, in the field of consumption, green consumption has been the leading force among Swedes, which guides Swedish producers to raise their environmental images and produce more environment-friendly products

3.1.1.5 Analysis of Necessity of Developing Circular Economy in China

Alleviate the Resource Shortage

According to Chinese development plan, to 2020 the GDP will be two times that of 2000. Chinese energy and resource will be difficult to offer enough supply even if the demand for them only increases by 100%. To 2020, Chinese energy consumption will reach 3 billion ton standard coal after carrying out the Circular

Economy which means that Chinese energy consumption reduces from 2.68 ton standard coal per 10 thousand Yuan RMB in 2002 to 1.54 in 2020. Therefore, developing Circular Economy is an inevitable choice for alleviating resource pressure and fulfilling sustainable development (Ma Kai, 2004).

Lightening Environmental Pollution

Generation of pollutants is closely related to the level of resource utilization, and also interrelated to extensive economy growth pattern. If Chinese energy utilization efficiency were close to global advanced level, the emission amount of sulphur dioxide would be reduced by 4 million tons each year; if comprehensive utilization rate of waste solid rose one percent, the emission amount of it would be reduced by 10 million tons each year; If the utilization rate of coal ash increased by 20%, the emission amount of it would be reduced by 40 million tons. Developing Circular Economy will lighten Chinese environmental pollution radically (Ma Kai, 2004).

Raising Economic Efficiency

Production cost of Chinese industry is high and economic efficiency is low relatively compared with advanced industry due to low resource utilization rate. Facing severe international competition, Chinese industry must circumvent its later-mover disadvantage by promoting Circular Economy (Ma Kai, 2004).

Handling with Green Barriers

China has become one of main countries who suffer from green barriers. The best measure is to produce more environment-friendly products by carrying out cleaner production and promoting Circular Economy (Ma Kai, 2004).

Fulfillment of Human Overall Development

Traditional growth pattern has caused serious ill effects on Chinese health. About 100 million Chinese can not breathe fresh air and 15 million Chinese catch

bronchitis each year due to air pollution. The safety for drinking water is severely threatened by the water pollution. People's health can be protected most efficiently only by developing Circular Economy and reducing pollution (Ma Kai, 2004).

Present Situation of Circular Economy in China

On the whole, there are some bases for China in development of Circular Economy. Explorations have been made in three levels (Xie Zhenhua, 2004) : First, in the level of enterprise, cleaner production is carried out actively. China has enacted *Law on Promotion of Cleaner Production* and *Law on Energy Saving*. Second, in the level of industrial park, ten bio-industrial parks have been built according to the thought of Circular Economy. Third, in the level of region, many regions have launched trial task concerning Circular Economy. About eight provinces, thirty-five cities and over three hundred counties have engaged in it.

Compared with developed countries, the achievements made in China are minute because China just takes the first step. There are many problems and barriers in the face of China (Ma Kai, 2004): It is lack of unanimous thought on the significance and urgency of promoting Circular Economy; There is no total layout and promotion plan of Circular Economy, and indices and check system on resource utilization; Legal system is not very perfect, particularly laws on resource reclamation and recycling being not wholesome; Workable stimulus policy and reasonable price and rate system on recycled resource have not been built; It is lack of technique support system. Nowadays, Chinese key technique and equipment whose skill can be close to international level is only 15%. The whole level of science and technology of China lags behind developed countries by 15 to 20 years.

3.1.2 General Introduction of Theories of Circular Economy

3.1.2.1 Definition of Circular Economy

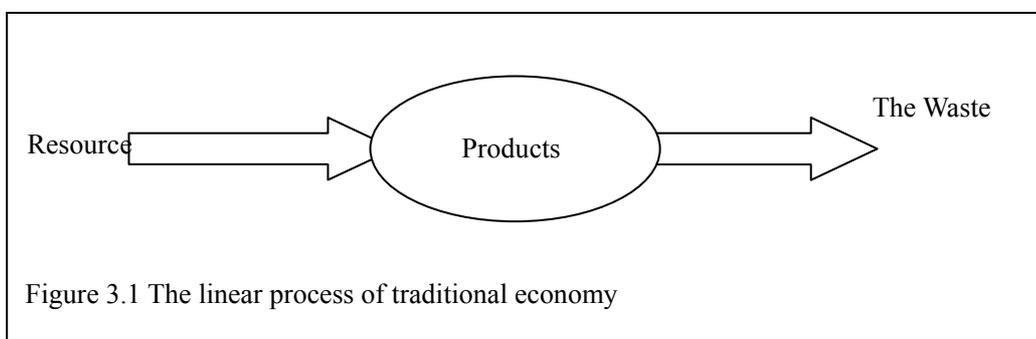
Chen Demin (2004) gives followings definition: Circular Economy is a kind of economic operation pattern in which material resource can be utilized in a circular system including production and life through cleaner production, market mechanism and social macro-control. It is required objectively by the ecological circular system and its goal is to fulfill the never-ending utilization of material resource.

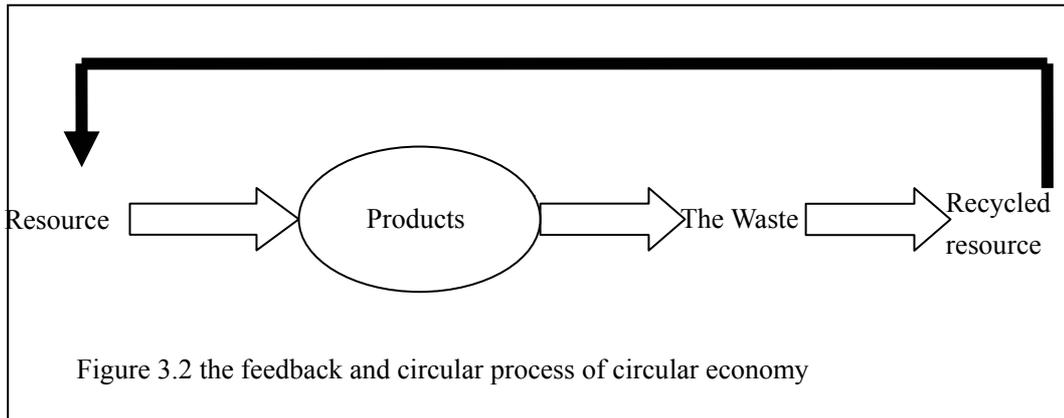
Ma Kai (2004) gives another definition: Circular Economy is a kind of economic growth pattern which fits the thought of sustainable development, puts it core to utilize resource circularly through carrying out 3Rs principle.

3.1.2.2 The Pattern of Circular Economy

Circular Economy changes the pattern of traditional economy thoroughly. The traditional economy pattern is defined as a unidirectional linear process (see figure 3.1). The pattern of circular is defined as a feedback circular process (see Figure 3.2).

Thus, Circular Economy can reach several goals including a minimization of pollution, a maximization of material resource utilization and meanwhile gaining more social and economic efficiency (Ma Kai,2004, Chen Demin,2004) .





3.1.2.3 The Main Principle of Circular Economy

Circular Economy relies on the 3Rs principle in which each R is imperative and interrelated (Makai,2004; Li Jian, 2004) . The Reducing Principle belongs to the measure of input end which aims to reduce the amount of material input in the production and consumption process. Meanwhile generation of waste and consumption of resources are both reduced as much as possible in order to raise the efficiency and protect environment. On the other hand The Reusing Principle, is a process measure which aims to prolong the time intensity of products and services. The Reusing Principle places an emphasis on reusing, recovering, retreading of products and discarded products in order to prolong the use life of products and prevent them from becoming refuse too early. Furthermore the Recycling Principle belongs to output end measure whose goal is to transform waste into usable resources in order to reduce the amount of the waste which has to be disposed of ultimately.

3.1.2.4 Active Fields of Circular Economy

According to Makai(2004), in the micro level, Circular Economy puts forward the following requirements: each enterprise should reduce consumption, save material and energy and raise the efficiency of resource utilization; each enterprise should overall utilize its waste, and promote the co-existence and coupling between different enterprises and industries by extending or expanding

the production chain. In the macro level, Circular Economy puts forward the following requirements: an industrial structure and layout should be regulated based on the thought of Circular Economy; a circular use of the resource system should be founded and improved (Makai,2004) .

3.1.2.5 Circulation Being the Core Concept

However, circulation does not directly mean a circulation of the economy, but of resources in each aspect of the re-production system of the national economy. According to Chen Demin (2004) , the main contents of circulation of resource are:

Rational exploitation of natural resource; Production of environment-friendly products through appropriately advanced technique and the waste and surplus raw material being reused in site incessantly; Rational consumption of end products in the field of circulation and consumption process; Recycling of secondary resource into production process.

3.1.2.6 Basic Characteristics of Circular Economy

There are also a set of basic characteristics of a Circular Economy. Chen Demin (2004) lists them as followings:

Objectivity: also called as internal regularity which means that the emergence of Circular Economy is inevitable choice by the human society facing exhausting resource and limited environmental capacity.

Technicality: the emergence and development of Circular Economy bases on advanced science and technology. Only through technique advancement, more extensive and efficient resource utilization can be fulfilled while new resource will be developed.

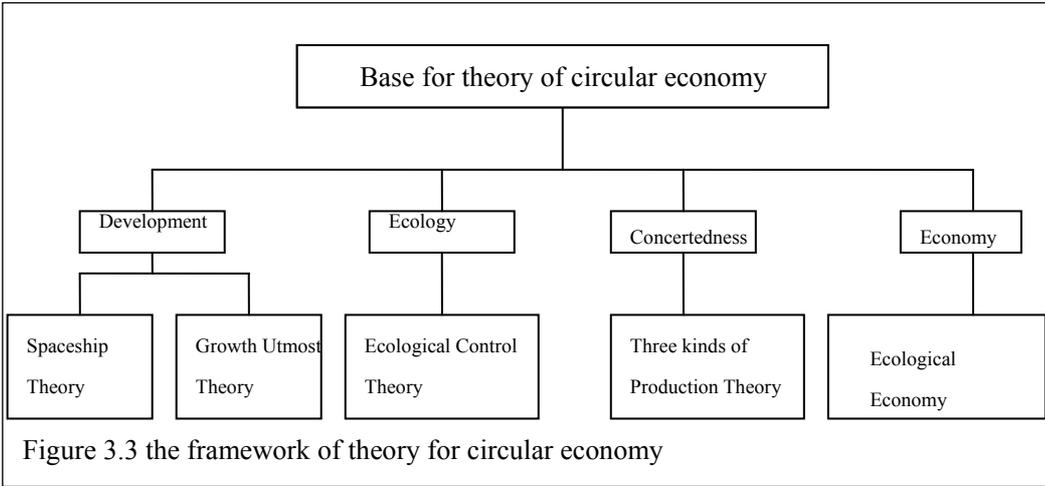
Schematism: Circular Economy is concerned with every aspect of re-production system. Only coordinating the whole system, the goal of Circular Economy can be realized.

Oneness: its goal is the combination of environmental protection and social development.

Reactivity: Circular Economy is the product of rational introspection.

3.1.2.7 The Base for the Theory of Circular Economy

The Base for the Theory of Circular Economy can be illustrated by figure 3.3 (Li Jian, 2004)

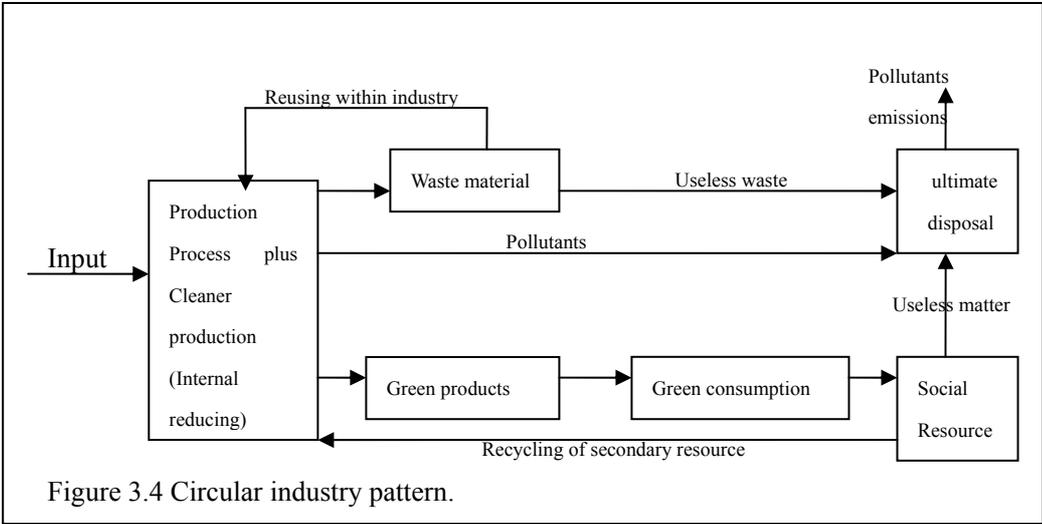


Spaceship theory and Growth Utmost Theory both put forward circular type of economy by analyzing finite earth resource and limitedness of social development from the aspects of economy, population, resource and environment. Ecological Control Theory emphasizes the ability of a society for self-regulation and self-control like an ecological system in order to protect the benign development of the human society. It includes six principles: the wholly regular principle, the circular and regenerating principle, the interaction principle, the feedback and equilibrium principle, the self-regulation and the layer escalation

principle. Three Productions' Theory argues that only the coordination of three productions, which include the production of material resource, the human beings own production and the production of environment, will promote the sustainable development. This coordination needs concrete operation which requires appropriate theory, rule, measures and technique to be guided.

3.1.3 Summary of the Definition of Circular Economy

In conclusion, Circular Economy is a new economic pattern which emphasizes the ecological protection while raising the economic efficiency. It also conforms to the thought of sustainable development. Three Rs principle is its core contents. Its key characteristics are a high efficiency of production, a maximization of resources utilization and a minimization of pollution. Based on above knowledge, an ideal circular industry and circular agriculture can be illustrated by figure 3.4 and figure 3.5 respectively.



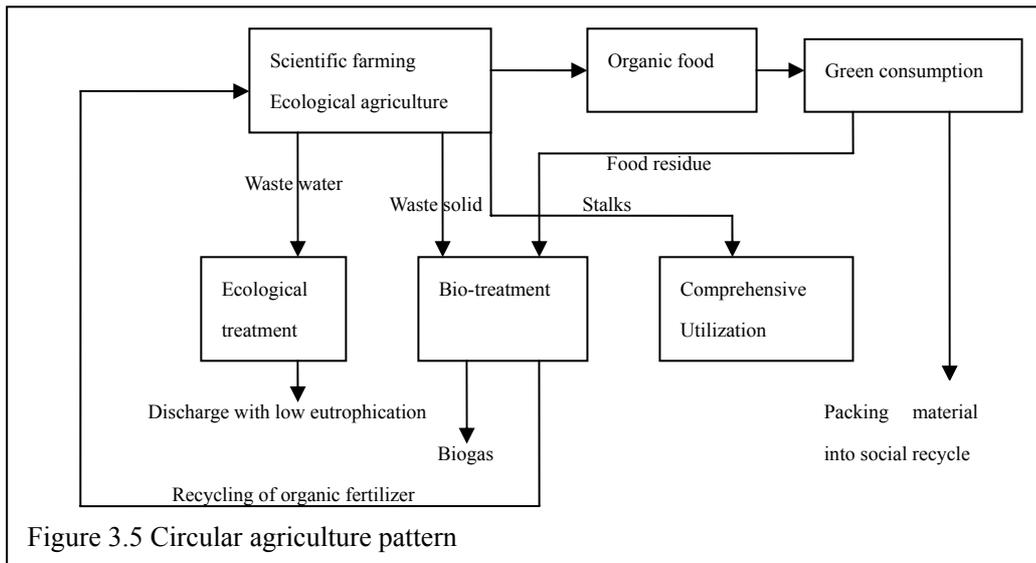


Figure 3.5 Circular agriculture pattern

3.2 The Theories of Microeconomics

3.2.1 Market Failure

Market failure has three main reasons, type of structure (monopoly), public goods problem, and externality. Monopoly occurs when there is only one supplier supplying goods and it can stop other competitors' entry into the market. So the equilibrium price will be high and equilibrium quantity will be low comparing to perfect market. For the second reason, it is difficult to get return from the investment of public goods. There is no incentive for market to provide public goods. The pure public goods have two characteristics, non-excludable and non-rival. Non-excludable means that one person can't prevent another from consuming resource. Non-rival means that when a good is consumed by one person it does not diminish the amount of the good consumed by another person. Normally private sector will be reluctant to supply public goods. So it can only be provided by government (public). The third reason is about externality. Externality exists when production and consumption of one economic unit will influence the welfare of others positively or negatively. The goods with the characters of externality are always unpriced or underestimated of its value. Usually externality can not be solved by market mechanism. When you grow some flowers in your garden your neighbor can enjoy it without payment. That is the positive externality for your neighbor. If you turn on your radio so loudly that

your neighbor gets bothered, that is the negative externality for him (her). For the goods with externality are unpriced so the “invisible hand “of market will fail to adjust it.

3.2.2 The Coase Theorem

Coase has not made a very clear definition of his theorem. According to the Microeconomics (2nd edn) (Hugh Gravelle, Ray Rees, 1992),”bargaining can achieve an efficient allocation of resources whatever the initial assignment of property rights “. The implication behind it is that the parties affected by negative externality can contact with each other and contract with producer. If the bargaining cost is at zero price the externality will be internalized by market without intervention. But this contract is difficult to make in big size of affected parties due to free rider problem. If it fails then the party who has the legal power to control the level of pollution will enforce the “bargaining “.That is one explanation for government to control the externality of environment in society.

3.2.3 Pigouian tax

“If the parties can not internalize the externality via Coasian bargaining it may be possible to mitigate the inefficiency by government action. A. C. Pigou suggested that externalities could be internalized by a suitable set of taxes or subsidies.”(Gravelle, 1992)

3.2.4 The theory of the second best

“The theory of the second best concerns government policy formation in an economy in which there is market failure” (Gravelle, 1992). There is a long debate since 1940s concerning the functions of government and market. When there is no market failure the (first best) Pareto efficiency conditions can be achieved through the “invisible hand “. But under some circumstances when the first best is unreachable political authorities in an economy will be the second best choice to rectify the departure.

3.2.5 Government Failure

Government could be the second best in an economy but it would be a failure. There are two reasons for explanation, non-altruism and information cost. Non-altruism means the politician, bureaucrats who make the policy or exercise the power of government may have a sense of their own interest. The information needed to make a suitable policy is widely dispersed among the citizens in society. It is costly to collect them to make the policy perfect.

3.3 The Theory of Environmental Economics

“Environmental economics has at last come into its own, some twenty years perhaps since the main writing has served as its foundation. Its essence lies in a sequence of logical steps : assessing the economic importance of environmental degradation ; looking for the economic causes of degradation and designing economic incentives to slow, halt and reverse that degradation “(Turner ,Pearce and Bateman 1994) The main thoughts of environmental economics is to take the physical environment into the classical economic calculus. The cost will include the “social cost”. The non-priced environment will be valued.

3.3.1 The Big Economy

For a long time after the economics came into the world we just talk about money, profit. But from another perspective the economy is an interaction and exchange of material between the economic activities and nature. The nature supplies a lot of natural resources as the raw material of production and at the same time assimilates all the waste caused by production and consumption. Due to the market failure the environmental goods are underestimated or ignored. When the economy develops to big enough human being has to confront the bigger degradation of our living environment. So when we talk about profit the cost will not only comes from internal but also from external. The big economy encompasses economy, society and environment. When all of them are taken into consideration can the human society move forward in a harmonious way.

3.3.2 Limits to Growth

When GDP becomes bigger and bigger, a question will be put forward. Are there any limits to the economic growth? It is accepted by many environmentalists as the reason why growth has to stop. The most dominant expression of this view is in the limits to Growth, a book by 'the Club of Rome' published in 1972 (R. Kerry Turner, 1994). The limits cause from two aspects, waste receiving and resource availability. **The waste receiving limit to growth** means that when economy becomes bigger and bigger the waste emission will be beyond the assimilation capacity of nature. The natural resources can be divided into two types, renewable and exhaustible. For the renewable resources there is speed limitation of exploitation. For the exhaustible resources the quantity in the world is limited. That is the reason for **resources availability limit to growth**.

There are many critics of the limits to growth. Some of the reasons are as follows:

- Technical progressions enable us to make full use of natural material. This ability will increase over time and makes the available resources last longer.
- More and more resources will be exploited around the world.
- We can recycle the material to reduce the amount of waste entering the environment.
- The market mechanism will work to conserve the limited resources or find substitution for it.

3.3.3 Sustainable Development

The most publicized definition of sustainable development (SD) is that from the world Commission on Environment and Development (WCED) (the 'Brundland Commission', 1987). The Commission defined SD as: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987, p. 43).

3.3.4 Polluter Pays Principle (PPP)

PPP is a basic economic principle for environmental policy-making adopted in

1972 by the OECD and the EU. "The basic tenet of PPP is that the price of a good or service should fully reflect its total cost of production, including the cost of all the resources used "(Turner, 1994)

3.4 Perspectives from the Green Economics

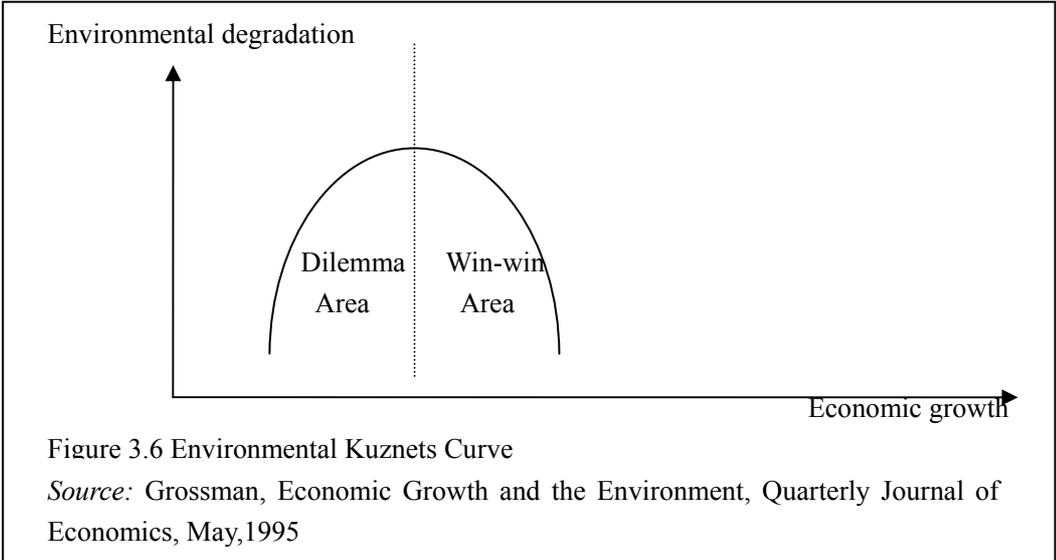
The green economy (Michael Jacobs, 1990) covers two strands of thoughts: the academic discipline of environmental economics and the ideology of green movement. If environmental economics simply incorporates the environmental cost into the economy the Green Economics sees the environment problem from different perspective. It puts the environment into the surrounding of political, social and ethic mix. In Greens' eye the economic growth is the consumption of environment. It does not exclude the economic ways to deal with environment. But more attentions are focused on the "Green "idea. Just as the idea is embodied in many Green parties emerged around the world. According to the first law of thermodynamics the resources and wastes are ultimately the same quantities." So for any given unit of environmental output there are two possibilities for raising efficiency: reducing depletion of the original resource, and reducing pollution caused by its consequent waste."(Jacobs, 1990)

3.5 Environmental Kuznets Curve (EKC)

In 1955, Simon Kuznets discovered the inverse U distribution law when analyzing the relation between difference of economic growth and average income. The inverse distribution was called as Kuznets curve. In 1992, Grossman and Kureger applied this curve in the environmental economy and concluded environmental Kuznets Curve which tells the relation between the environmental quality and average income per capita. Figure 3.6 shows the EKC. In the beginning, environmental quality is negative regressive with economic development (dilemma area). When the economic development reaches a certain level, there is a benign turning point after which environmental quality will be positive regressive (win-win area) (Zhang, 2004).

According to Chen Huawen (2004), there are following conclusions: On the whole, economic development finally leads to the improvement of environmental quality and solving the environmental problems needs economic growth in itself; In addition, there is no evidence that the process that economic growth will improve environmental quality will happen automatically. If environmental degradation exceeds the ecological utmost, environmental will be irreversible; Negative regression between income growth and environmental degradation will be fulfilled by policy response. EKC is a dynamic and changing process with economic, technical and political conditions. This curve will not be the pretext for “prior pollution and treatment later” and needs policies to prevent the KEC from exceeding the ecological threshold.

There is a critical view about the EKC curve which emphasizes that this curve was concluded from the old development pattern and new development pattern will change the operation law. This argument is reasonable. However, we also think EKC curve will still work before Circular Economy is established completely. So we use this curve to analyze Swedish and Chinese situation. Furthermore, our objective is to change the operation law of EKC curve and make the turning point come earlier by the overall implementation of Circular Economy.



3.6 New Public Management Theory

3.6.1. Introduction

New public management (NMP) bases on modern economy theory and private department management theory. The whole theory spreads with the hypothesis of rational person and the theory of Public Choice. NMP emphasizes improvement of administrative efficiency by enforcing entrepreneurial management model and the change of government orientation from administrative management (emphasis of regulation) to government governance (emphasis of market) (Zhu H., 2001).

3.6.2 Two Opinions Concerning Circular Economy

3.6.2.1 Selection and Creation of Tools for Government Governance

In the traditional model of public administration, the government action is regarded as unilateral obligatory intention through which shows the government's power. Coercive tools were selected. NPM prefers better government governance and puts forward many efficient new tools such as traditional tools (single tool), creative tools (market measures) and pioneer tools (combination of different tools) (Zhu P., 2003).

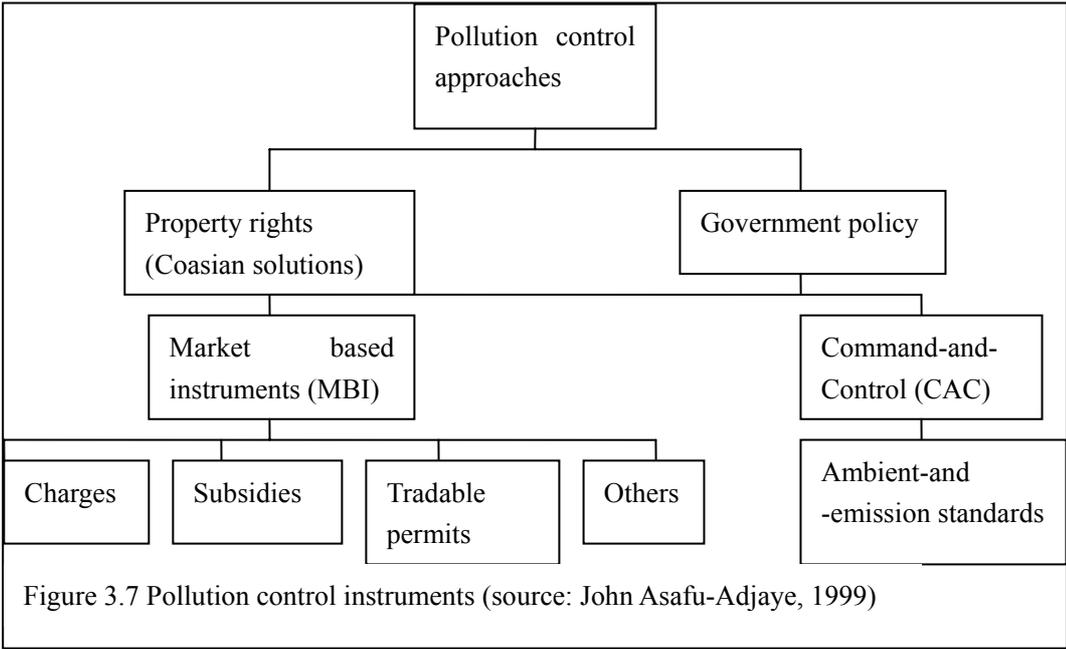
3.6.2.2 Market Failure and Government Failure

In the development of capitalism market, embarrassing situations often emerge when both market and government fail. NPM puts a lot of efforts to handle with this situation. According to the practice in developed countries, market measure or regulation measure has its separate limitation. NPM points out two ways to overcome government failure. One is to re-orientation of government role; the other is to import the third kind force which will participate in the distribution of public products and social wealth. (Xie X., 2004)

3.7 Why should Government Take Part in the Circular Economy?

The core content of Circular Economy is to reduce the environment pollution to minimization. Usually the economists will category the environment goods into

public goods. And environment pollution is good illustration of negative externality. Market mechanism does not work to supply the goods of environmental protection and overcome the negative externality of environment pollution. According to the theory of the second best the government can take the responsibility to fulfill it. Always the environment pollution is a big issue concerning with community, country and even the world. It is difficult to reach a Coasian bargaining to find a solution. Only when the property rights are settled down could the Coasian solutions be effective. Government will be the optimal body to take care of the responsibility of clarifying the property rights. There is a generation of pollution control instruments (see figure 3.7) in the book *environmental Economics for Non –economists* (John Asafu-Adjye ,1999).



From the above graphics we can see all the measure can be integrated into two categories, economic measures and government policy. Also the social balance mechanism is helpful in consumption sectors and nature conservation. We can find the shadow of government in voluntary organization and education program. We are not afraid to say the government should play a very important role in pollution control and the government has cast light on every aspect of

environment. A low emission and environmental protection is a main goal of a Circular Economy.

3.8 The Types of Government Intervention

Deng Zhiming (2002) listed three kinds of government intervention: state regulation, economic instruments and social balance mechanism.

3.8.1 State Regulation

State regulation means that different levels of governments or authoritative organizations use traditional command and control measures, often through obtaining coercive power by legislation, to manage resource and protect environment. There are three features with state regulation. First pollution cost from polluters is internalized by state coercive measures. Second, state regulation can protect the precision of environmental management. Third state regulation can promote fairness. Its shortcoming is high enforcing cost and imperfect effects. So some economists call it diseconomy measure. The main types of it include standard and technical control, control of total emission amount of pollutants, polluter-pays system and environmental impact appraisal system etc.

3.8.2 Economic Instruments

Governments carry through some measures to allocate natural resource and protect environment according to market mechanism in order to overcome the diseconomy of state regulation. These measures are called economic instruments. Its feature is low cost management and high efficient allocation of environmental resource. The main types of Economic instruments include tradable permits, environment tax, and subsidy or grant etc.

3.8.3 Social Balance Mechanism

To offset the limitations of state regulation and economic instruments, or the so-called market and government failure, people create a social balance mechanism which guides and normalizes polluters' action by emphasizing

altruism and public awareness. The social balance mechanism promoted by government support such as propaganda and education is one part of intervention.

3.9 Framework of Government Intervention and Proposals on the Action Law

According to the above theoretical review, it is possible to summarize the preliminary framework of government intervention (figure 3.8) and to build several proposals. The following eight proposals we put forward are the most important for the action law of government intervention on Circular Economy:

Figure 3.8 the preliminary framework of government intervention

Economic Instruments	State Regulation	Social Balance Mechanism
Permit and Permit Transaction	Control of Emission standard of pollutants.	Cleaner Production
Environment taxes	Total Amount Control of Emission of Pollutants	ISO14000 Certification
Subsidy	The-Polluters-pay principle And polluters-treat-principle	Environmental Label Products
Grant	Environmental Impact Appraisal System	Claims for the Losses of Environment Rights, Education promotion
Green fund or bail	Plan control	Mass Media Promotion

3.9.1 State regulation is the foundation and legal protection for the promotion of Circular Economy.

3.9.2 Economic instruments are the best way to allocate natural and environmental resources with high efficiency.

3.9.3 If economic instruments want to play its full role, they must be under the protection and support of state regulation. Most of economic instruments include the contents related to state regulation.

3.9.4 In order to reduce enforcing cost and play its full role, state regulation needs corresponding economic instruments.

3.9.5 There is a possibility that both state regulation and economic instruments are in failure under which social balance mechanism will play its foundational role in building Circular Economy.

3.9.6 In each level and aspect of Circular Economy, government intervention will play its best role by the integration of three measures.

3.9.7 Compared with developed countries, state regulation in developing countries receives more attention due to an immature market economy.

3.9.8 China should build and improve social balance mechanism by emphasizing environmental education and propaganda, cultivating more green groups, and expanding media freedom and civil rights.

3.10 Summary

Many theories are discussing the concept of circular economy. Different scholars have different views on it. In our dissertation all the theories are classified into four categories: Microeconomics; Environmental Economics; Green Economics and New Public Administrative Management. Developing a circular economy is not only a economic problem but also a environmental problem. It is also a new task for government to set the direction and fulfill it. We have drawn a model which is dominant in modern literature. Eight proposals are put forward to strengthen the model. The prospective model is based on the framework and

these eight proposals. All of the proposals will be supported by the cases analyses in Sweden and China.

Chapter 4: Analysis on Swedish Cases

In chapter four the overall analyses of four Swedish cases on government intervention in developing Circular Economy are made. Finally the framework of Swedish government intervention is summed up and six proposals are provided.

The promotion of circular economy is a systematic project. Different kinds of factors are supposed to concert a practice. Tradable permits and environmental tax are two important economic instruments used to fulfill the target of circular economy. They have been widely used in developed countries. Sweden was the first country in the world to adopt green tax (environmental tax). In this chapter we will study the applications of them in Sweden. In order to illustrate a concerted function of government intervention we also take the Kristianstad Community as a case study. Kristianstad is a major city of Skane and the industrial and residential hub of northeast Skane in Sweden. About 75 000 people live in the city. This region has some of the best agricultural land in Europe. It is a major food centre of Sweden. Kristianstad has fulfilled its preliminary goal to be a model city of sustainable development in the field of environment and resources thanks to the long-term implementation of a sustainable development strategy. Its main characteristics include: in the area of enterprises and industry, cleaner production has been promoted as obligatory for thirty years; regionally and nationally, the 3Rs principle has been implemented; a complete and wholesome environmental and resource law system has been set up; in the sphere of consumption, green consumption has been the main trend; the comprehensive decision-making system has been established concerning the coordinated development of economy, society, environment. So analysing the Kristianstad case will be helpful to conclude what the impact of government intervention is on the Circular Economy and what the role model is. We will focus on waste

management and the C4 Energy Company in Kristianstad.

4.1 Tradable Permits and Green Certificate System in Sweden

4.1.1 Tradable Permits

Tradable permits are relatively new market-based instruments for the control of environmental pollution and the conservation of natural resources (Turner, 1994). Tradable permits were first introduced in the U.S. in 1977 as part of the Clean Air Act. Crocker (1966) and Dales (1968) independently developed the idea of using transferable discharge permits to allocate the pollution-control burden among sources. Montgomery (1972) provided the first rigorous proof that such a system could provide a cost-effective policy instrument. This instrument is a good illustration of the Coasian Theorem. When the pollution is clarified with property rights, the tradable permits can be efficiently allocated to achieve Pareto optimization. This market can be analyzed as follows: the optimum level Q_s is set by the environmental agency. We can take this vertical line as the supply curve. The marginal abate cost (MAC) can be seen as the demand curve for permits in that it tells us how much it will cost the firm to abate the last unit of pollution. Then the market for permits will establish an equilibrium price (P_1) which will result in the appropriate level of pollution abatement (Q_p).

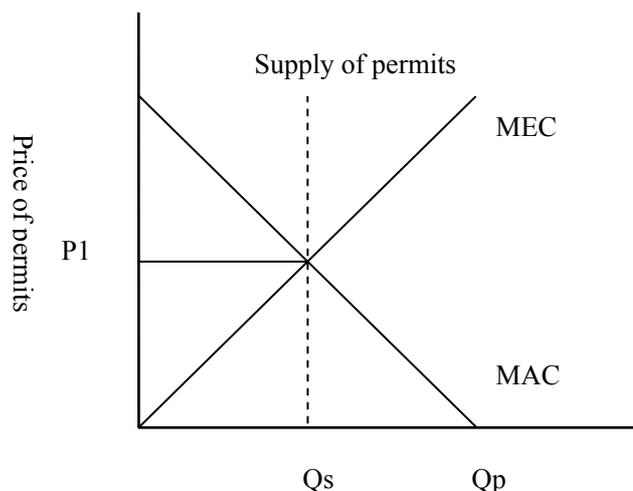


Figure 4.1 Level of emissions and number of permits
(source: John Asafu-Adjaye, 1999)

The basic principle of tradable permits is that those firms which can achieve a lower level of pollution can benefit by selling permits to those firms which at

present find it either too difficult or too expensive to meet the standard set (Stephen Ison, Stephen Peake and Stuart Wall, 2002).

4.1.1.1 The Advantages and Disadvantages of Tradable Permits

Advantages of Tradable Permits:

Efficiency. The environmental agency can set a variable standard to control pollution. And if it wants to tighten the control it can buy permits from the market. It is convenient to adjust to meet the change situations. Through the trading of permits the polluters can achieve the lowest-cost way to abate the emission. So this approach is a cost-effective instrument.

Macro-control. This instrument gives the government a macro-control of pollutant volume. The agency is flexible to adjust the price of permits by market intervention. The cost of making the standard of emission will be reduced.

Flexibility. The tradable permits give the polluters who have difficulty abating the emission more choice. Some owners can buy emission permits instead of making technical improvement. The others who have potential capacity to reduce pollution are stimulated to improve their performance by selling permits.

Acceptability. Any new form of tax, such as green tax, faces difficulties in terms of acceptability. By using tradable permits, however, a new property rights is issued which has a market value. It is also easier for political acceptance.

Disadvantages of Tradable Permits:

- It is possibly manipulated by some big companies which have obtained many permits in order to use these tradable permits as “a barrier to entry” for new entrants;
- The administrative cost will be expensive if there are a large number of polluters. The work of supervision and measurement are supposed to be

excessive;

- The tradable permits system is criticized on ethical grounds for that the polluters are entitled to pollute.

4.1.1.2 The Operation of Tradable Permits

A new approach is usually guaranteed by law. So a specific legislation or regulation should be put into force before setting up a permits market. Some technique factors concerning with calculation of environmental capacity, supervision of emission, and administration of permits issue should be take into consideration. The original allocation of permits is fairly important for the start of future operation.

A tradable permits system operates in three stages:

- The government determines the socially acceptable level of aggregate emissions in a given region;
- A fixed number of permits are then issued using grandfathering or bidding system. For example, if 150 units of emissions were acceptable in the region, then 150 one-unit permits would be issued;
- The government establishes a market for permits within the region, which is then allowed to determine the permit price. (John Asafu-Adjaye, 2000)

How to allocate the initial permits? One popular approach is grandfathering where rights to pollute are based on past emission. This is more flexible for politicians and polluters who have no previous obligation to accept. The other way is a bidding system where all the producers have same starting point. They have to bid for the price they are willing to pay for permission to emit a specific quantity of pollutant.

4.1.1.3 Tradable CO₂-emission Permits in the EU

The green house effect is drawing a great attention of citizens on earth. The

climate problem concerns every country. In 1997 nearly 160 countries met in Kyoto, Japan, to discuss the binding limitations of green house gas (GHG) emission. The outcome of the meeting was the Kyoto Protocol. The EU is the biggest GHG emission party. So when the Kyoto Protocol came into effect the European Union (EU) commenced the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) in January 2005. The scheme is based on Directive 2003/87/EC, which came into force on 25 October 2003.

The aim of this Scheme is a common greenhouse gas reduction of 8% by the years 2008-12 compared with 1990. According to the agreed burden shared within the EU this overall EU-target is converted into national GHG-targets for each of the member states. Undoubtedly, the EU commission has to coordinate the countries to fulfill the aim in a cost-efficient way. According to the 1990's base, Denmark and Germany have to carry a 21% reduction while some other countries have a positive figure. So, how to trade off the benefits among the member countries is a question. What are the most acceptable strategies for a country's specific actions to comply with their Kyoto commitments?

Of course, this does not rule out the possibilities and relevance of the use of Eu-co-ordinated policies. An example of such a policy is the EU-directive on the promotion of renewable energy technologies (European Commission, 2000), including a proposal on the share of renewable in the individual member states in 2010, based on the percentage of each country's consumption of electricity. Thus the directive signals the need to include renewable energy technologies as one of the serious options in achieving the targets for GHG-reductions. (P.E. Morthorst, 2003)

The framework instructions above-mentioned have not pointed out the efficient instruments to reach these targets. When the experience of tradable permits in the US and some other countries comes to maturity, a relevant solution is to establish

an EU-market for Tradable CO₂-emission Permits (TEP). Over the past few years green certificate markets (discussed later) have gained a lot of interests in Europe, among several countries Sweden, Denmark, Italy, Belgium, England and Austria. All these experiences facilitate the scheme of directive proposal for a common EU emission (European Commission,2001).The main idea of such a scheme is to ensure that CO₂ reductions in the power and other selected industries are undertaken in the most cost-efficient manner ,that is in those countries with the highest reduction potentials and the lowest costs. In this way the tradable permits (TEPs) will help ensuring that the EU member countries achieve the Kyoto greenhouse gas reduction as cheap as possible. (P.E. Mort horst, 2003)

4.1.1.4 The Practice of Tradable CO₂-Emission Permits in Sweden

As an EU member state, Sweden has commenced the implementation of the EU emission trading directive and launched the trading scheme by 1st of January 2005. Sweden does not have a big challenge of CO₂ reductions. According to the Kyoto Protocol, there is a task for 4% reduction on the base of 1990. But if the development is taken into consideration Sweden has to plan a bigger ambition level. The most important thing is how to allocate the initial quotas. The introduction of an emission law is a long process. A set of effective and efficient institutions are setting up for monitoring and reporting of emission. The Swedish National Allocation Plan (NAP) was approved by the EU-commission in July 2004. In short, the Swedish NAP can be summarized as follows:

- Over 600 installations are covered by the scheme. Most of them are combustion installations in the energy sector. The dominant emission resources are however steel, cement and mineral oil refineries.
- The trading sector stands for approximately 30% of the total Swedish greenhouse gas emissions.
- Small boilers under 20 MW in district heating systems are unilaterally included.
- In average 22.9 Mton of CO₂ will be allocated each year during the period

2005-2007. To compare, in 2002 the emissions were 21.4Mton.

- The allocation for existing installations will be based on the average emissions during the years 1998-2001.
- The energy sector carries a relatively higher burden compared to industry. The allocation to the energy sector is multiplied with a factor 0.8. Industries receive an additional allocation based on future emissions from certain industrial processes.
- A reserve of 0.8 Mton per year is created for new entrants. The allocation is based on future production levels. Benchmarks are used for combustion installations (Truls Borgström, 2004).

4.1.1.5 Conclusions of Tradable Permits Practice in EU and Sweden

All the work is just on takeoff. The effective data and analyses are still not available. A new instrument will bring a lot of changes to the time-being operations. The tradable permits are market-based instruments and have been approved of a cost-efficient way to reach the Kyoto target within a nation or on an international market. But one thing is sure that tradable permits are the best precedent approaches to coordinate the 25 member states in the EU with different level of development. For a specific state, Sweden, the changes will take place on legislation, technology innovation, consumption of relevant price and many uncertainty areas. The tradable permits practice will be proved to be the most cost-efficient way of cost reduction in reaching the Kyoto targets. Comparing to command and control policy tradable permits are more comfortable to be accepted by the relative parties.

4.1.2 The Tradable Green Certificate System in Sweden

4.1.2.1 Introduction

One important character of Circular Economy is the efficient use of energy. From the law of the thermodynamics we infer that the material will become lower energy and higher entropy as it proceeds in the circle of economy. All kinds of

energy on earth will become heating and are diffused to outside universe. So the efficient using of energy and developing renewable energy is a paramount content of Circular Economy. In this part we take an insight into the energy sector in Sweden.

4.1.2.2 The background of introduction to the tradable green certificate

At present three issues are in particular focus in the European energy discussions: the liberalization of the electricity and gas market, the reduction of CO₂ emission from the energy sector, and the foreseen increasing dependence on imported energy. The White paper on renewable energy within the European Union (EU) sets as a target to increase the share of renewable energy from the present 6% to 12% (22% for electricity supply) by 2010. (Thomas Unger, Erik O. Ahlgren, 2004) Consequently all the member states have proposed to adopt the renewable energy. To boost the renewable electricity several countries have chosen to implement the market-based schemes through tradable green certificates (TGCs). Among them Swedish system is already operating on a national level since May 1, 2003. The original Swedish proposal expressed a wish to merge the Swedish TGC system into an extended Nordic system. (Swedish government, 2001)

4.1.2.3 The Operation of Tradable Green Certificate Market

Presently almost no renewable energy technologies on their own can economically compete with conventional energy producing ones. So the idea of the TGC approach is to use the market forces to determine the additional payments to the investors of renewable energy. (P.E Mortorst, 2000) The incomes of renewable energy industry include two parts: the ordinary price as the conventional power in spot market and additional revenue of selling the green certification. The two parts will be traded at two separated markets and thus the green certificate market in principle is completely separated from the physical electricity market. The end consumers are obligated to have a share of “green power” in their electricity consumption. Usually this obligation will be finished

by big power trading supplier on their behalf. All renewable energy technologies are certified for producing green electricity. The owners can obtain a green certification per unit of produced electricity (per MWh). And if consumers can not meet the obligation they will be penalized by Energy Authority. In the Swedish electricity certificate system, the penalty is the quota obligation fee. If the quota-obligated parties do not fulfill their obligations by 31st March each year; they must pay a penalty charge to state. The penalty is set at 150 % of the volume-weighted average price of certificates over the period from 1st April to 31st March. During 2003 and 2004, the charge was capped at SEK 175 and SEK 240 respectively. Preliminary results for 2003 show that only 77 % of the quota was met, which means revenues amounting to roughly SEK 181 million were received by the state from the penalties - money which, at the same time, failed to remain in the electricity certificate system.

In Sweden the electricity and energy sources eligible for certification are: wind power ;solar energy ;geothermal ;some of the biomass ;some wave power; hydro power under 1500MW ; hydro power that have not been in operations until after 1st of July 2001; increased hydro power capacity decided after 1st of July 2002; hydro power put into operation after 2002.

Figure 4.2 Data of share of TGC obligations of consumers

Year	2003	2004	2005	2006	2007	2008	2009	2010
Share	6.4%	7.6%	9.5%	11.4%	12.8%	13.9%	14.6%	15.3%

4.1.2.4 The Appraisal of Tradable Green Certificate Practice

The Government has instructed the Swedish Energy Agency to review the performance of the country's electricity certificate system (N2003/9037/ESB). The overall purpose of the review is to evaluate the performance and effects of the electricity certificate system, and to consider the potential for raising the

system's ambition level.

4.1.2.5 The National Energy Agency's conclusions and recommendations

The Agency feels that there is a risk that the target of 10 TWh of new renewable electricity production by 2010 will not be achieved unless the system is made permanent, and long-term quota obligations are set.

There are good prospects for achieving the other underlying objectives of the certificate system.

However, the Agency feels that the electricity certificate system does not provide sufficient support for technical developments or market introduction of as yet unestablished or uncommon technologies. We wish to emphasize the importance of continuation of parallel efforts in research and technical development for renewable electricity production technologies.

There have not been any larger new investments in renewable electricity production as a result of the first year's operation of the certificate system. However, as the system has been in operation only for a year, this should not be seen as a problem, although the willingness of parties to invest has been affected by uncertainty concerning continuation of the system after 2010.

In practical terms, the system has operated essentially well. Less successful points have been mostly teething troubles, and have been dealt with.

4.1.2.6 The Conclusion of Tradable Permits and Green Certification in

Sweden

From the above appraisals we are confident in the performance to achieve the setting goals. The share of renewable energy in the whole energy structure keeps on rising after adopting the TGC approach. The report from the Swedish Energy Agency: "In practice, the electricity certificate system has worked satisfactorily". The cost of electricity certificates makes up for only a small part of the total cost of electricity." "The economy of existing plants is good."

But still there are some unsatisfactory comments such as: “The certificate system does not provide sufficient support for technical development.” “No large investments in new renewable production capacity.”

As a market-based instrument it becomes mature and is expected to form an international market in future energy industry. Comparing with command and control policy the tradable green certificate system is a more cost-efficient way to stimulate the renewable energy development.

4.2 Environmental Tax and Swedish Practice

4.2.1 General Information

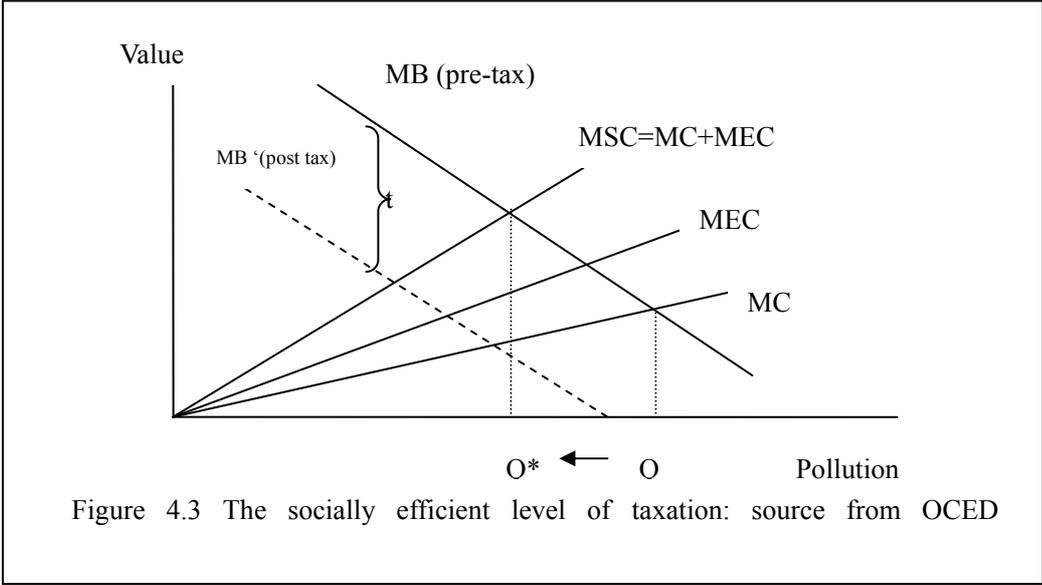
Environmental tax is defined as any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance. Taxes are unrequited in the sense that benefits provided by the government to taxpayers are not normally in proportion to their payments. (OECD Environmental Report 2005)

Its main goal is to introduce incentives to reduce polluting activity and waste, to slow resource depletion, or to meet other objectives (i.e. environmental and fiscal). Correspondingly there are different mechanisms for deciding the rate of the environmentally related tax.

Its theories are based on natural capital theory and externality theory of public products. Natural environment and resources are some kinds of asset like other production factors. Any production units wanting to share the service of environment and resource have to pay the price. The practice proves that no price for them will easily cause actions of environment disruption and resources misuse. (Lei Xinhua, 2002)

Externalities exist due to the public goods nature of the environment. Figure 4.3 describes the economic model which explains externality and the role of

corrective environmental taxes. The Pigouvian solution to reduce pollution to the social optimum at Q^* is to introduce an indirect tax at rate t per unit of pollution. The introduction of the tax shifts the environmental resource scarcities and the costs of pollution. The socially optimal level of pollution is realized by internalising the environmental damage in the private market decision, with that damage captured by the environmental tax. (OECD Environmental Report 2005)



4.2.2 Basic Characteristics

4.2.2.1 One Kind of Economic Instrument

Economic instruments also produce incentives for industry to abate pollution and to restructure away from producing polluting products and from polluting production methods, thereby reducing pollution without “abating”.

Environmental tax is a policy instrument that can be used to ensure that some, if not all, of the externality costs, the costs to the environment, are internalised into the decision-making process. For example, in designing a policy to reduce carbon dioxide emissions a policymaker could either tax the emissions directly, thereby setting the price – but not the quantity – of the emissions, or he could issue or sell emission permits that set the quantity – but not the price – of pollution abatement. In practice, the quantity “guarantee” delivered by tradable emission permits is subject to the level of the penalties for non-compliance, and its detection.

Alternatively, energy-efficiency standards for industry, households, and transport could be enforced or industry could be encouraged to sign voluntary agreements with the government. (OECD Environmental Report 2005)

4.2.2.2 Fair and High Efficient Tax Type

Through the levying of environmental taxes, polluters will pay the price on one hand. On the other hand, taxes will produce great market force which promotes the enterprises and industrial fields to select appropriate pollution control techniques and engage in the research and development on new techniques for reducing pollution. Government can compensate the pollution victims by the revenue from environmental tax which shows the principle of fairness.

Environmental tax also reflects the principle of efficiency. In the modern economic system, this principle is confined within the sphere of keeping neutrality. More importantly, environmental taxes will intervene in economic and market activities, control and guide the rational allocation of resources and adjust to the relation of supply and demand. In addition, environmental taxes will correct the market failure in the allocation of environmental resources and take the place of other sources of income. (Lei Xinhua, 2002)

4.2.3 Tax Design Issues

In designing environmental taxes, it is necessary to minimize negative effects. Reasonable decisions on tax type, tax base and tax rate are extremely important. There are different mechanisms for deciding the rate of the environmental tax. A given tax is levied on one or several tax-bases, with varying tax rates. There are four kinds of tax-bases: the discharge amount of pollutants, output of polluting enterprises, poisonous substances contents in input factor, and production and techniques standard. What tax-bases should be selected depends on comprehensive consideration of environmental and economic consequences. For example, in the case of a “Tax on mineral oils”, separate tax rates could be

levied on the tax-bases “leaded petrol”, “unleaded petrol”, “diesel with normal sulphur content”, “diesel with low sulphur content”, etc.

The environmental tax rate is directly related to its adjustment depth on polluters. Tax rates could be chosen in order to seek to fully internalise the environmental costs of pollution. Externality evaluation using benefit-cost analysis supported the choice of tax rates for the 1996 UK landfill tax and also the planned tax rates on the UK extraction of aggregates from quarries [Pearce and Barbier (2000)]. Rates can be set to protect the fulfilment of an environmental tax target, e.g. Kyoto greenhouse gas targets. Alternatively rates could be chosen independently of environmental considerations, i.e. to raise the revenue.

In the long run, the marginal cost of pollution abatement will reduce with the rise of pollution prevention techniques. Thus the environmental tax will also adjust to the new situation and play its full role.

4.2.4 Environmental Tax in Sweden.

4.2.4.1 Outline

In the 1970s, Sweden levied energy tax on fossil fuels, which was the first environmentally related tax in Sweden. In 1988, Swedish parliament decided on more economic instruments in environmental policies. And in 1991 the environmental tax was carried into enforcement officially as well as the reform of the energy tax system. Carbon Dioxide Tax, Sulphur Tax, Nitrogen Oxide were introduced while the energy tax was reduced and diesel was levied by 50% energy tax. In 1994, Sweden adopted the environmental grade system for non-lead petrol and levied different annual vehicles tax rate. Other kinds of environmental taxes include electricity consumption and production taxes, vehicles sell tax, fertilizers tax, domestic aerial tax, insecticide tax, natural gravel tax etc. The total revenue from environmental taxes is about 3.2% of Swedish GDP. (Wang Jinnan, 1997)

4.2.4.2 Energy tax and Carbon tax

When the new taxation system was introduced industry was exempted from energy tax and had to pay only 50% of the general carbon tax level. In 1993 this fraction was reduced to 25%. In 1997 the fraction was once again raised to 50%. For energy intensive industries there are special rules that allow further reductions of the carbon tax. The total effect of the 1991 tax reform on industry was reduced tax levels, for some fuels by more than 50%. There is no energy or carbon tax on electricity production but non-industrial consumers have to pay a tax on electricity consumption tax. The current general carbon dioxide tax is 36.5 öre/kg CO₂/ (~USD 150/tonne C). The energy tax on fossil fuels, especially on petrol and also on other oil products, is rather high and is therefore, outside the industrial sector, a powerful complement to the carbon tax.

4.2.4.3 Environmental Effect

The most obvious effect of the reformed taxation system has been the expansion of biomass use in the district heating system. The levying of environmental tax efficiently raises the initiative of industrial circle. There have been some studies that have tried to quantify the impact on CO₂ emission of the policy instruments implemented in the beginning of the 1990s. For example, the Ministry of Environment shows in the second national report on climate change that the CO₂ emissions in 1995 were about 15% lower than they would have been if the policy instruments of 1990 had been in use. By the year 2000 the CO₂ emissions would have been 20-25% if the 1990 policy instrument package had been in use. Almost 90% of this reduction was the result of the reformed tax system, whereas the remaining 10% was a result of investment grants and official programmes on energy efficiency. After the enforcement of sulphur tax, the goal to reduce the emission of sulphur dioxide has been fulfilled several years earlier than expected. According to statistics, the emission amount of sulphur dioxide in 2000 was reduced by 50% compared to that in 1990.

4.2.4.5 The Main Obstacles to Implement Environmental Tax

Industrial competitiveness: a key issue that has confronted countries which have implemented the green tax reform is the possible loss of international competitiveness of some economic sectors. Income distribution concerns: taxes on production inputs are shifted onto higher prices, to lower wages, to lower rates of return on capital, or to lower resources prices.

4.2.5 Conclusion

The theory and practice of environment has proved that the environmental tax is a more efficient economic measure. The combination between the environmental tax and regulation or voluntary agreements could provide added flexibility, environmental certainty and reduced costs.

Environmental tax is carried out with regulation. In Swedish waste management, governments levy a waste garbage tax and have regulations on waste discharge and disposal. In energy, Swedish government sets relatively low rates in energy/carbon taxes, supplemented with regulation on energy efficiency requirements sector-wide best available technology. In local areas, the governments combine taxation with regulations on sulphur contents in fuels and technical standards for power stations.

Voluntary approaches are favoured by industry for the flexibility they embody and as a means to avoid other regulation or tax. Some counties have combined negotiated agreements concerning energy efficiency with either carbon or energy taxes. In Sweden, the energy tax and carbon tax have combined with domestic carbon-equivalent emissions trading with the guidance of EU.

4.3 Waste Management in Kristianstad

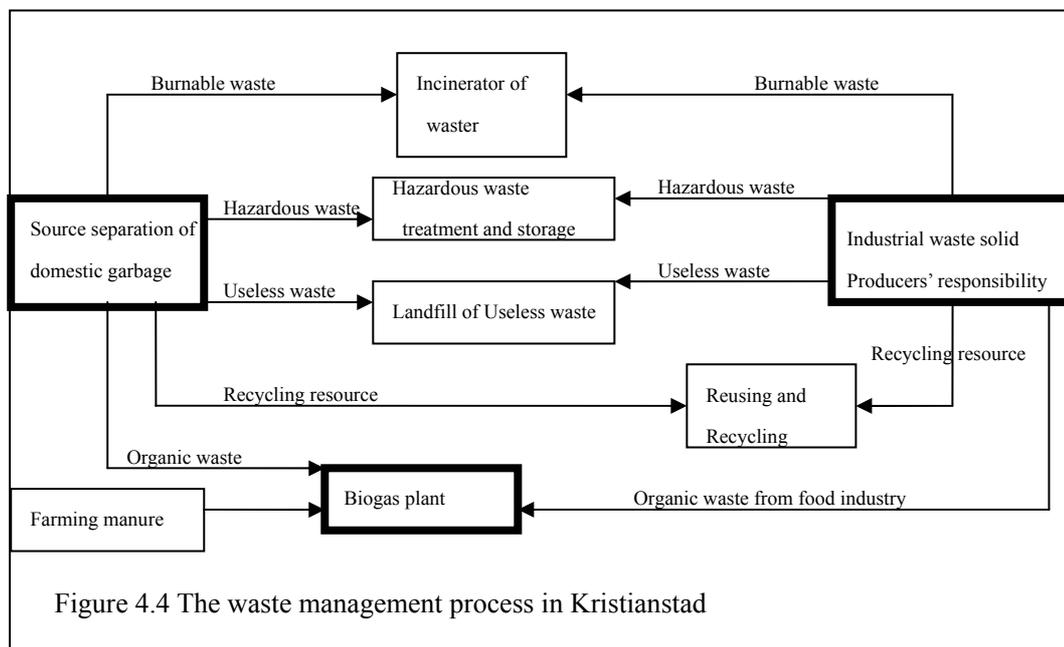
Waste management process is shown in figure 4.4. Here we concentrate on four aspects: general information, source-separation of domestic garbage, producers'

responsibility and Karpalund bio-gas plant.

4.3.1 General Information about Waste Management

4.3.1.1 Basic Principle

Kristianstad has carried out following four principles: Minimization of the quantity of waste solid produced; Reusing and recycling of waste resource as much as possible; Promoting the harmless and sound treatment of waste; Improving the collection method of waste solid and sanitation conditions.



4.3.1.2 Main Classification and Treatment Methods

Waste solid is classified into ten types: domestic garbage, garden garbage, construction garbage, waste from electric power plants, garbage from industrial waste water treatment plants, waste from the ore industry, special waste from industry, non-special waste and special refuse such as oil, organic solvent etc.

There are five different methods to treat above waste:

1. The recycling waste such as newspaper, metal, glass and wood etc. will be sorted and collected separately, and then sold to professional company for

recycling;

2. Organic waste such as organic garbage from household, farming manure and waste from food industry will be digested for producing biogas;
3. Burnable waste such as plastics, waste tire, fiber and leather etc will be incinerated in burning plant;
4. Special treatment waste such as discarded electric appliance and electronic equipment, and cars will be reclaimed in certain site.
5. Some recyclable material will be sent to a recycling company for further process and the hazardous waste will be sent to special treatment for safe storage; Non-usable waste such as residues from incineration, construction waste will be land filled with sanitation.

4.3.1.3 The Present Situation of Waste Management in Kristianstad

About 154 thousand tons of waste solid were produced in Kristianstad in 2004, among which 43, 000 tons of industrial material were recycled, 10, 000 tons of burnable waste were sent to the incineration plant, 7000 tons of garden garbage were composted, 41,000 tons of organic waste were digested for producing biogas, 38,000 tons of slag were used for construction material, 13,000 tons of non-usable waste were land-filled, and about 1080 tons of hazardous waste were sent to national treatment centres for safe storage. All waste solid has been treated in appropriate ways.

4.3.1.4 The Main Units for Waste Management

The municipal authority is responsible for the waste macro-management in the city. The municipal authority empowers Kristianstad Renhallnings AB, wholly owned by the municipality, to collect, assort, process and manage industrial, farming, and domestic waste. KRAB has three branches: karpalund biogas station, Snararp Recycling Park, and waste management department. Snararp Recycling Park is half owned by KRAB, another half by a private company. Two other units, the incineration plant in Hässleholm and the landfill plant in Hässleholm,

also engage in waste management.

4.3.1.5 New Trend for Waste Management

Material recycling and Biological treatment (Digestion) are on the rise. Incineration is stable in quantity whereas the quantity for Landfill is dramatically dropping. The feature for Circular Economy is becoming sharper.

4.3.2 Government Intervention in Waste Management

4.3.2.1 State Regulation

Swedish Environment Code and Swedish Waste Management Law regulate the important principles involving waste management. These principles includes: polluters-pay-money principle, source-separation principle, producers responsibility, 3Rs principle and special operation permit principle etc.

Permit Management

If any company wants to build a landfill plant, it must apply for a permit from the government. Permits are checked and approved by different levels of authority according to the scale of the planned plant. For a handling capacity being less than 50,000 tons, the company can apply to the municipal committee; if the scale is between 50,000 tons and 100,000 tons, it should apply to the county committee; and if the scale is over 100,000, it should apply to the national environmental court. The authorities will define business sphere, permissible handling capacity and operation time limits as well as the management after closing of landfill. The business for collecting and conveying waste also needs government permission. All companies who engage in waste business must offer statistics and annual reports to relative authorities. Temporary storage of waste before landfill or incineration needs permit.

Polluters-pay-fee Principle

The protection for the normal operation of waste companies lies in their stable

income. The source of their income comprises five parts: the domestic garbage fee is collected by the authority and the authority appropriates certain money to them according to the handling quantity; fee is charged for handling hazardous waste; fees are from hospitals and administrative units; fee is charged to industrial enterprises; fee is from producers' responsibility.

Empowerment Principle

The new environmental code as well as other regulations, defines the responsibility for different parties in waste management. The parliament empowers its government or relative authorities to draft detailed administrative regulations involving waste management. The municipal authority is also given the power to define the concrete management requirements.

4.3.2.2 Economic Instruments

The principles mentioned above are put forward based on a market economy mechanism. As for the producers' responsibility, producers can exercise their duty by themselves or delegate other professional companies to do it by paying certain fees. This can also happen to the polluters-pay-money principle. Meanwhile, many economic instruments are adopted to promote the management level. In addition, The municipal government has changed its role from overall management to macro-control and its concrete management has shifted to public companies. These companies have become the development centre for new management. Furthermore the company has the right to raise the charge rate except for domestic garbage fee if the service cost cannot meet the investment.

4.3.2.3 Social Balance Mechanism

The raise of Swedish waste management level contributes some part to its voluntary actions. The green groups launch many actions to raise the awareness of the masses. For example, there are 200,000 members in the Swedish natural protection association. Green groups publish their own newspapers and books,

independently investigate all kinds of environmental problems and monitor the emissions of industrial enterprises. Many Swedish companies appoint the leaders of green groups as their counselors to avoid conflicts. When the companies make their plans, environmental problems and waste management will be the inevitable contents.

4.3.3 Government Intervention in Source-separation of Domestic Garbage

Domestic garbage is assorted into four categories at households' source; Reusable waste directly such as newspaper, metal products and glass; Burnable waste such as fiber products, plastics packing material; Degradable organic waste such as kitchen waste and food waste; Hazardous waste such as waste batteries and electronic appliance.

4.3.3.1 State Regulation in Source-separation of Domestic Garbage

From early 1990s, Swedish Waste Management Law regulated that all municipalities should carry out the source-separation principle for domestic garbage within five years. In 1995, Kristianstad Municipality decided to implement the policy of source-separation. Now this principle has become a permanent system and the best obligatory standard for assortment, collection, treatment or recycling throughout Sweden. National code defines the basic requirement and the local government makes detailed regulation on operation for industry and household.

The source-separation defines the responsibilities for different parties:

The responsibility of residents: Turn in the garbage treatment fee per year, SEK 2000 per household. If a household does not pay in time, it will be confronted with charges and fined after twice written notice. The households have the duty to assort their garbage according to the requirements and put them in the appropriate and defined place.

The responsibility of municipal authority: Define the requirements on the collection, reusing, recycling and treatment of domestic garbage; Regulate definite rule and waste management plan, monitor the operation of source –separation and put forward counter-measures for solving present problems. The producers’ responsibility includes legal, physical and economic responsibility.

4.3.3.2 Economic Instruments

For smooth operation of source separation, many economic instruments are adopted to promote it such as the deposit system for return of metal containers and other economic stimulus mechanisms.

4.3.3.3 Social Balance Mechanism

When source separation was first carried out, Kristianstad organized many promotion and education activities. First, the authority popularised some information and basic knowledge about source separation. Second some lectures were organized by community schools to teach residents how to assort garbage. Third, all public schools opened the new labour class which taught students relative learning. Through these methods, source separation has become familiar to every citizen. With the rise of awareness, the assortment rate of domestic garbage has increased from 70% in 1995 to over 90% nowadays.

4.3.4 The Producers’ Responsibility

4.3.4.1 General Information

The strategic goal of this principle is to establish one circular economy in which today’s waste is transformed into reusable new resource.

4.3.4.2 The Content for Responsibility:

The responsibilities include: do not produce products whose process will pollute the environment, raise the rate of recycling and reusing, reduce the quantity of waste produced, take into account the waste treatment from whole life cycle.

4.3.4.3 Situation of Implementation

The achievement is evident. The implementation sphere has expanded from early packing materials to waste paper, waste tyres, waste cars, and waste electronic products. From 2002, office paper, agricultural plastics and waste batteries have been dealt with following the principle.

4.3.4.4 Implementation Units

Most enterprises have no ability to build a collection and reclamation system by themselves and so some special companies were built to carry out the principle. In 1986 a company for reclamation of glass was built in Sweden. In 1994, four packing reclamation groups were built for reclamation of plastics, paper, wood and metal. These five groups have covered the reuse and recycling for all packing materials. They also built a REPA company which act as the service unit for them. Producers apply for membership and turn in membership fees and reclamation fees, while REPA will execute their duty as producers' responsibility. As for Kristianstad, only 18% packing material is reclaimed by producers themselves, while the remainder 82% is executed by professional companies. After carrying out the principle, the pollution produced by original incineration and landfill is reduced sharply and consequently energy is substantially saved.

4.3.4.5 The Analysis of Government Intervention on the Implementation

State Regulation: Swedish parliament regulated the principle of producers' responsibility in 1994 which requires the producers to undertake relative responsibility involving the environment after the products are consumed ultimately. That means producers must reclaim their products or pay tax to the country after loss of use value. Meanwhile consumers have the duty to assort waste products and packing materials according to requirements and send them to the reclamation centre.

Economic Instruments: Economic instruments are active in this field. First producers have the right to select methods to execute their duty by themselves or deliver it to society and market. Producers have to pay the deposit to the relative government for further reclamation. If they do it, they can get the deposit back; if other professional companies do it, the relative government will transfer the deposit to the professional.

The business for reclamation is also competitive. Any companies, private or public, can apply for the business and participate in competition in their service, rate and reputation.

Social Balance Mechanism: The producers' responsibility is a product of voluntary actions and later also plays an important role in implementation. The masses and green groups have been monitoring the environmental action of producers and other concerning parties.

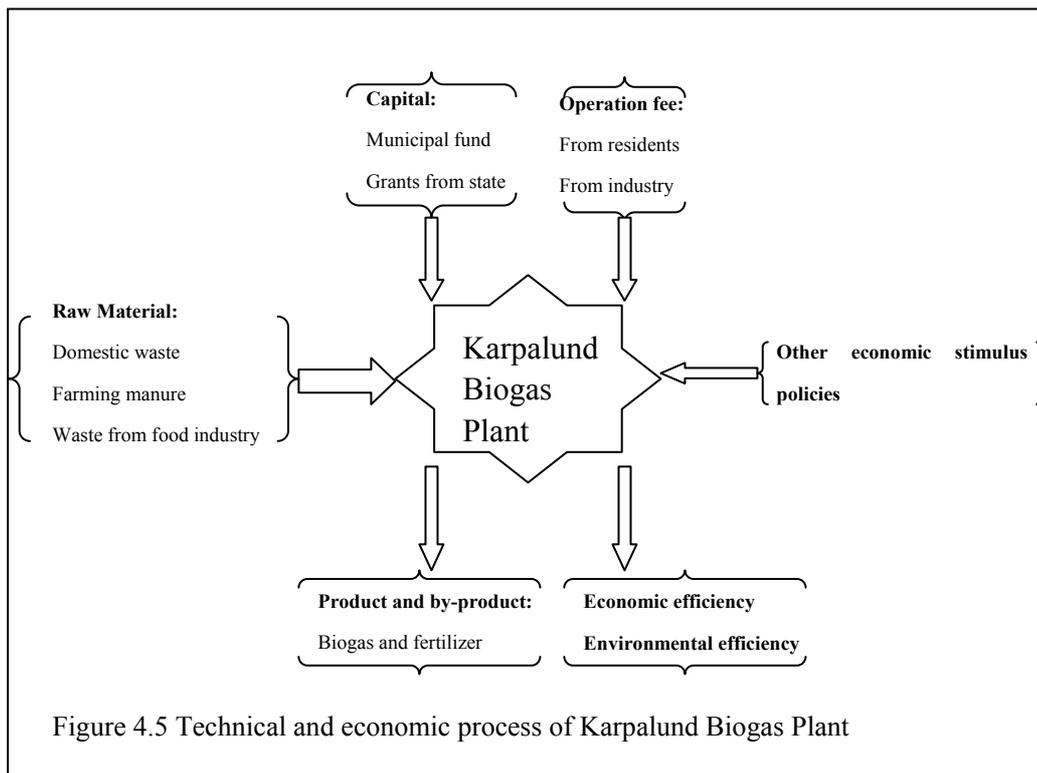
4.3.5 Karpalund Biogas Plant

4.3.5.1 General Information

Karpalund Biogas Plant, owned and operated by KRAB, was built in northwest suburbs of Kristianstad in 1997 as the first in Sweden to co-digest organic waste from households, food industry and manure from farming. It has experienced expansion or transformation twice. Now its capacity is 40 GWh. Its handling capacity is 150,000 tons of organic waste per year with an accumulative total investment of SEK 87 million. Its production technology is the mesophilic bio-digestion method. The plant is designed for automatic operation, monitoring and data collection. Only one full-time manager and one assistant oversee the operation.

4.3.5.2 Technical Process

Figure 4.5 shows the whole technical and economic process.



4.3.5.3 Why the Biogas?

Kristianstad has a good foundation for the plant. In 1995 Kristianstad introduced a waste system involving source-separation of household waste. Second, there is booming food industry which discharges much waste and if the food industry treats the waste within itself, the treating cost will be high. In addition, farming is flourishing and much waste manure is produced in the farming areas. So the plant is a product of co-operation between the municipality, farmers, food industry and residents in order to fulfil the harmony of environmental and economic effects.

4.3.5.4 Raw Material

Types and proportion: Waste from food industry takes up 55%, domestic waste 10% and farming manure 35%.

Treatment fees: Domestic waste is charged by SEK 550 per ton and waste from food industry is classified into two kinds. For the old customers, it is free; but for the new incomer, the fee is SEK 300-500 per ton waste according to different

food industries.

For farming manure, farmers need not pay fees; they are returned with free fertilizers while the plant will be responsible for the transportation of the manure and fertilizers.

4.3.5.5 Capital and Operation Fee

The total investment is SEK 87 million, among which the grant from the state is SEK 14.5 millions. Altogether the state has appropriated grants for four times, among which 4 million was appropriated in 1997, 2.1 million in 1999, 3.93 million in 2003, and 4.5 million in 2004. Operation fee is SEK 350 per ton, about SEK 100 per ton less than the gate fee at a landfill site.

4.3.5.6 The Utilization of Biogas and By-product

The plant can produce 8000 tons of biogas each year, equivalent to 4 million litres of petrol/diesel. This production can offer fuels for twenty-two city buses, ten heavy vehicles, ten taxi cars and one thousand five hundred cars. Up to 2004, the following vehicles have been using biogas: twenty-two city buses, three school buses, five heavy transport vehicles and about 100 cars. About 75 % of the biogas is used in energy plants as clean fuel and 25% used in vehicles. In addition, about 6000 cubic meters of fertilizers are produced.

4.3.5.7 Economic and Environmental Effect

Economic Effect: The plant is proved to be an economical way of treating organic waste. From October 2004, the plant's performance has improved for little profit.

Environmental Effect: This is the main goal to build the plant. The plant has digested most of the organic waste in Kristianstad with very little adverse

environmental effect so that a significant amount of waste is turned into useful energy and resource. Meanwhile, biogas is cleaner than fossil fuel. If biogas supersedes fossil fuel, the amount of CO₂ emission will be reduced by eleven-thousand tons per year and the emissions of other pollutants such as SO₂, NO_x will reduce by a large extent.

4.3.5.7 Analysis of Government Intervention on Karpalund Biogas Plant

State Regulation: The local government has the duty to reduce pollution from waste and protect environmental safety regulated by Swedish 21 Agenda and the Environmental Legislation Code. As for the collection of raw material, there are three aspects concerning state regulation: the residents have to assort their domestic garbage before discarding regulated by Kristianstad City Council in autumn 1995; they have to put their assorted garbage into fixed places; they have to pay garbage fee to the municipal authority. For the food industry, there is regulation about their emission control. So they have to treat their pollutants by themselves, or find the third party to treat them by paying the treating fee. In addition, expansion of the plant, as part of the local climate change program, is also beneficial for the reduction of emissions of greenhouse gases regulated by the Swedish government as well as the European Union under the guidance of Kyoto Protocol.

Economic instruments: Market measures are embodied in each aspect. Treating fee paid by food industry and residents reflects the main market principle, the polluter-pays-fee principle. However, the customers have the right to bargain over the price. Meanwhile grant is the most important economic instrument in the case. When the first stage was completed, the plant got the grant from the central government, about 10% of its total investment. Since 1998, Sweden has carried out its local investment programmes as well as incentive grants in the mid-1990 to implement local Agenda 21 plans. Up to now, the plant has obtained grants as high as SEK 14 million, about 16% of its accumulative total investment. Besides,

the municipal authority regulated many economic policies to encourage the use of biogas: the price of biogas is fixed about 25% cheaper than petrol, the municipality offers free parking in certain parking lots, the municipality offers subsidies for those who purchase bio-gas cars, the regional authorities levy low taxes on gas vehicles.

Social balance mechanism: Social balance mechanism is important and reflected in each layer of production and consumption. For the farmers, there is no obligatory rule to send their manure to the plant. But many farmers are ready to offer the material. Garbage assortment is obligatory. But how to make it perfect depends on residents' voluntary action. In the case, only 1 to 1.5 % of the total organic waste is rejected and land-filled, which suggests the high quality of source-separation. Though biogas is a clean fuel, it will also cause some kinds of inconvenience for biogas consumers such as lower driving force, the difficulty to find the gas refilling station, short driving distance etc. Many customers select biogas cars due to the thinking of a cleaner environment at the expense of their present comfort. The purchasing of surplus fertilizers needs good environmental awareness from farmers. For joint benefits, some people have to sacrifice their short-time comfort and benefits which depends on the rise of the masses' environmental awareness. The government at each level in Sweden exerts its influence in this field through education, propaganda and guidance.

The environmental education guided by the government covers all the compulsory schools. Meanwhile environmental education is emphasized in state and local 21 Agenda plan. From 1998, it has been one part of concrete programmes in local investments programmes. Many voluntary organizations concerning environment exist in Sweden and Kristianstad. The central and local government will appropriate certain sums of fund to green organizations.

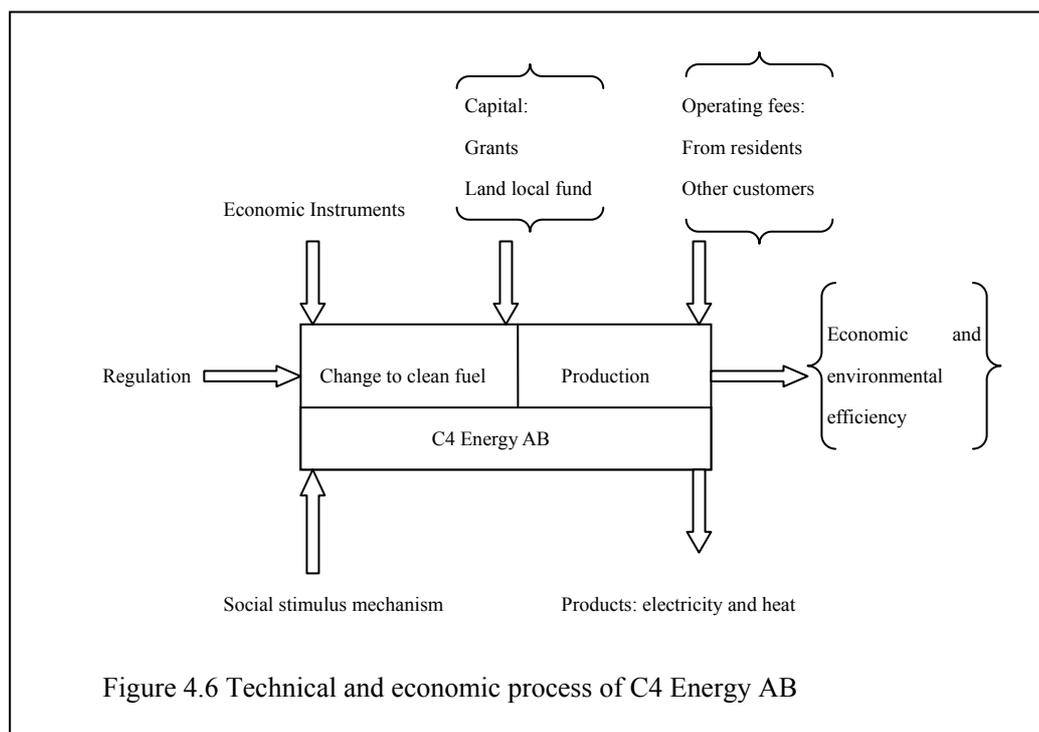
4.4 C4 Energy Company in Kristianstad

4.4.1 General Information

C4 Energy AB is invested and owned by the municipal government. Its main service is to offer electricity and heat. It built the first district heating-grid in the south of the city in 1980. In 1989, Allöverket stage 1 was carried out by using LP-gas. And in 1994, Allöverket stage 2 built bio-fuel-powered combined heating and power unit in 1994. Later, further transformations have been implemented for five times such as the expansion of the district heating system and building three new bio-fuel plants. The company produces about 300 Gwh heat per year in Kristianstad (94%), Va (2.4%), Fjalkinge (1.2%), Ahus (2.4%).

4.4.2. Technical process

Figure 4.6 illustrates the technical and economic process for the company.



4.4.2.1 Why the Bio-fuel?

In the 1980s, Sweden implemented its cleaner production plan for clean air quality under which C4 Energy has worked towards replacement of oil by LP-gas. In 1994, Allöverket changed its energy from fossil fuel to all bio-fuel for further reduction of pollutants. In 1999, the executive of Kristianstad municipality made

a decision on its goal to become a Fossil Fuel Free Municipality. Kristianstad is one of the partners in the EU campaign for climate change programme from Feb 1, 2001. All these factors promote the company to change towards cleaner fuel. Up to now, its 96% energy is clean energy, among which 87% is renewable energy.

4.4.2.2 Raw Material

Wood-fuel and biogas are the main energy. 65% of total energy is wood-fuel which is consumed by 270 000 m³ wood fuel each year. Wood-fuel is renewable and pose no harm to the environment. Wood-fuel comes from three areas: wood industry, 50% within the radius of 80 km from Kristianstad, recycled wood, 25% within the radius of 80 km, forests, 20% within the radius of 80 km and willow, 5% within radius of 30 km. Its 22% energy is biogas and it consumes 5,500 000 m³ methane gas each year among which about 60% is from landfill and 40% from Karpalund biogas plant. They have low operation costs compared with fossil fuel.

4.4.2.3 Capital and Investment

Total investment reaches SEK 125 millions. The company got grants for three times with a total amount of 1 million.

4.4.2.4 The Utilization of Heat and Electricity

When electricity is produced in a plant powered with bio-fuel it becomes green power and owns a green certificate. Meanwhile the company promotes environmental protection by expanding district heating which is an environmental way to heat houses as well as save energy. By 2004, the company has offered district heating service to 1100 customers. The electricity is sold to national distribution companies. There are 1900 tons of ash used as good inorganic fertilizer in the agriculture and forestry.

4.4.2.5 Economic and Environmental Effect

Economic Effect: The cost of operation is lower compared with fossil fuels. In 2004, sales rose by 40%, income by 100% and the customers for district heating increased by 50% compared with 1997.

Environmental Effect: Sulphur dioxide is reduced by 95%, carbon dioxide (net) by 80%, nitrogen-oxide by 35% and dust by 10% compared with the levels before transformation. Much money is saved for fewer environmental taxes.

4.4.3 Analysis of Government Intervention on C4 Energy AB

4.4.3.1 State regulation

The Swedish Environmental Code enacted in 1998 comprises co-ordinated, stringent and wide-arranging environmental legislation aimed at sustainable development, particularly mentioning the limitation of climate change and reduction of air pollution.

Swedish 21 agenda plan and local implementation plan also regulate the concrete steps for the substitution of cleaner energy and the reduction of air pollutants. In 2001, EU and Sweden ratified the Kyoto Protocol and put forward the goal to reduce the emissions of greenhouse gases by 4% between 1990 and 2010 for which Sweden carried out many plans such as the local investment programme. Consequent decision made by Kristianstad council is to build a Fossil Fuel Free Municipality. For the application of Local Investment Programme, the company has to conform to some stringent conditions concerning more excellent environment and energy efficiency. All above regulations will be pressed for the company towards more environment-friendly actions. As for the offering of raw material, there are some related regulations. For example, it is illegal to landfill organic waste (compost), because this waste can make the biogas plant more popular. Sweden also regulates that waste wood is not to be discarded without further use.

4.4.3.2 Economic Instruments

Environmental taxes are the most important economic instrument to promote the transformation. The levying of energy taxes and environmental taxes on SO₂, NO_X, and CO₂ raises the initiative of the energy company towards cleaner energy. After transformation, the company gets much refund due to the reduction of pollutants such as SO₂, NO_X and CO₂. Furthermore Grant is another important economic instrument. The company got grants from the central government, about 10% of its total investment. The use fee of heat paid by commercial buildings and residents reflects the role of the main market principle, the polluter-pays-fee principle. The customers have the right to bargain over the price. Besides, the electricity produced by bio-fuel is given priority to be used by the national electricity net. For new residence, the municipal authority has planned district heat system. Finally the company owns a green certificate and trades it for profits.

4.4.3.3 Social Balance Mechanism

For the residents, there is no obligatory rule to order them to use district heat. District heat costs high for a single resident. But for the reduction of air pollution and protection of urban environment, residents have to sacrifice present benefits, which depend on the rise of the masses' environmental awareness. The purchasing of surplus fertilizers needs good environmental awareness from farmers.

4.5 Summary of Analysis

Based on the above analysis, the framework of government intervention on Circular Economy in Sweden is generalized in figure 4.7. Meanwhile following six proposals are supported in the cases:

Figure 4.7 the Framework of Government Intervention in Sweden

The type of government intervention	Concrete Pattern
Regulation	<p>1. Environmental legislation has been implemented via regulatory instruments coupled with systems of monitoring and sanctioning of non-compliance such as producers' responsibility, source-separation, the-polluters-pay principle and polluters-treat-principle, limits in terms of maximum rate of discharge from a pollution source, pollution density limits related to emissions, environmental impact appraisal system and mandatory permit system for new projects.</p> <p>2. Regulations from international protocol and national implementation agenda. EU and Sweden have signed the Kyoto Protocol and make their objective to reduce the emissions of greenhouse gases by 4% between 1990 and 2010; After Rio E&D conference in 1992, Sweden enacted Swedish 21 Agenda and Local 21 Agenda among which include many regulations such as cleaner energy plan etc.</p> <p>3. regulations from local authorities such as fossil fuel free municipality program and concrete regulations about source separation, cleaner energy and producers' responsibility etc.</p>
Economic Instruments	<p>1. Environmental taxes such as energy tax, sulfur dioxide tax, NOx tax, aerial tax, vehicle tax, fertilizer & insecticide tax, and tax on Gravel.</p> <p>2. Tradable emission permit;</p> <p>3. subsidy and grant;</p> <p>4. product charge for reclamation of waste products and packing material such as batteries;</p> <p>5. the-polluters-pay such as garbage fee for household, treatment and operation fee from consigner or producers.</p> <p>6. deposit-refund for reusable drinking containers and waste cars.</p>
Social Balance Mechanism	<p>1. environmental education such as nine-year compulsory education system and adult education system;</p> <p>2. Green groups such as national nature protection association.</p> <p>3. Mass Media Promotion;</p> <p>4. Claim for Rights from environment loss</p> <p>5. Environmental Label Products and ISO14000 Certification</p>

4.5.1 We argue that state regulation is the foundation and legal protection for the promotion of Circular Economy. From Swedish cases, there are twelve relative regulations for the waste management (including Karpalund biogas plant) and six regulations for C4 energy AB respectively. These regulations play their important roles in the promotion of Circular Economy. First they force the relative parties to carry out national and local policies concerning environment.

Meanwhile they will protect the fulfillment of national and local environment objectives by coercive power. In addition, they can be as evidence to assess the effect of certain policies.

4.5.2 It is argued that economic instruments are the best way to allocate natural and environmental resource with high efficiency. Economic instruments are the most active factors to promote Circular Economy. From Swedish cases, there are twelve, six relative economic instruments for the waste management (including Karpalund biogas plant) and C4 Energy AB respectively in Kristianstad respectively. These instruments offer efficient economic stimulus for the relative parties. Particularly environmental taxes, tradable permit, grants, treating fee for waste have encouraged the parties to quicken the pace for transformation, to sustain their routine operations and to protect them from economic loss and even obtaining certain profit. Through market measures, the relative resources including environment are allocated efficiently and with low cost.

4.5.3 It can be argued that if economic instruments want to play its full role, they must be under the protection and support of state regulation. Most of them include the content related to state regulation. Before implementation of the tradable permit, one important base has to be done--the control of emission amount of pollutants and assignment of permit, both belonging to regulation. The government will define the concrete amount of emission and order the relative enterprise to carry out the control requirement defined in the permit. If the amount of emission is over the amount defined in permit, the enterprise will be punished severely. Meanwhile the government will monitor the emission and relative emission enterprises have to report their emission. For the concrete transaction of permit, the government has enacted some regulations protecting it corresponding to the market mechanism.

4.5.4 It is argued that state regulation needs corresponding economic instruments in order to reduce enforcing cost and play its full role. Despite the twelve regulations on waste management in Kristianstad, the whole operation, paying and receiving fee and offering service are all selected by the market. Economic instruments promote the whole system towards higher efficiency and make it more environment-friendly. Over the past ten years, the state regulations have kept stable and more economic instruments have been created for new development: in Sweden the metal containers reclamation rate has increased to 90% from 70% in the 1990s; metal reclamation rate has risen to 80% from 50% in the 1990s; only 20% useless waste is land-filled now while it was about 40% ten years ago. Meanwhile the reclamation cost has become less, economic effect is very evident and government operation cost almost keeps constant.

4.5.5 We argue that there is a possibility that both state regulation and economic instruments are in failures under which social balance mechanism will play its foundational role in building Circular Economy. In some spheres and to some degree, the impact of state regulation and economic instruments becomes weak, or even fails under special situation. Taking the source separation of domestic garbage as an example, after many years of implementation, the roles of regulations and economic instruments are stable. But the effect of source separation becomes better. According to statistics, the assortment rate of garbage rose stably from 70% in 1995 to over 90% in 2004. Here is a third force playing its role. It is the social balance mechanism. All kinds of environmental education, promotional activities as well as activities from green groups are conducive to the masses' environment awareness. So citizen's awareness becomes the main propulsive force for further improvement in source separation.

4.5.6 It is argued that in each level and aspect of Circular Economy, government intervention will play its best role by the integration of three measures. As for waste management or energy plants, three measures are

incorporated and play their joint and cooperative roles according to the above laws. State regulation and economic instruments play an important role. But neither of them alone can cope with the environmental problems; only a perfect combination of the two can reach the harmony of efficiency and effectiveness. For example, pollution permit trade, a typical economic instrument, is based on total emission amount control of pollutants, a typical state regulation. Emission charge is also combined with regulation. Faced with market failure and government failure, it is necessary for the social mechanism system to play its fundamental role in reducing marginal treatment cost, enforcing polluters' treatment, advocating green consumption and promoting Circular Economy.

Chapter 5: Analysis on a Chinese Case

In chapter five a Chinese case is introduced and analyzed. The framework of Chinese government intervention is generalized. Meanwhile six proposals supported in Swedish cases are also proved in the Chinese case.

Bio-park, as key part of Circular Economy, is a new type industrial organization based on the theories of Circular Economy and industrial ecology. Guigang Bio-park is the first bio-park and trial unit for Circular Economy in China. Analysis of government intervention on its establishment and development will be helpful to describe the government intervention in the development of Circular Economy in China.

5.1 Outline of Guigang Bio-park

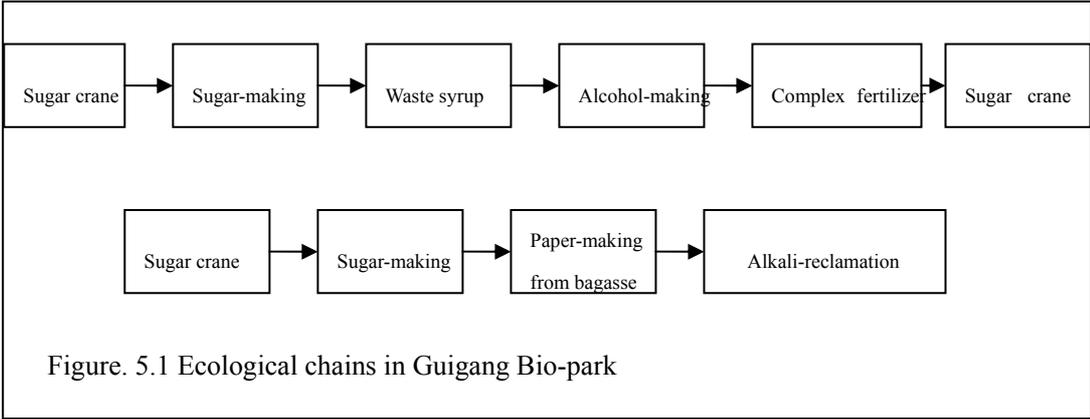
Sugar and consequently paper and alcohol are major industries in Guigang city of Guangxi Zhuang Autonomous Region. Since 1990, the city's annual output of sugar has remained over 200,000 tons. Meanwhile these industries are major polluters. For example, wastewater discharged by these three industries occupies 80% of total wastewater in Guigang. Structural and regional pollution is extremely severe there.

So, handling pollution from sugar and related industries is not only a concern of producers, but the top job of Guigang government. Under the guidance of experts at home and abroad, Guigang bio-park was established in 2001 and has solved pollution problems while promoting local economy by raising the resource utilization rate and developing Circular Economy.

5.2 Main Features of Bio-park

This bio-park centres on Guigang Sugar Group as a framework of six systems including sugarcane farming land, sugar-making, alcohol-making, paper-making, combined heat and power and complex waste treatment. The six systems, each

turning out some specific products, are inter-affected and interrelated by the exchange of middle products or wastes, forming a relatively complete and cyclic industrial network. In this park, wastes are reused and recycled, pollution is reduced to the lowest level and resources are allocated with the highest efficiency. There are two ecological chains in the bio-park (see figure 5.1)



In addition, there are small ecological chains such as that from organic sugar to low poly-fructose, and that from filter sludge of sugar-making to cement. These chains form transverse coupling relation and to some degree a net framework. In the park there is no waste, only resource. Each joint fulfils the goal to share resources and shift negative environment impact to positive benefits of resource.

5.3 Benefits of Resource and Environment

The biggest achievement is the ever-increasing comprehensive utilization rate, a main source of income in the bio-park. 65.74% of total product in the park comes from comprehensive utilization. Furthermore environmental quality in the region is improved a lot. In 1995 the emission of COD in Guigang bio-park was reduced to 10,500 tons from 37,984 tons while the production of paper was increased to 100,000 tons from 40,000 tons. Besides, Guigang bio-park paves a new road for solving structural pollution of traditional industries and transforming them to modern industry by promotion of Circular Economy.

5.4 Government Intervention on Promotion of Guigang Bio-park

5.4.1 The Leading Role of State Regulation

Transformation under coercion from resource-consuming and environment polluting industrial area to bio-park: In 1996, the State Council delivered the order that all industrial enterprises must build their treatment facilities and raise their emissions to the national obligatory standard until the end of 2000. Any enterprises which do not fulfil the aim will be closed down. By the end of 2000, the sugar industry in Guigang had not fulfilled the aim and was faced with ultimate punishment. The industry had to promise to carry out overall cleaner production, reduce the emission of pollution and promote the comprehensive utilization of waste while it was going through temporary closing-down. In 2004, China enacted *Cleaner Production Promotion Law* setting new requirements for further cleaner production. In this sense, the government orients the main development of sugar industry in Guigang.

Obligatory Planning: The development plan of cleaner production and Circular Economy in the park has to be approved by the local authority before implementation.

Emission Control: By 2005, the park and internal enterprises must lower their pollution down to the national emission standard and the total emission amount of pollutants has to be reduced by 20% compared with that in 2000.

5.4.2 Economic Instruments Being the Main Propulsive Force

Finance policy: Paper-making from bagasse and alcohol-making from secondary resource are part of the comprehensive utilization projects which can get some tax incentives such as being exempt from value-added tax. Sugar industries will award farmers who grow large areas of sugar cane.

Investment policy: Guigang municipal government offers investment support through loans. For example, the park may return loans and interests by using profits from new projects. The remaining loans and interests will be paid back by product tax or value-added tax. For the new projects, there is no tax or lower tax for land use.

Emission fee system: The environmental protection department will charge emission fees according to the type and quantity of pollutants emitted by enterprises. If the emission amount is not up to the national standard, five times fees are charged as punishment.

Subsidy and grant: The local government returns 80% of emission fees and appropriates certain sums of special fund as subsidy for pollution treatment and comprehensive utilization projects.

Interest-free loans: The central government will offer to projects in the park some sums of national debt, about 20% of the total investment.

Signing contract with farmers: to build a contract with the government, the park and farmers are given more initiative and the efficiency of sugar cane industrial chain is improved.

5.4.3 Fundamental Role of Social Balance Mechanism

Governments at each level invest much fund in scientific and technological creation and progress. Many techniques on resource utilization are advanced and many of useful and new techniques emerge.

The local government, by means of media, popularises the environment and resource law, which presses related industries to carry out the policies concerning cleaner production and Circular Economy. During the construction of the

bio-park, two pollution incidents happened and the local government helped the residents claim for environmental compensations. Thus citizen's right was protected and a warning was given to the environmental action of industry.

The park incorporates international environment management system into the whole process of production and its management. Meanwhile, the park has received environmental certificates for its products such as sugar, paper and complex fertilizer etc.

5.4.4 Action Mechanism of Government Intervention

Based on above analyses, three kinds of government intervention in China exist and play their roles with the similar law concluded in Swedish cases in chapter 5. Furthermore Chinese case can also prove following proposals: State regulation is the base and legal protection for the promotion of Circular Economy; Economic instruments are the best way to allocate natural and environmental resource with high efficiency. Economic instruments are the most active factors to promote Circular Economy; if economic instruments want to play its full role, they must be under the protection and support of state regulation. Most of them include the content related to state regulation; It can be argued that state regulation needs responding economic instruments in order to reduce enforcing cost and play its full role; There is a possibility that both state regulation and economic instruments are in failures under which social balance mechanism will play its foundational role in building Circular Economy; In each level and aspect of Circular Economy, government intervention will play its best role by the integration of three measures.

5.5 The summary of Government Intervention in China.

The framework of government intervention on Circular Economy in China is generalized in figure 5.2 according to the Guigang case and researches of other Chinese scholars.

Figure 5.2 the Framework of Government Intervention in China

The type of government intervention	Concrete Pattern
Regulation	<p>1. Environmental legislation has been implemented via regulatory instruments coupled with systems of monitoring and sanctioning of non-compliance:</p> <ul style="list-style-type: none"> Emission standard control; Emission treatment technical control; Limits in terms of maximum rate of discharge from a pollution Source; Municipal environmental quality control system; environmental impact appraisal system & mandatory permit system for new projects; The-polluters-pay principle and polluters-treat-principle. <p>2. Regulations from Environmental Coercive Policies</p> <ul style="list-style-type: none"> End-point treatment policy; Policy of “One Order, Two Goals”; The policy of regional environmental treatment; Cleaner production and Circular Economy plan; <p>3. Regulations from international protocol and national implementation agenda.</p> <p>China signed the Montreal Protocol and has carried out the policies involving reduction of the ODS carefully.</p> <p>After Rio E&D conference, China enacted Chinese Agenda and Local 21 Agenda among which include many regulations such as mandatory emission standard and techniques plans etc.</p> <p>4. regulations from local authorities such as eco-city and eco-park construction program, environmental plan and concrete regulations about emission fee charge system etc.</p>
Economic Instruments	<ul style="list-style-type: none"> 1. subsidy and grant; 2. the-polluters-pay such as emission fees, garbage fee for household, treatment and operation fee from designer or producers. 3. administrative charge for obtaining resource exploitation permit; 4. Ownership sanction such as the sanction of license plate for cars in Shanghai. 5. Financial policy such as non-interest or low-interest loan, taxes exemption and refund of emission fees.
Social Balance Mechanism	<ul style="list-style-type: none"> 1. environmental education such as nine-year compulsory education system and adult education system; 2. Mass Media Promotion; 3. Environmental Label Products and ISO14000 Certification

Chapter 6: Comparison of Government Intervention between Sweden and China

In this chapter the comparison of government intervention between Sweden and China is made. Meanwhile two extra proposals are proved and the Swedish experience is concluded.

According to Swedish framework (figure 4.7) and Chinese framework (figure 5.2) of government intervention on Circular Economy, we make following comparison.

6.1 Sweden Lies in the Stage of Government Guide and Market Leading, While China Is in the Period of Intensive Regulation

6.1.1 Flexible and Efficient Application of Economic Instruments in Sweden

Sweden, a developed country, has much experience in implementing sustainable development, which can be divided into three stages: the dilution emission in the 1950s, end-point treatment in the 1960s, cleaner production in the 1970s and 1980s and implementation of sustainable development strategy towards Circular Economy from the 1990s. Until now, Sweden has fulfilled preliminary sustainable development and the feature of Circular Economy is very sharp.

Between the 1960s and 1980s, Sweden adopted a government interventionist policy based on the thought that environmental problems are completely caused by externality of environment and resource and only government coercive intervention can solve pollution. Under this condition, many state regulation measures were put forward such as concentration control of pollutants' emission, the total quantity control of emission and production quota control.

These state regulations played decisive roles in protecting the environment and saving resources. Since the 1980s, Swedes have discovered that excessive coercive government intervention reduced the function of the free market as

allocating environment resource rationally and efficiently. Consequently, the use efficiency of environment and resource decreased. Many economic instruments have been introduced from that time. In this stage, the national income has spanned the critical point and entered the win-win area in Kuznets environment curve.

Levying environmental tax is the most successful. In 1988, Sweden decided to introduce the environmental tax instead of the long-term emission fee system. In 1991 the environmental tax system was put to use, which effectively raised the initiative of industry to reduce pollution and protect resource. Many other economic instruments were adopted in agricultural ecological protection and waste management and resource management such as grant, refund, resource guarantee etc. The flexible application of economic instruments becomes the most active factor in Swedish development of circular economic.

6.1.2 State Regulation Has Been Playing Its Leading Role in China

China is the largest developing country in the world. At present it has a large population (1.3 billion), but a weak economic foundation and an imbalance of development throughout the country. Conditions of resource and natural environment are also bleak. In the 1970s, China took its first step in its career of environmental protection. Since the 1980s, there has been some concrete development. Yet for twenty years after the 1980s, Chinese environmental protection has been in dilemma in Kuznets environmental Curve. The whole environmental situation is deteriorating though some local areas are improved. In this period, state regulation has been playing its leading role.

A Relatively Complete Legal System of Environment and Resource Protection Has Been Built.

There are about eight laws by the central legislature such as Environmental Protection Code of PRC, Cleaner Production Promotion Code, and Environment

Impact Appraisal Code etc. These codes specify a series of regulations such as emission standard, technical control, the total quantity control of emission, environmental appraisal system etc. Nevertheless there is no special promotion law on Circular Economy and reusing and recycling of waste resource.

Many Environmental Coercive Policies Are Adopted.

Though these policies are not yet embodied in laws, they achieve the same power and coercion as law after the central government and relative authorities released them. End-point treatment policy was carried out in the 1980s, which ordered the industrial enterprises to build their treatment facilities and alleviate pollution. Policy of “One Order, Two Goals” was put forward by the State Council in 1996 which regulated: total discharge of 12 industrial pollutants in China by the end of 2000 shall not exceed the total amount mandated by the central government; the discharge of industrial pollutants should meet both national and local standards by the end of 2000; air and surface water quality in all urban districts in 47 major cities should meet related national standards by the end of 2000. The policy of total emission control of pollutants regulates that by 2005 total discharge of 12 industrial pollutants must be reduced by 20% compared with that in 2000.

The policy of regional environmental treatment in some important areas began in early 1990s and has been kept up to now, which involves regions such as Huai River, Yangtse River and Yellow River delta and Beijing etc. The central government often regulates total control and treatment plans and the local government plans concrete implementation. Among the plans, there are many regulations and some will be transformed later into national or regional laws and regulations. Cleaner production and Circular Economy is promoted by regional coercion. Some provinces and cities have enacted plans about circular development. These plans are passed in local people’s congresses and become obligatory.

6.2 Economic Instruments Have Been Taken the First Step in China, but Their Roles Are Not Thorough and Overall Compared with Sweden.

The emission fee only occupies 30%-50% of pollution cost. Under the market mechanism, an emission fee less than treatment cost encourages industries to choose turning in emission fees, but not to treat pollution voluntarily. The pricing system of environment and resource has not been implemented and green GDP statistics is still under research. The ability of market adjustment for resource reclamation is severely restricted. Because the public environment and resource are used free of charge or with low prices, many industries shift pollution cost to society, leading to disharmony between product cost and social cost. China still lacks economic instruments able to internalise the external diseconomy of the environment and resource. It is necessary to improve the fee-charging system for environment and resource in order to reflect the real value and scarcity of resource by raising charges for resource and extending the sphere of resource compensation.

Environmental tax and tradable permit, two types of most efficient economic instruments, have not been carried out. The failure for the former originates in block from interest groups such as large state-owned groups and companies, and the failure in the latter lies in the weak work foundation for environmental protection.

The above factors lead to the result that economic instruments play their limited roles and consequently the role of state regulation is expanded.

6.3 Social Balance Mechanism in Sweden Plays Its Foundational Role, While in China It Is Very Weak.

Swedish Situation

Sweden has established a high level of social balance mechanism with a wholesome democratic and legal system. The Swedish Constitution and Environmental Code regulate that the citizen has right for knowing

environmental situation and making a claim for the loss from environmental pollution. The law also requires that every activity affecting the environment must be made public and ask for advice from local residents. Meanwhile, due to independent media there are many voluntary actions. Sweden pays much attention to environmental education by which it emphasizes the participation of the masses and organizations. The following measures are carried out: environmental knowledge is instilled into pupils through classes of environmental education and social practice in the nine-year compulsory education system; construction and contests in green and ecological schools are carried out; actions involving sustainable development are publicized by websites or media and special forums are open for the masses' participation.

The government supports the routine actions of voluntary groups. The Swedish government appropriates some money as the routine expenditure of green groups. As for the actions that these groups launch for obtaining legal and rational environmental rights, the government offers all possible convenience such as evidences in court.

In the consumption sphere, green consumption has taken the leading place encouraging the producers to raise their environmental image and offer more environment-friendly products. Environmental label certificate is the main measure. As for the products that own an environmental label, the government will promote them free.

Chinese Situation

Social balance system is far from enough in China. In the economic sphere, social organizations and the masses have penetrated each aspect of the market economy. But in the environment and resource sphere, the government's direct control still predominates. First, China lacks legal regulations on mass participation in environmental management and legislature. Second, the masses

do not enjoy rights for knowing, monitoring, claiming in environmental management. Third, though China puts emphasis on environmental education, there is certain deviation from developing good environmental actions and promoting mass participation to the instilment of environmental knowledge. Fourth, local media are dependent on local authority, so local authority sometimes will interfere in reports on local environmental problems and obstruct press freedom and the right for environmental information.

6.4 Similarity in Action Law of Three Kinds of Government Intervention

As for China, three kinds of government intervention exist and play their roles with the similar law concluded in Swedish cases in chapter 5. Swedish cases and Chinese case can also prove six proposals.

6.5 Summary-- Swedish Experience and What can China Learn from It?

Swedish Experience No 1:

For one region or country, when it has skipped the critical point in Kuznets Curve, the function of state regulation will be reduced and economic instruments will play their leading role. If economic instruments are carried out actively and efficiently in the stage of state regulation, the time to hurdle the critical point will come earlier than expected. Under the situation of both government and market failure, social balance mechanism will press the government and stimulate the market to revive their functions, leading to the early arrival of critical point. Three measures play their cooperative roles and gain the best effect. This is Swedish experience.

In China, three types of government intervention develop with imbalance. The state regulation still predominates. So in the voyage to Circular Economy, on the one hand each party of actors such as legislature, enforcing organs, social organizations, media, enterprises and the masses must play its role as much as possible and an appropriate relation among them should be formed. On the other hand, state regulation, economic instruments, social vox populi and voluntary

action should form a reasonable structure. Meanwhile the social balance mechanism should be put in the fundamental place.

Swedish Experience No 2:

After the 1980s, national income has spanned the critical point and entered the win-win area in Kuznets environment curve in Sweden. Many economic instruments have been introduced in Sweden at that time. The flexible application of economic instruments becomes the most active factor in Swedish development of Circular Economy.

However, Chinese environmental protection has been in the area of dilemma in Kuznets environmental Curve from 1990s to now. The whole environmental situation is developing towards worsening though some local areas are improved. In this period, state regulation has been playing its leading role. **It is argued that compared with Sweden, in China state regulation is paid more attention due to immature market economy, low economic development level and weak management base in environment and resource.** China must put efforts into the development of market economy and promote the steady and active implementation of economic instruments in Circular Economy.

Swedish Experience No 3:

Sweden has established high level social balance mechanism with a wholesome social system and legal system. This kind of mechanism plays irreplaceable role in Circular Economy.

But in China social balance system is far from enough. **It is argued that compared with Sweden, China should build and improve social balance mechanism by emphasizing environmental education and propaganda, cultivating more green groups, and expanding media freedom and civil rights.**

Chapter 7: Conclusion

In chapter seven we make a summary of this dissertation. The findings of research are presented. The applicability of the model is also shown. Finally the opinions about future research are recommended.

7.1 Summary of Dissertation

Circular Economy is a kind of economic growth pattern which reflects the thought of sustainable development in environmental and resources protection. Developed countries with Sweden as a typical example have accumulated plenty of experience in this field. This experience will offer much help for sustainable development in developing countries such as China, which is suffering from environmental degradation and resource exhaustion with the rapid growth of economy. Meanwhile government intervention has played its leading role in the field of Circular Economy and sustainable development in developed countries. So we decided on the research topic and research questions. We hope the advanced experience of Sweden will be concluded through the analyses of Swedish cases which will provide guidance for China in the promotion of Circular Economy.

In critical review, many theories concerning Circular Economy and governmental intervention are presented in four categories: Microeconomics Theories, Environmental Economics Theories, Green Economics Theories and New Public Theories. We also describe the new development of theory and practice of Circular Economy in the world. Then preliminary framework of government intervention and eight proposals are put forward on a theoretical basis.

Five cases are selected as follows: Kristianstad Waste Management, C4 Energy Plant, Swedish Tradable Permit, Swedish Environmental Tax and Chinese Guigang Bio-park. For collection of data and materials on Swedish cases, we did

five interviews and six on-the-spot visits. The interviewees are mostly professional and have offered a lot of national and local government reports which have become the main source of data. In addition, we collect data from eight presentations of some government departments and companies. Through analyses on Swedish cases, the Swedish framework of government intervention in Circular Economy is summed up and then six proposals are proved. The material about the Chinese case is from official reports. Through analyses on Chinese case, the Chinese framework of government intervention in Circular Economy is summed up. Meanwhile six proposals which have been supported in Swedish cases are re-proved. Furthermore through a comparison between the Chinese and Swedish framework, difference and similarity of intervention government is concluded as well as Swedish experience and two extra proposals. So the integration of Swedish framework of government intervention and the eight proposals constitutes what Chinese government should do in the Circular Economy. The whole dissertation has taken over five months.

7.2 Applicability of the Model

Our ideal model consists of the Swedish framework of government intervention as well as eight proposals. The theories and our research show that the model is characteristics for the role of government intervention in Circular Economy. The eight proposals in our dissertation are connected to cases study in Sweden and China. The cases analyses have proved each proposal.

Our research shows that the model can be helpful when any countries, particularly developing countries like China develop their economy and protect environment. This conclusion is based on the following facts: first it is drawn from serious theoretical reviews; second, Swedish cases are typical for the characteristics of Circular Economy and sustainable development in the world. The total framework of government intervention in sustainable development and Circular Economy is extremely similar in western countries, because they have

common features such as market economic system, parliamentary democracy, high individual freedom and developed economy. Thus the ideal model stands for universal models in developed countries. Action law of government intervention in China is much similar to that in Sweden though there are two big differences. Their differences originate from different development levels in economy and society especially market economy. Other developing countries will follow the steps that Sweden and other developed countries have taken in sustainable development. So the model is not only the summary of experience of developed countries, but also new guidance for developing countries devoted to promoting social development and fulfilling sustainable development. The research is full of importance from reality and theory.

7.3 Summary of Findings

Circular Economy is a kind of economic growth pattern which conforms to the thought of sustainable development. Three Rs principle is its core contents. Its key characteristics are a high efficiency of production, a maximization of resources utilization and a minimization of pollution.

Because a market mechanism can not supply the goods of environmental protection and overcome the negative externality of environment pollution, it is difficult to reach a Coasian bargaining to find a solution for property rights of environment and resource. The government will be the optimal body to take care of the responsibility of clarifying property rights and exercise the duty of protecting the environment.

The Swedish experience in sustainable development and Circular Economy is typical in the world. The Swedish framework of government intervention is also typical in developed countries. For China, the role of government intervention is much similar with Sweden because six proposals are both supported by Swedish and Chinese cases. But there are two big differences which are shown in last two

proposals. One difference is that state regulation still predominates in China, while economic instruments play their most active roles in Sweden. The other is that the social balance mechanism (the third force) is not fully developed in China, while it has been the important force in Sweden. So China can learn at least three pieces of experience from Sweden. The first is that the time to hurdle the critical point will come earlier than expected, if economic instruments are carried out actively and efficiently in the stage of state regulation. The second is that the flexible application of economic instruments becomes the most active factor in the Swedish development of Circular Economy. The third is that Sweden has established a high level social balance mechanism with a wholesome social system and legal system. This kind of mechanism plays an irreplaceable role in Circular Economy. So the Swedish framework plus eight proposals form the model which will fit in China.

7.4 Future Research

The real meaning of our research depends on whether our model can be applied to other countries, especially to other developing countries. Our research has testified its applicability in China. But for applicability in other countries, we believe that our model should be improved. It will be more workable by taking into account the concrete situations of different regions such as economic, social and historical backgrounds. Our dissertation will be a good starting point for future research:

For suggestions for future research: To what degree, do the state regulation, economic instruments and social balance mechanism play their roles;

In developing countries, state regulations are always predominant. How they can traverse the dilemma into a win-win area in the Kuznets Curve as soon as possible by actively making use of economic instruments is an imperative theme.

The establishment and development of social balance is a systematic project concerning the transformation of social structure which belongs to the sphere of sociology.

Environmental taxes and tradable permit are the most important and effective economic instruments. But developing countries rarely use them because of an immature market economy. So how to promote their uses in developing countries and what preparations are necessary for implementation are also interesting and constructive research topics.

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