BIOMASS ENERGY

A MARKET RESEARCH ON THE OPPORTUNITIES FOR DUTCH ORGANIZATIONS IN THE CHINESE BIOMASS MARKET

26 August 2009
Bachelor graduation project

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Management summary

Climate change, increasing global energy demand and uncontrollable oil prices indicate the need for new technologies and more efficient infrastructure in order to create sustainable energy. Sustainable energy is also high on the agenda of the Chinese government. This is clearly expressed in the 11th Five-Year Plan (2006-2010). Biomass plays an increasing role in this strategy, because biomass resources tend to become more renewable, cost-efficient, readily available (i.e. waste biomass) and biomass energy does not affect the CO_2-cycle. The government's stimulus packages and subsidies greatly affect investment in R&D and business development in the future biomass market. Chinese entrepreneurs are highly dependent on government subsidies because these generally make their plant/business profitable. It should be noted that the share of biomass in today's total energy production in China is relatively small.

Purpose of the research

This research is conducted for the Economic and Commercial Department of The Embassy of the Kingdom of the Netherlands in Beijing. They proposed to do a research into the Chinese biomass market which contributes to their understanding of the developments in the Chinese biomass market and the opportunities for Dutch organizations in this market.

Research approach

This study is an exploratory research with a qualitative nature. The research particularly aims at a better understanding of the biomass market and feasibility for more extensive study in the future. In order to provide a answer to the knowledge gap of the Dutch Embassy regarding the opportunities for Dutch organizations in the Chinese biomass market, the literary review has established three *conditio sine qua non* for Dutch organizations that want to operate in the Chinese biomass market: government influence; the existence of a certain need for the product or service; and competitive advantage. The literary review provides a basis for analyzing the Chinese biomass market and determining the relevant opportunities for Dutch organizations in this broad market.

Government involvement

Because an organization has to adapt to macro-environmental factors, it is important to map the factors which influence the organizational domain before an organization decides to operate in the international environment. After a description of the political, economical, socio-cultural, technological, environmental and legal forces (PESTEL), analysis on factors that are of great importance to the Chinese market has determined the major and omnipresent influence of political element. The effect of policy in energy markets is significant for businesses operating in that market. Although at present, China adopts a more liberalized approach to energy markets, the government is still heavily involved for instance through subsidies, and for the future years to come it is predicted that this will not be any different. More specifically, without good relationships with the Chinese government organizations are not successful in the Chinese market.

The need for energy

Biomass can be converted into refined liquids (liquid bio-fuels), electricity, heat and biogas. An

important characteristic of the Chinese market is the difference between energy use in rural areas and energy use in urban areas and industry. More specifically, there are two trends visible: (a) about 54% of the Chinese population lives in rural areas, in which they rely for 80% on biomass energy, and (b) there is a rapid urbanization trend caused by a growing middleclass in China. Since car- and vehicle ownership is strongly related to per capita-income, the growing middleclass causes motorization in China. In addition, China is more sensitive to their contribution to climate change and recognizes the importance of diversification in the energy sector by a focus on renewable energy. Therefore, the transport sector offers high potential opportunities for Dutch organizations who want to be active in the biomass market in China. Biomass applications of renewable energy in the transport sector are the liquid bio-fuels bio-diesel and bio-ethanol.

Competitive advantage

An organization is successful in a market environment where its core competences will have value. Competitive advantage increases if value is added in the activities of a firm. In other words, competitive advantage is important to succeed in the Chinese biomass market. To realize *sustained* competitive advantage, (a) a firm's resources must be rare to current and potential competition; (b) must be hard to imitate, and; (c) cannot have strategically equivalent substitutes that are valuable but neither rare nor hard to imitate.

Supply chain analysis

To achieve competitive advantage, we determined where in the supply chain of bio-diesel and bio-ethanol, value is added by identifying needs in the supply chain. In addition, to succeed in a business environment, relationships with suppliers are becoming increasingly important because organizations are becoming more dependent on suppliers. This research looks at the supply chain as a chain of businesses, i.e. an inter-business supply chain. Based on the supply chain analysis on the Chinese bio-fuel market, inadequate provision of resources; fragmented collection of biomass from farmers; fuel production techniques and technical equipment that is behind worldwide standards; and marketing and sales channels that do not function well, were identified as gaps that offer opportunities. Furthermore, the development of second generation bio-fuel can offer opportunities in the mid-term future; there is particularly a need for developing technology that is less costly and more commercially viable. The development and introduction of third generation bio-fuel offers opportunities in the long-term future.

Dutch strengths

Because of the high potential of third generation bio-fuel and its development in the Netherlands regarding algae and the genetic manipulation of seeds (the latter in which the Netherlands is regarded as world leading), a focus on the development of the third generation might give the Netherlands a competitive advantage in the long term future. Because of an increasing motorizing Chinese middle class, the second generation bio-fuel will already emerge in a large commercial market in the mid-term future providing sufficient market opportunities for the Netherlands in the mid-term, regardless of their non-leading position on second generation biomass.

Preface

This report is the result of a research project carried out at the Embassy of the Kingdom of the Netherlands in Beijing. For a 3-month period I stayed in China to study the ins and outs of the Chinese biomass market. More specifically, I focused on the relevant opportunities for Dutch organizations that want to be active in this Chinese market. This research project in China served as the foundation for my bachelor graduation project at the University of Twente.

I would like to thank everyone that helped me find my way through a gigantic Chinese market, cooperated with me on this report and contributed to it in making it a success. Special thanks go to:

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List of abbreviations

BTG	Biomass Technology Group
CAAS	Chinese Academy of Agricultural Science
CEO	Chief Executive Officer
CO2	Carbon Dioxide
COFCO	Chinese National Cereals, Oils and Foodstuffs Corporation
ECN	Energie Centrum Nederland
EEKC	Energy-environmental Kuznets curve
ETBE	ethyl tertiary butyl ether
etc.	etcetera
EU	European Union
EUR	Euro
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
ha	hectare
i.e.	it est
IEA	International Energy Agency
LPIT	Leo-Petrus-Innovation-Trophy
MT	Million Tons
N.V.	Naamloze Vennootschap
NDRC	National Devolopment and Reform Commission-
NL	Nederland

NODE	Nederlands Onderzoeksplatform Duurzame Energie
PPP	Purchasing Power Parity
R&D	Research and Development
RMB	Renminbi
RU	Rijksuniversiteit
t	tons
TJ	TeraJoule
TPY	Tons per year
TU	Technische Universiteit
TWA	Technical & Water Attaché
VNBI	Vereniging Nederlandse Biodiesel Industrie
y	year

Monetary values

1 Euro (EUR) = 8,8 Chinese Yuan Renmibi (RMB)

€1,00 = ¥8,80

1. Introduction

This chapter will introduce the research by giving background information on sustainable energy and biomass. Subsequently, the context and the purpose of the research are determined, followed by the problem definition. This will serve as foundation for the literary review. Furthermore, this chapter introduces the research design and the relevance of the research.

1.1. Background

Climate change and global warming are mounting problems of the 21st century (Intergovernmental Panel on Climate Change, 2007). Action is needed in order to mitigate climate change, reduce global warming and CO_2 emissions and manage an energy market where long-term positive global effects are secured. This makes the need for clean and advanced technology in renewable energy increasingly important today. Particularly the contributions of the United States and China will be critical (IEA, 2008).

To maintain economic growth and raise society to a middle-income level, the energy demand in China will keep growing at a fast pace coming decennia. Up to 2020, about 50% of the worldwide growth will come from the rapid growing economies of China and India (IEA, 2008).

For China it is thus essential to secure energy supply. Coal is the most important source of energy (68% of the Chinese energy mix), while China is a net importer of oil since 1993 because Chinese oilfields cannot meet up with the demand (Economic Department of the Dutch Embassy in Beijing, 2008). Yet China does not want rely on the supply of these fossil fuels. Therefore the Chinese government recognizes the importance of diversification, i.e. a focus on renewable energy to improve independency in the energy sector (Information Office of the State Council of China, 2007).

For these reasons more sustainable energy is a high priority to the Chinese government (Information Office of the State Council of China, 2007). This is clearly expressed in the 11th Five-Year Plan (2006-2010). Biomass plays an increasing role in this strategy, which creates opportunities for business and cooperation operating in this market (Roland Berger Strategy Consultants, 2009).

1.1.1. Biomass

Biomass is the biological destructible fraction of products, waste, and agricultural residues (including material derived from plants and animals), forestry and related businesses, as well as the biological destructible fraction of industrial and household waste (EU directive 2001/77/EG, 2001).

Although the type and quality of biomass depends on environmental factors like climate and soil, some general characteristics can be distinguished. Usually, biomass resources are solid materials with low bulk density, high moisture content but low heat energy content. In addition, it generally contains high oxygen and ash values and highly variable property values. The efficiency of transport and handling of biomass properties compared to traditional fossil fuels is poor, because biomass is usually large in volume. However, this is increasingly outweighed by the advantages, because biomass sources tend to become more (Buffington & Wilson, 2005):

- Renewable
- Cost-efficient
- Readily available (i.e. waste biomass)
- Carbon-neutral; because biomass energy does not affect the CO_2 cycle, it is sustainable for the environment and contributes positively to climate change.

According to the World Energy Council (2007) biomass will expand in two directions. The first direction represents the residues from the production and processing of agricultural resources. Examples are waste-to-energy production and gasification of agricultural residues for power. The second direction represents the planting of energy crops on available land. This method can for example be used for bio-fuel. In other words, two streams are evolving; waste biomass and cultivated biomass respectively (Ministry of Economic Affairs the Netherlands, 2008). Waste biomass is sustainable with respect to the environment. Cultivated biomass is at present relatively unsustainable. In particular because the majority comprises the so-called first generation biomass, that competes with food security.

Although the use of biomass that has negative impact on the food chain and the environment is unthinkable, there are significant development opportunities for energy from so-called second-generation biomass in China, i.e. biomass energy that does not compete with food security (Koizumi & Ohga, 2007).

1.2. Context

This research is conducted for the Economic and Commercial Department of The Embassy of the Kingdom of the Netherlands in Beijing. The Economic and Commercial Department aims to extend and improve the economic ties between the Netherlands and China. Their main goals are the identification of opportunities, advocacy of favorable laws and regulations for Dutch organizations, and provision of direct support to Dutch companies. Henceforth, the Embassy of the Kingdom of the Netherlands in Beijing will be called Dutch Embassy (in Beijing).

The Dutch Embassy in Beijing has a clear picture of several areas within the renewable energy sector - mainly wind energy, clean coal technology and sustainable engineering- regarding the opportunities for Dutch organizations in China. However, a clear picture on the developments in the Chinese biomass market is still missing. This endangers their provision of adequate information and direct support to Dutch organizations who want to be active in the Chinese biomass market. Therefore, the Dutch Embassy in Beijing has proposed to conduct a research into the Chinese biomass market which should contribute to a better understanding of the developments in this market and the opportunities for Dutch organizations.

Before conduction of this research, the understanding of the Dutch Embassy in Beijing is that China cannot tackle biomass market alone yet. They presume there are several gaps in the biomass market, which present opportunities for other countries. This is confirmed by the fact that China and the Netherlands are currently working on enhanced strategic cooperation in the form of a Memorandum of Understanding on renewable energy, of which biomass is one of the focus areas. In this regard, future cooperation between China and the Netherlands concerning biomass is promising.

1.3. Purpose of the research

The purpose of this research is to contribute to the knowledge and understanding of the Dutch Embassy in Beijing in the area of biomass in China, by studying and analyzing the Chinese biomass market and providing insights on where Dutch organizations can best utilize their qualities.

More specifically, this research can be split up into three components which all have their specific objective. The first objective is to study the Chinese biomass market from a macro-economic perspective. This will give insight into the external factors that influence the biomass market. The second objective is to further analyze the Chinese biomass market by identifying *conditio sine qua non*, i.e. inevitable requisites for Dutch organizations that want to operate in the Chinese biomass market. The identification of *conditio sine qua non* provides a basis for the third objective, which aims at providing insights into the opportunities for Dutch organizations in the Chinese biomass market. This is done from a micro-level perspective, by investigating where in the supply chain Dutch organizations can best utilize their qualities.

Because of the vast size of the Chinese biomass market, it is impossible for a bachelor graduation project to focus on the opportunities of all applications in the biomass market. In addition, this would endanger a profound advice on the opportunities for Dutch organizations. Therefore a focus on the most relevant application(s) has to be made during the research process.

1.4. Problem definition

Following the context and the purpose of the research, the problem definition is formulated. This research deals with the problem that:

“The Embassy of the Kingdom of the Netherlands in Beijing has a knowledge gap regarding the opportunities for Dutch organizations in the Chinese biomass market”

This problem definition will serve as the foundation of this research. In order to provide a solution to the problem, research questions will be formulated after the literary review has identified relevant aspects of the subject that provide a more substantial approach to the research.

1.5. Research design

This study is an exploratory research. Exploratory research often has a qualitative nature, characterized by the absence of quantitative data but rather an emphasis on valid methodology (Geurts, 1999). Generally, an exploratory research aims at finding out what is happening and seeking new insights (Saunders et al., 2007). More specifically, exploratory research is done to: (a) satisfy the researcher’s curiosity and desire for better understanding; (b) test the feasibility of undertaking a more extensive study; (c) develop a method to be employed in further research (Babbie, 2007). This research particularly aims at a better understanding of the biomass market and feasibility for more extensive study in the future. Although explanatory research is regarded as valuable when it comes to understanding new subjects, a shortcoming is that study objects are often not representative of the whole population (Babbie, 2007). It is impossible to study all objects in the biomass market in China, which can endanger the validity of this research. However, exploratory research has the advantage that it is flexible, unstructured and adaptable to change (Saunders et al., 2007) and is therefore suitable for this large field of study.

1.6. Social and scientific relevance

The social relevance of this research is the description of a relatively unknown market, amongst others because it's recent fast developments and new applications. This mainly contributes to the knowledge of the Dutch Embassy in Beijing by providing a picture of the biomass market in China and the opportunities for Dutch organizations that is more clear and up-to-date. This will facilitate the information supply of the Embassy to Dutch organizations that want to operate- or are already active in the Chinese biomass market.

The scientific relevance of this research is the demonstrated link between current theories on macro-environmental factors, emerging markets, competitive advantage, and their relevance with the Chinese biomass market. At present, the literature lacks sufficient information regarding the application of these theories to the Chinese biomass market. Furthermore, the supply chain perspective is used to describe the current state of the bio-fuel market in China. Since a complete picture of the bio-fuel market used to be absent, the supply chain analysis proved to be successful method to identify market opportunities in the Chinese biomass market. This application to the Chinese biomass market indicates an extension of supply chain analysis to a specific market in China.

1.7. Structure of the report

The report will proceed with a literary review. Based on this literary review the research question is formulated and the methods for obtaining and analyzing data are outlined. After this, the findings will be presented and interpreted in the conclusion, and recommendations will be made to the Dutch Embassy, Dutch organizations and the academic world.

2. Literary review

In order to provide a solution to the knowledge gap of the Dutch Embassy regarding the opportunities for Dutch organizations in the Chinese biomass market, some sub-objectives have been distinguished in the previous chapter. The first objective is to study the Chinese biomass market from a macro-economic perspective, which will give insight into the external factors that influence the biomass market. The second objective is to further analyze the Chinese biomass market by identifying *conditio sine qua non* for Dutch organizations that want to operate in the Chinese biomass market. The identification of *conditio sine qua non* provides a basis for the third objective, which aims at providing insights into the opportunities for Dutch organizations in the Chinese biomass market. This literary review will provide a foundation for analyzing the Chinese biomass market and determining the relevant opportunities for Dutch organizations in this wide-ranging market.

2.1. Influence of the macro environment

If Dutch organizations want to operate abroad, they will come across an international environment. This means they will deal with "interactions (a) between the domestic environmental forces and the foreign environmental forces and (b) between foreign environmental forces of two countries when an affiliate in one country does business with customers in another". Environmental forces can be internal or external. The latter are often named uncontrollable forces, because of the limited influence management of a firm has on these forces opposed to the internal, controllable forces like production factors (Ball et al., 2006).

Daft (2007) is more specific about the environmental domain. He distinguishes a task environment which "includes sectors with which the organization interacts directly and that have a direct impact on the organization's ability to achieve its goals" and the general environment which "includes those sectors that might not have a direct impact on the daily operations of a firm but will indirectly influence it". He considers government, socio-cultural, economic, technological and financial factors as general environmental factors that impinge on all organizations in the environment. It is these factors that Ball et al. (2006) classifies as uncontrollable factors.

The PESTEL-analysis is a macro economic model that can be used to present an overview of the factors that are categorized under the general environment which Daft (2007) distinguishes. The PESTEL-analysis comprises Political, Economical, Socio-cultural, Technological, Environmental and Legal factors (Ball et al, 2006).

Because PESTEL-factors are out of the internal locus of control of the organization, the organization needs to adapt to these uncertain factors of the general environment (Daft, 2007). We could therefore argue that it is important to map these factors, and see which factors influence the organizational domain before an organization decides to operate in the international environment. Important is the interpretation of PESTEL-factors by considering the factors that are subject to change and that will most impact the organization (Oxford University Press, 2007). More specific, to decide what opportunities the Chinese biomass market offers Dutch organizations, key factors of the macro environment have to be revealed.

First, the PESTEL-factors will be shortly explained, after which the key factors are identified which are most relevant for this research. This is done based on the theory of Ball et al. (2006).

2.1.1. Political factors

The major attributes of politics involve "making a common and uniform decision applying in the same way to all members of a group of people" and "the use of power by one person or group to affect the behavior of another person or group" (Shively, 2008). Before doing business in a country, political factors should be considered, because these factors can bring along political risk, i.e. "governmental or societal actions and policies originating either within or outside the host country and negatively affecting either a select group, or the majority of foreign business operations and investments". Managing political risk is important for succeeding in the macro environment (Simon, 1982 in Alon & Martin, 1998). A country risk assessment can give insight into political risks, but other risks as well (Ball et al., 2006).

Political factors refer to government policy and the extent it influences the economy. Examples of these factors are the type of government based on political ideologies, government ownership of business vs. privatization, nationalism, government protection of economic activities, traditional hostilities, and government stability (Ball et al., 2006).

2.1.2. Economic factors

Before doing business in another country, organizations should consider that they operate -besides their domestic environment- in a foreign environment and an international environment. It is not necessarily the case that organization policies designed for the domestic environment also function well in a foreign and/or international environment with different economic conditions (Ball et al., 2006).

Economic information is needed to estimate market potential. Among the key economic factors are (a) gross national income (GNI), which measures the total of all final goods and services produced; (b) gross domestic product (GDP) which measures total value of all *domestically* produced goods and services; (c) GDP per capita, which measures purchasing power; (d) purchasing power parity (PPP) which measures purchasing power to compare standards of living, including exchange rate of a currency; (e) income distribution; (f) private consumption expenditures, which give insight into the purchases of essential and nonessential goods; (h) inflation rates; (i) investment rates; (j) exchange rates; and (k) unit labor costs, which provide opportunity for investment if they are low than current costs of the firm (Ball et al., 2004).

2.1.3. Socio-cultural factors

Culture is defined as "the sum of the beliefs, rules, techniques, institutions, and artifacts that characterize human populations" (Brady & Isaac, 1975 in Ball et al., 2006). Culture is learned, shared, its aspects are interrelated and it defines boundaries of a group of people. Some major factors that define culture are: (a) aesthetics; (b) attitudes and beliefs; (c) religion; (d) material culture; (e) education; (f) language; (g) and societal organization (Ball et al., 2006).

Cross-cultural interaction between the domestic and the foreign environment affects organizations. To reduce the psychic distance and uncertainty between the familiar and unfamiliar culture, it is important that these items are studied carefully in order to be fully prepared for conducting business outside the domestic environment (Cavusgil et al., 2002).

2.1.4. Technological factors

In this research, technology is seen as the outcome of a socially constructed process of knowledge development and utilization (Narayanan, 2001). Technology is deeply involved into society (Smit & Van Oost, 1999). On an organizational level, technological factors influence customers as well as organizations that provide the technology. Technology can create advancements like cost reduction and quality improvement (Oxford University Press, 2007). Because technology and society are interwoven, technological advances often means societal change (Smit & Van Oost, 1999). Based on the previous, we assume that technological factors affect organizations and technological opportunity affects organizational market positions. In addition, utilization of a technological opportunity can create competitive advantage in a certain industry (Narayanan, 2001).

Technology can bring about invention and innovation (Schumpeter, 1950 in Narayanan, 2001). An invention is "a new combination of preexisting knowledge", while innovation is "a technological change new to the enterprise and the economy, which has diffused into the economy and is adopted by the firm". An invention can thus be seen as part of the innovation process (Narayanan, 2001).

The technological environment is shaped by level and direction of technological advancements (Narayanan, 2001). Technological factors that influence these technological advancements are the (elements of) technical skills and equipment that affect how resources are converted into end products (Ball et al., 2006). More specifically, technical macro environmental characteristics include (a) appropriability of rents associated with the product - patents, lead time for development of the product, learning curve efficiency and sales and service effort that underlies the innovation; (b) size of the product's value net - linkages with suppliers and producers; (c) standard setting process –by market forces or formal procedures- which influences when a technological design becomes dominant, i.e. results in competitive advantage (Srinivasan et al., 2006 in Van den Berge, 2009).

2.1.5. Environmental factors

Although environmental factors are generally not seen as the most important element in determining to study the nature of the economy, they influence the way of life and activities performed in a certain geographical area. Geographic factors that are useful for organizations, who want to do business in another country, are (a) location; (b) topography; (c) climate and; (d) natural resources (Ball et al., 2006).

There is a growing awareness to protect the environment. One of the major factors that cause this awareness is the increasing climate change and environment pollution, which become more problematic for human nature. This impacts a wide range of industries, for instance transportation- and energy industries (Oxford University Press, 2007). The presence of natural resources, like the energy resources petroleum, coal, and natural gas, impact an economy as well (Ball et al., 2004). It can be argued that a logical reasoning following this statement is that the presence of geographic factors can determine the competitive advantage of one region over another.

2.1.6. Legal factors

An organization has to deal with numerous legal factors that cannot be ignored. Particularly, an international business environment can provide some challenges. A stable host government and -legal system is important for a foreign organization. To be successful in a foreign environment, it is essential that the foreign organization is protected by the legal system of the host country. A country has a protective legal system if: (a) it is governed by rule of law; (b) there is a dispute resolution in international contracts; (c) it acknowledges intellectual property (trademarks, patents, copyrights, trade names etc.; (d) acknowledges standardizing world laws. The presence of specific national legal forces like tax legislation, e.g. to discourage consumption of tobacco etc., and antitrust laws which intend to stop inappropriate large concentrations of economic power, also influences organizations when the law is specifically applicable on their business (Ball et al., 2006).

2.2. Factors that influence the Chinese biomass market

The PESTEL-framework offers an insight into the macro-environmental factors that generally influences a market environment. Most probably, all these factors influence the Chinese biomass market to some extent – one more than the other. Obviously, environmental factors like the quest for more sustainable energy to protect the environment have a major impact on the existence and development of the Chinese biomass market. However, this research does not look for factors that explain the latter. It rather seeks factors that influence businesses of Dutch organizations in the Chinese biomass market. To provide an advice on the opportunities for Dutch organizations in the biomass market, assessing the entire macro environment appears to be irrelevant. It seems wiser to narrow these macro-environmental factors down to those that are most important for the biomass market. Therefore, we search for *conditio sine qua non* applicable for Dutch organizations that want to be active in the Chinese biomass market. Our quest starts at examining the setting in which Dutch organizations are (possibly) going to be active, namely China.

2.2.1. China as an emerging economy

According to the theory of Cavusgil et al. (2002) China is an emerging economy because it has: (a) started an economic reform process aimed at alleviating problems, for example, of poor infrastructure and overpopulation; and (b) achieved a steady growth in the gross national product (GNP) per capita. Emerging markets are characterized by a high concentration in decision making and market potential. In this, government influence exceeds regulatory involvement, although today this trend decreases. However, it is still reality that in emerging markets “all major deals go through government at one point or another”. Business often goes through bureaucratic government organizations instead of the individual involved party. Possible explanations for this active government involvement in economic activities are ambitious economic development goals and the influence of historical factors. Government involvement in the economy can have a direct and indirect nature; respectively through ownership of economic enterprises and centralized economic planning (Cavusgil et al., 2002). Based on the theory of Cavusgil (2002), we could thus argue that because China is an emerging market, government influence is a heavily weighted factor to be considered before entering the market. Interviews with employees of the Economic and Commercial Department and several other departments of the Dutch Embassy have confirmed this assumption by stating that the influence of politics is omnipresent in the Chinese business market, in particular the energy market. In other words, although other factors are to be considered as well, the multidimensional influence of politics surpasses the other PESTEL factors as distinguished by Ball et al. (2006). Therefore, we elaborate on theoretical concepts regarding political influence in China and the Chinese energy market.

2.2.2. Government influence in the Chinese energy market

More applicable to China as emerging market, Cavusgil et al. (2002) emphasize the importance of contact with Chinese authorities in doing business in China. The findings in a study conducted by Luo (2001), who analyzed 131 Chinese multinationals in his research on cooperation-based relations between multinationals and host governments, supports this statement by implicating that resource commitment, personal relations, political accommodation and organizational credibility are the so-called 'building blocks' to improve the relationship with host-governments.

More specifically, the research of Aden & Sinton (2006) confirms the relation between the energy system and government policy in the Chinese energy market. Biomass is one of China's energy resource endowments (Aden & Sinton, 2006). Thus, we could argue that the influence of energy policy on the Chinese energy system as schematically displayed in the figure below is applicable on the Chinese *biomass* market as well. Figure 1 presents the relation between the energy system, government policy and environmental outcomes:

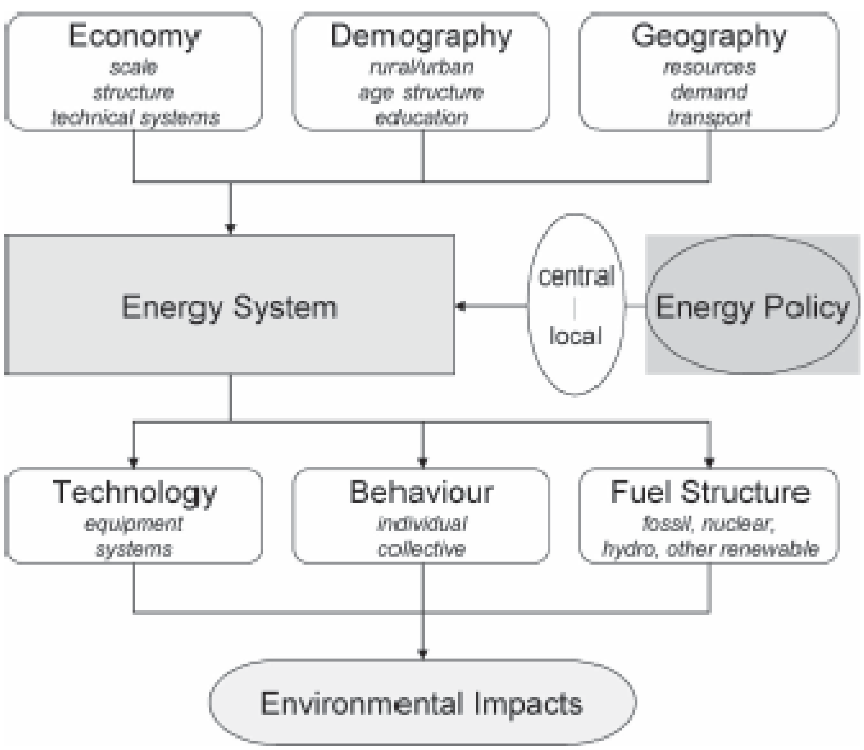


Figure 1 - The relation between energy system, government policy and environmental outcomes (Aden & Sinton, 2006)

The above figure shows economic, demographic and geographic factors as drivers that shape the energy system. Although economy, demography and geography shape the energy system, the energy system is "mutable according to government policies, implementation and institutions" (Aden & Sinton, 2006). In other words, the shaped energy system (due to economic-, demographic- and geographic factors) can be influenced by politics. Energy policy strives after access to international trade resources through open trade policy, a security of supply and technology access. Aden & Sinton (2006) give as example the support of the strategic goal to shift to cleaner fuel by internationalizing the country's energy politics. Available technology, consumer behavior and fuel structure are the local usage factors that affect environmental impacts of energy usage in the energy system.

The influence of politics on energy systems is illustrated through the following example. In the 1970s, biomass accounted for roughly 30 percent of the total primary energy consumption. However, from then on, decades of rural energy policy activity aimed at reducing the share of biomass; by 2003 it was about half of the share in total primary energy consumption compared to the 1970s. This was caused by an increase in the availability of modern fuels. The total amount of biomass began to grow again in the year 2000, probably as a result of a long existing government campaign on the closure of small rural mines that provided rural areas with cheap coal so that biomass again had to become the primary energy consumption source in Chinese rural areas. This sudden policy shift on rural energy comes from the concern of urgent environmental issues laid upon China. However, the government realizes energy feeds the growing distributional inequality between urban and rural regions. Surely, greater wealth leads to a lower reliance on biomass in household energy (Aden & Sinton, 2006). This example proves the major influence of politics on the energy system.

More generally, three themes have dominated China's energy sector since policy reforms in 1978; decentralization, a shift to liberalized markets, and internationalization. This has lead to increasing economic competition, energy efficiency and a shift towards renewable energy. There are also significant negative effects. For instance, decentralization in itself has caused dirty inefficient local coal mines to emerge with serious environmental consequences (Aden & Sinton, 2006).

The energy-environmental Kuznets curve (EEKC) is regarded as a useful framework to analyze the relation between energy and environment in China. It shows that in the "initial development stage, energy consumption increases at the cost of environmental degradation". However, increasing energy consumption will result in collective action to prevent pollution and environmental degradation, represented in a decrease of the EEKC slope instead of a positive ongoing relationship represented by the dotted line. That is, if full information is accessible to the public and collective action is not prohibited. This is both not the case in China. In addition, regulatory effectiveness from China's government is seen as essential to realize a decreasing EEKC slope. The fact that energy markets are not entirely liberalized – a cause of ineffective

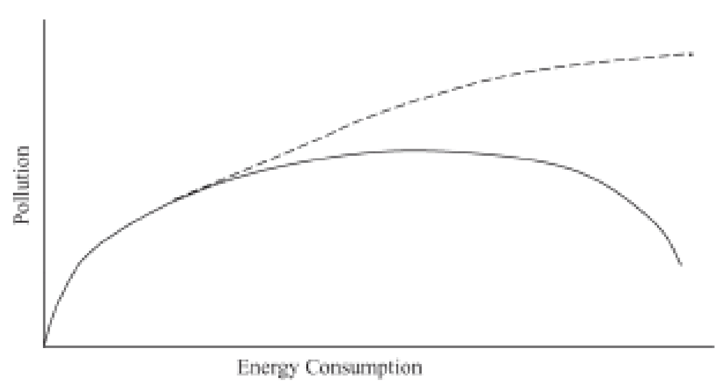


Figure 2 - The energy environment Kuznets curve

government policy-, results in unfair competition and a negative effect EEKC slope. A positive contribution of government policy to the EEKC slope is the transition to unleaded vehicle fuels and the replacement of cfc-using refrigerators (Aden & Sinton, 2006). We could argue that, one way or another, the effect of policy in energy markets is significant for businesses operating in that market, and cannot be ignored. However, it should be noted that other macro environmental factors also influence China's energy system, although politics is omnipresent.

2.2.3. Elaboration on political factors

The previous paragraph determined politics as *conditio sine qua non* for the Chinese energy market. For a full understanding of political factors, this paragraph intends to give more insight into political factors.

The political climate of a country reflects political ideologies of governments, political parties and people. These can be for instance communistic, socialistic, capitalistic, conservative etc. (Ball et al., 2006). The political ideology can affect its environment, and thus we could assume that it also affects organizations operating in that environment. For instance, China is a communistic country. Communism, as introduced by Karl Marx, strives after the ideal of a classless society. Historically seen, the government of a communistic country would want to own all major production factors. Government control on factories and farms was no exception in communistic China. Still the government controls most of the oil companies, grid companies etc. More importantly, its control shows from suppressing its opposition, for instance during the arrant Student Revolt on Tian'men Square in 1989.

Government ownership of businesses influences an industry. For instance, there is often unfair competition between state-owned corporations and privatized firms in markets. This can be a result of unequal subsidy provision (Ball et al, 2006). This might affect the competitive advantage of privatized firms and the feasibility of success in the market.

Another important influence is the degree of nationalism in a country. Nationalism is the emotional devotion to a person's own nation. According to Ball et al. (2006), nationalism has its effect on international companies, for example requirements for minimum local ownership, reservation of industries for local companies, preference of local suppliers over foreign supplies, limitations on the amount and type of foreign employees, protection through tariffs, quota's etc, or even a total barrier to foreign companies.

The degree of government protection of economic activities is important as well, because certain events –like war and terrorism- are at national level demanding a national approach but also affect the economy. Whether a country is involved in war, or has traditional hostilities, also impacts the economy of a country.

Furthermore, government stability influences an industry. A government is stable when "it maintains itself in power and when its fiscal, monetary, and political policies are predictable and not subject to radical change" (Ball et al., 2006). It can be assumed that, based on this definition, predictability facilitates equal and fair business treatment, opposed to radical change which causes unpredictability and uncertainty for organizations. An instable government can be the cause of revolution, racial conflict, or invasion from abroad.

For a company to be successful in a foreign market, it is essential that managers develop and maintain a network of relationships in the international environment. One of the key relationships is the relationship with foreign governments, government officers, bureaucrats and policy makers (Cavusgil et al., 2002).

2.3. The Chinese biomass market

In the previous paragraph we have determined politics as a *conditio sine qua non* for Dutch organizations that want to enter the Chinese biomass market. Without relationships with foreign governments, bureaucrats and policy makers, we argue that Dutch organizations cannot be successful in the Chinese market (Cavusgil et al., 2002). This paragraph elaborates on the characteristics of the Chinese biomass market.

According to the research of DeLaquil et al. (2003) biomass can be converted into refined liquids, electricity, heat and biogas. The research was build upon the China MARKAL model which focuses on a bottom up technology based approach for analyzing future energy scenarios for China (Wu et al., 2001 in DeLaquil et al., 2003). Refined liquids can be used in end-use technologies like industrial processes, urban- and rural cooking and water heating, passenger transport and freight transport. Liquid fuel for transport purposes is said to have most potential (Roland Berger Strategy Consultants, 2009), particularly because of China's growing middleclass. The end-use technologies of electricity are industrial electricity and non-fuel, commercial space heat, commercial air conditioning, urban air conditioning, urban space heat, lighting and appliances, and agricultural processes (e.g. electric motors). Heat is used for industrial processes, commercial air conditioning, commercial space heat, urban space heat and rural space heat. At last, biogas is used for rural cooking and water heating, and rural space heat.

An important characteristic of the Chinese market reveals itself, namely the difference between energy use in rural areas and energy use in urban areas and industry. This is particularly important since the share of rural population is larger than urban population (Chinese National Bureau of Statistics, 2009). However, the per capita energy demand is higher in urban areas compared to rural areas (Aden & Sinton, 2006).

Although the electricity sector is still state-operated and enjoys the heaviest subsidies from the Chinese government, we can assume government influence (e.g. through subsidies) is still reality in the entire energy sector. This is confirmed by Pernick & Wilder (2008), who state that in the clean energy and clean technology sector in most emerging economies, government influence is significant. More specifically, the government is traditionally involved in most of the funding that results in clean-tech growth, together with international government-financed agencies like the World Bank (Pernick & Wilder, 2008). At present, China adopts a more liberalized approach to energy markets (Aden & Sinton, 2006). However, the government is still heavily involved, and for the future years to come it is predicted that this will not be any different (Pernick & Wilder, 2008).

2.3.1. The need for energy

To determine where the opportunities for Dutch organizations are in the wide-ranging Chinese biomass market, we adopt a marketing approach. The key idea of marketing orientation is that "to satisfy the consumer it is necessary to identify the products for which there is demand and to understand the needs and wants with which the product will satisfy the consumer" (Boddy, 2008).

There are two trends visible: (a) about 54% of the Chinese population lives in rural areas (China's National Bureau of Statistics, 2008), in which they rely for 80% on biomass energy, and (b) there is a rapid urbanization trend (Aden & Sinton, 2006); about 400 out of 700 million (National Bureau of Statistics China, 2009) people are expected to move from rural to urban areas by 2020. One of the factors that cause this migration is the growing middleclass in China (Pernick & Wilder, 2008).

This urbanization trend causes a need for energy in urban areas. Since (a) China is the second largest CO_2-emitter in the world and has ratified Kyoto protocol targets (IEA, 2008); and (b) there is a need for independence of fossil fuel supply from abroad, China's government recognizes the importance of diversification in the energy sector by a focus on renewable energy (Information Office of the State Council of China, 2007).

Based on the above, this research focuses on renewable energy in urban areas because the need for renewable energy is highest due to rapid urbanization in these areas which already deal with a high population density. Furthermore, the government acknowledges the need for renewable energy.

Since car- and vehicle ownership is strongly related to per capita-income (Dargay & Gately, 1999), it can be said that a growing middleclass causes motorization in China. Figures from the National Bureau of Statistics of China support this statement; the total number of private-owned cars used by civilians was 19,47 million in 2008, an increase of 28% compared to 2007. In addition, the Chinese car market is expected to overtake the U.S. car market, the biggest in the world, by the year 2016 (IEA, 2007).

Because of a motorizing middleclass and a need for more renewable energy particularly in urban areas, we can argue the transport sector offers opportunities for Dutch organizations who want to be active in the biomass market in China. The most potential applications of renewable energy in the transport sector are bio-diesel and bio-ethanol (Pernick & Wilder, 2008).

2.4. An approach for Dutch organizations

Now we have determined that politics influences the Chinese biomass market, and that without a need for renewable energy there is no market opportunity, we can determine *where* the opportunities are in the market. However, we do not know what characteristics of Dutch organizations will exploit these opportunities. Therefore, this paragraph determines what is necessary for Dutch organizations to become successful in the Chinese biomass market.

2.4.1. Competitive advantage

According to the theory of Reid & Sanders (2005), an organization is successful in a market environment where its core competences will have value. Core competencies are the strengths of an organization expressed in its workforce, facilities, market understanding, financial know-how, and technology (Reid & Sanders, 2005).

Boddy (2008) relates core competences to competitive advantage, by identifying core competences as "the activities and processes through which resources are deployed to achieve competitive advantage in ways that others cannot imitate or obtain". The resources of a firm are "all assets, capabilities, organizational processes, firm attributes, information, knowledge etc., controlled by the firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness" (Daft, 1983 in Barney, 1991).

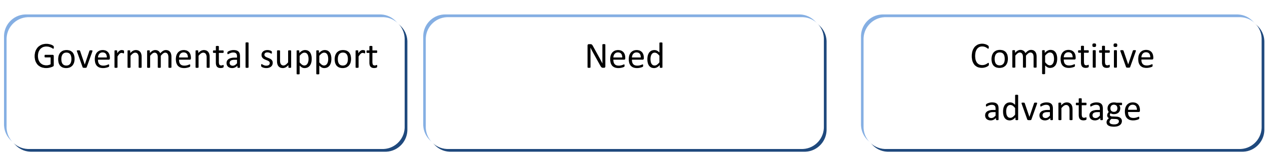
Porter's diamond model on competitive advantage of nations is based on the premise that firms - rather than nations - compete in international markets. In other words, a nation gains competitive advantage if its firms are competitive. Competitive advantage increases if value is added in a firm's activities (Porter, 1990).

To realize *sustained* competitive advantage, Barney (1991) argues that a firm's resources need to be valuable, i.e. exploiting opportunities and neutralizing environmental threats. More specifically, a firm's resources: (a) must be rare to current and potential competition; (b) must be hard to imitate, and; (c) cannot have strategically equivalent substitutes that are valuable but neither rare nor hard to imitate. Based on the theory of Barney (1991), we can thus argue that Dutch organizations have competitive advantage in the Chinese biomass market when:

- They obtain resources that are valuable to the biomass market
- Their resources are rare to the current and potential competition
- Their resources must be hard to imitate
- Their resources do not have strategically equivalents that are valuable and neither rare or hard to imitate

2.5. Conditio sine qua non for the Chinese bio-fuel market

Literature analysis has limited our broad scope regarding the biomass market, to the most potential application of biomass that responds to a motorizing Chinese middleclass, namely bio-fuel. To enter the bio-fuel market, we argue based on this literary review, that there are three *conditio sine qua non* for Dutch organizations to be successful in the bio-fuel market; governmental support, a "need" for a certain product, and competitive advantage.



2.6. Value in the supply chain

We have stated that, for Dutch organizations to be successful in the Chinese market, government support, a market need and competitive advantage are crucial elements. The first two have reduced the possible opportunities in the entire biomass market to a more specific market, namely the bio-fuel market. Because we now decided to focus on the bio-fuel market, we can further look at how to be successful in this specific market. The previous paragraph determined the relation between competitive advantage and a companies' success in a certain market, this paragraph aims to create a framework to determine competitive advantage.

As stated before, competitive advantage increases if value is added in a firm's activities (Porter, 1990). "The network of all activities involved in delivering a finished product to the customer" is called a supply chain (Reid & Sanders, 2005). We can therefore argue that to achieve competitive advantage we have to determine where in the supply chain value can be added. Furthermore, we can say that without governmental support, a company cannot enter a specific supply chain, and that without a need for a certain improvement it is hard to be successful within the supply chain. In other words, the previous established *conditio sine qua non* can all be related to a supply chain analysis.

2.6.1. The supply chain

For succeeding in a business environment, relationships with suppliers are becoming increasingly important because organizations are becoming more dependent on suppliers. To control the relationships with suppliers and other stakeholders, supply chain management is essential. Harland (1996) categorizes the term 'supply chain management' in four ways; (a) an internal supply chain which involves and integrates functions within a business; (b) the management of dyadic relationships with direct supplier parties; (c) the management of a chain of businesses; (c) the management of a network of interconnected businesses.

Since we are studying the bio-fuel *industry*, we focus on more relationships than only the dyadic

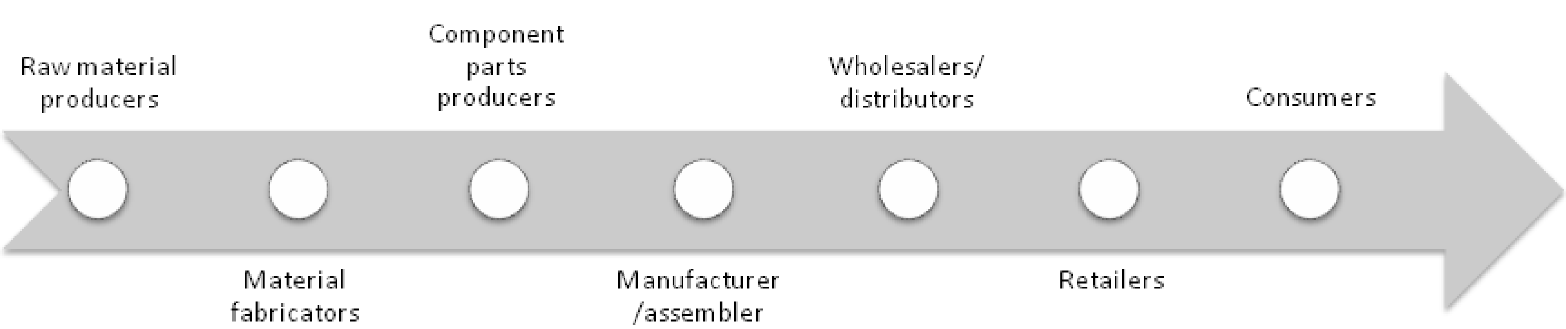


Figure 3 - Inter-business supply chain

relationship between business and supplier. This means we look at the supply chain as a chain of businesses, i.e. an inter-business supply chain (Harland, 1996). We assume that actors will not be dependent of each other like in a network of interconnected businesses. The inter-business supply chain is presented in the figure below:

In the book 'The competitive advantage of nations', Porter (1990) writes about the importance of value systems for competitive advantage. His definition of a value system closely resembles the inter-business supply chain. The value system exists out of various organizational value chains as part a larger stream of activities. According to Porter (1990), the value system offers insight in the sources of cost advantage and shows the foundation of differentiation. Both cost advantage and differentiation give insight to a firm's position in its collective.

To what extent competitive advantage is reached, depends on how well this value system is managed (Porter, 1990). Porter's value system includes supplier, firm, channel (distributor/retailer) and buyer value chains. In other words, we can argue that his value system is the less detailed version of the inter-business supply chain. Because Porter (1990) focuses on competitive advantage at an industry level, we can argue that the inter-business supply chain is also applicable on industry level and therefore suitable for this research into the bio-fuel industry. An inconsistency of Porter's study is that it is focused on competitive advantage in 10 nations, of which only two can be classified as an emerging economy (South Korea and Singapore).

To determine where value is added in the supply chain, we have to identify inconsistencies ("needs") in the supply chain which cause an ineffective and inefficient supply chain. Inconsistencies imply a source of opportunity and therefore serve as the basis for adding value in a market. However, we should take into account that an opportunity does not necessarily imply a market (Kerin & Peterson, 2007). We thus have to analyze the supply chain for bio-fuels in order to determine where there are inconsistencies, which should be solved in order for the Chinese market to satisfy the demand in the bio-fuel sector.

2.7. Conclusion

The literary review established three prerequisites that applicable on Dutch organizations that want to do business in the Chinese biomass market; government support, a need for a product or service, and competitive advantage. At first, government support is needed to become successful in this foreign market. Second, there should be a need in the Chinese market for the product or service that Dutch organizations want to offer. Finally, competitive advantage will add value in the market for Dutch organizations, and will enclose the inconsistencies in the Chinese market. To determine value in the market, this research will adopt a supply chain approach.

Furthermore, the literary review has served as a framework to narrow the scope of the Chinese biomass market to the bio-fuel market, based on a growing middleclass with a need for energy that causes motorization.

3. Methodology

We have already determined that this is an exploratory research. After our exploration of theories and concepts in the literary review, we have narrowed down our scope from the entire biomass market to the bio-fuel market. Based on the literary review, this paragraph will introduce a research question, sub-questions and methods that will provide an answer to these questions.

3.1. Main research question

As was stated in the introduction, the purpose of this research is to contribute to the knowledge and understanding of the Embassy of the Kingdom of the Netherlands in Beijing in the area of biomass in China, by studying and analyzing the Chinese biomass market and providing insights on where Dutch organizations can best utilize their qualities. The literary review has limited the opportunities for Dutch organizations in the biomass market to a focus in the bio-fuel market. In order to determine competitive advantage for Dutch organizations, this research will take on a supply chain approach. Therefore the main question is:

"Where in the supply chain of bio-diesel and bio-ethanol are opportunities for Dutch organizations in China within a political context?"

3.2. Sub-questions

In order to provide an answer to the main question, several sub-questions are formulated. These questions will systematically provide an answer to the main question. The first sub-question is based on the first prerequisite the literary review identified for the Chinese biomass market, namely government influence. The position of the government and future targets regarding the bio-fuel sector in China, will serve as a basic introduction into the Chinese biomass market and its growth prospects. This is because government influences the state-of-the-art, and should therefore be acknowledged in order to interpret the present conditions in the right way. The second question will elaborate on the state-of-the-art of the bio-fuel sector in China. It will focus on the different types of bio-fuel, namely bio-diesel and bio-ethanol and their so-called generations. Then the supply chain of bio-diesel and bio-ethanol will be presented. Based on these supply chains, gaps are identified in the Chinese bio-fuel market. At last, we determine which gaps present opportunities for Dutch organizations. This approach leads to the following sub-questions:

1. What is the position of the Chinese government regarding bio-fuel?
2. What is the state-of-the-art of the bio-fuel sector in China?
3. What is the supply chain of bio-diesel in China?
4. What is the supply chain of bio-ethanol in China?
5. Where in the supply chain of are opportunities for Dutch organizations that want to be active in the Chinese bio-fuel market?

3.3. Conceptualization

The research question and sub-questions address the concepts 'supply chain', 'opportunities', 'Dutch organizations' and 'political context'. Because these concepts need some specification, this chapter operationalizes the relevant terms. In this research, when we talk about a supply chain, opportunities, Dutch organizations and 'political context', the following is meant:

- **Supply chain**: a chain of businesses, i.e. an inter-business supply chain (Harland, 1996). More specifically, a supply chain comprises all the activities involved in delivering a product to the customer (Reid & Sanders, 2005). This begins with the raw material producer, after which the material fabricators, component parts producers, manufacturer/assembler, wholesalers/distributors, and retailers will follow. The product eventually ends up with the consumer (Harland, 1996).
- **Opportunities**: all activities that add value in the supply chain (based on Porter, 1990), based on an analysis of the gaps or inconsistencies that make the supply chain inefficient and ineffective.
- **Dutch organizations**: all companies which are home-based in the Netherlands and want to sell their knowledge and/or technology in the biomass sector in China to broaden their market scope and/or enlarge their profits.
- **Political context**: The context in which political ideologies of the Chinese government, political parties and people is reflected. Political ideologies affect the business environment (Ball et al., 2006). More specific, the energy market is heavily governmentally influenced. The fact that energy markets are not entirely liberalized results in unfair competition and negative effects on the environment (Aden & Sinton, 2006). Furthermore, without government subsidies it is hard to make profit in the biomass energy market. Government targets as set in the 11th five-year-plan have a guiding role in influencing the emergence of (more) renewable energy in the nearby future. Therefore, the position of the Chinese government is a very important starting point to take into consideration when a company or institute wants to enter the Chinese bio-fuel market.

3.4. Research strategy

The research strategy is the total of inter-connected decisions regarding the way the research is performed (Verschuren & Doorewaard, 2007).

Because of the -still- enormous size of the Chinese bio-fuel market and the number of organizations it encompasses, we can classify this study more as a broadened investigation. The advantage of this type of research is that results can be generalized. However, an in-depth research will provide a more detailed picture, in this case for instance on the opportunities of one company in specific part of the supply chain. Furthermore, this research has a qualitative character, which means an explorative and contemplative view on the object of study (the Chinese bio-fuel market). This implicates desk study forms a major part of this research (Verschuren & Doorewaard, 2007). However, empirical data is obtained through interviews with Chinese and Dutch stakeholders.

3.5. Data sources

An exploratory study is usually conducted through; a search of literature, interviewing experts on the subject and conducting focus group interviews (Saunders et al., 2007). In this research, the method of data gathering is two-fold: a literature- or desk study in combination with interviews. This means on the one hand, data was gathered through the use of existing material and on the other hand interviews were conducted to acknowledge the data results gained from desk study or to gain more information on the topic.

3.5.1. Desk study

Saunders et al. (2007) distinguish first and secondary data. Secondary data are mainly compiled data, i.e. "data that have received some form of selection or summarizing". Secondary data can be documentary, obtained from multiple sources (area based and time-series based) or survey data. This research mainly uses (a) documentary data, i.e. written materials like newspapers, organizations websites, databases; (b) area based sources like government publications, books and journals; as well as (c) time series based sources like government statistics, industry reports etc. (Saunders et al., 2007).

3.5.2. Interviews

The conducted interviews had a semi-structured nature, also called qualitative research interviews. This means the interviews are not standardized, but are based on a list of subjects and questions which are to be covered during the interview. The subjects and questions vary in different interviews. The advantage of these non-standardized interviews is that they are flexible; the order of the questions may vary and additional questions can be added. This flexibility suits the nature of an exploratory research (Saunders et. al, 2007).

One of the methods for gathering diverse information in a relatively fast way is through interviews with several persons. The persons that were interviewed during this research can be classified as experts, who serve as a source of knowledge (Verschuren & Doorewaard, 2007). Interviews were mainly conducted in person. The following persons and or organizations were interviewed during this research:

- **Beijing Fei Nie Er Co., Ltd (2 March 2009, Beijing)**
  Lu Chao Liu - Chairmen of the Board
- **Biomass Technology Group (28 January 2009, Enschede)**
  Gerhard Muggen – General Manager BTG Bioliquids BV – the Netherlands
- **Chinese Academy of Agricultural Sciences – Institute of Environment & Sustainable Development (15 April 2009, Beijing)**
  Hongming Dong – Ph.D Professor
- **ClearWorld Fuels Company Ltd. (20 April 2009, Beijing)**
  Darrell Barnes – Chief Operating Officer
- **COFCO (7 April 2009, Beijing)**
  Lin Hailong – Assistant General Manager R&D Department Bio-chemical & Bio-energy Division
- **Embassy of the Kingdom of the Netherlands in Beijing**
  William Sun – Energy/Environment Commercial Officer, Economic and Commercial Department
  Henk van Duijn – Head Agricultural, Nature and Food Department (9 April 2009)
- **National Bio-energy Group, China (6 March 2009, Shandong)**
- **KEMA (24 March 2009, Beijing)**
  Rene Hooiveld – Country Manager Consulting Service China
- **Roland Berger Strategy Consultants - Press conference (6 March 2009, Shandong)**
  Watson Liu – Partner & Vice President for Greater China

- **Shengli Oil Field Shengli Power. Machinery Group.Co., Ltd (6 March 2009, Shandong)**
  Wang Zhichun – Vice-president Executive Director

As stated before, the majority of the interviews were semi-structured. The exception was the interviews with William Sun, which were mainly unstructured and informal. William Sun Is the Energy and Environment Commercial Officer at the Economic Department of the Dutch Embassy in Beijing. Because of his work experience at one of the major Chinese oil companies he has a lot of experience in the Chinese energy market, and is therefore regarded as an expert on the Chinese energy market. The non-directive interviews with Mr. Sun were a suitable means to gain a more in-depth view of the Chinese biomass market.

The interviews with several experts in the biomass market were conducted to get a clearer picture of the total Chinese biomass market. These interviews also helped to create a more profound decision base to focus on the bio-fuel market in this research, by comparing the latter to the opportunities that the other biomass applications bring about.

3.5.3. Non-probability sampling

The interviewed experts were selected based on non-probability sampling, given that we deal with absence of a sampling frame because of the vast size of the biomass market, as well as an in-dept study. Non-probability sampling is a "selection of sampling techniques in which the chance or probability of each case being selected is not known" (Saunders et al., 2007). Since we want to represent the activities of Dutch organizations that are opportune in the Chinese biomass market, the interviews represent the Chinese and the Dutch point of view:

- **Players in the Chinese market (production):**
  - Beijing Fei Nie Er Co., ltd
  - COFCO (Chinese market leader bio-ethanol production)
  - National Bio-energy Group
  - Shengli Oil Field Shengli Power. Machinery Group.Co., Ltd
- **Chinese knowledge institutes:**
  - Chinese Academy of Agricultural Sciences (knowledge institute)
  - Roland Berger Strategy Consultants
- **(Potential) Dutch players in the Chinese biomass market:**
  - Biomass Technology Group (not active –yet-)
  - KEMA (already active in the electricity market)
- **Dutch knowledge on the Chinese biomass market:**
  - Dutch Embassy in Beijing (Economic and Commercial Department & Agricultural, Nature and Food Department)
- **Other European players in the Chinese biomass market:**
  - ClearWorld Fuels Company ltd. (English company)

Particularly in China, there is a lot of time between the application for an interview and the actual interview to take place. This made it impossible to conduct more interviews due to time limitations.

Apart from the conducted interviews described above, I also tried to interview Ilse Pauwels of the Ministry of Housing, Spatial Planning and Environment at the Dutch Embassy in Beijing, and Judy Zhang who is in charge of DSM's bio-tech activities in China. Due to a busy schedule both interviews did not take place. Since DSM is a Dutch company that is active in the Chinese bio-fuel market in China, we can say that this research misses an area of expertise on the subject. The interview with Ilse Pauwels would have given more insight into the Dutch situation on biomass energy from the Ministry's point of view. Because these interviews did not take place, this research lacks two areas of expertise. However, with the use of secondary data I have tried to compensate for this.

3.6. Research criteria

3.6.1. Secondary data

Because this research is largely based on secondary data, it is wise to investigate the suitability of this data for the research. More specifically, we look at whether data is reliable and valid. Reliability concerns "the extent to which data collection procedures will yield consistent findings". Validity concerns "whether the findings are really about what they appear to be about" (Saunders et al., 2007). A high validity and reliability can be achieved by looking at the reputation of the source (Dochartaigh, 2002 in Saunders et al., 2007). Although I tried to get all information from sources with a high reputation, like direct company sites, well-known journals etc., there is still a danger of bias in the secondary data. This is mainly due to the fact that information was hard to find (sometimes only one source was used). In addition, sometimes information showed some discrepancies that can be explained by the fact that the biomass market is still relatively new and a consistent and comprehensive understanding of this wide-ranging market has not yet emerged. Therefore, data needed to be merged from different –sometimes contradictory- sources. The discrepancies, particularly regarding the Chinese situation, may have caused some disparity from actual circumstances. More general, another danger is that because of market growth expectations, the data represented in this report may be outdated in the nearby future.

3.6.2. Semi-structured and in-depth interviews

The use of semi-structured interviews and in-depth interviews can cause some data quality issues like reliability, validity and generalisability (Saunders et al., 2007). Because we have to detect qualitative data, which lack a standardized structure, there is a danger that the results are not reliable enough. In other words, the question is if other interview research in this subject would reveal identical results (Easterby-Smith et al, 2002 in Saunders et al., 2007). Non-standardization can be perceived as a weakness, but also as strength of qualitative research. Its strength is that it is highly flexible and adaptive which is suitable for determining relevant aspects in a very broad market (Saunders et al., 2007). In this research I have tried to overcome reliability issues by carefully preparing the interviews so that I was well-informed. In some cases I provided the interviewer in advance with a list of questions and or subjects that I wanted to discuss during the interview.

Validity in interviews is the "extent to which the researcher gains access to their participants' knowledge and experience, and is able to infer a meaning that the participant intended from the language that was used by this person". Generally, in qualitative research validity is not a real threat because un- or semi-structured interviews provide space for the respondent to express his intended knowledge and opinion (Saunders et al., 2007).

Generalisability concerns the question whether the found qualitative data can be generalized to the entire population (Saunders et al., 2007), in this case the entire bio-fuel market in China as well as all Dutch organizations that want to operate in this Chinese market. Only ten different experts where interviewed, which makes the number of cases very small when it comes to representation of an entire market. In addition, it should be taken into account that the various respondents all have a different background and therefore might be unrepresentative for the entire population.

3.7. Conclusion

The literary review has limited the opportunities for Dutch organizations in the biomass market to a focus in the bio-fuel market. The interviews with experts contributed to the formulation of the conclusion. This paragraph has identified a research question and sub-questions which will give more insight into the opportunities for Dutch organizations in the supply chain of bio-diesel and bio-ethanol in China. This research is conducted mainly through a desk study based on secondary data and semi-structured interviews. By critically analyzing the data resources on reliability, validity and generalisability, the weaknesses of the research are acknowledged and the strengths are determined. Particularly threats to the reliability and generalisabiliy of the research should be taken into account. Together with the literary review, the information obtained from secondary data and interviews serve as the basis for the next chapter which will present the findings of the research.

4. Findings

This chapter will present the findings of this research into the bio-fuel market in China. Since the goal is to answer the main question '*Where in the supply chain of bio-diesel and bio-ethanol are opportunities for Dutch organizations in China within a political context?',* we will start with describing the political context by presenting government position and targets. This will contribute to a better understanding of the market because it influences the market to a great extent. For instance, Chinese entrepreneurs are highly dependent on government subsidies, because these subsidies generally make their plant or business more profitable. Then the different generations of bio-fuel will be explained, followed by a description of the supply chain of bio-diesel and bio-ethanol. An analysis of gaps in the supply chain will provide us with information on opportunities in the markets. Eventually, a determination of Dutch competitive advantage will reveal opportunities for Dutch organizations in the Chinese bio-fuel market.

Biomass can be processed through various conversion technologies into energy resources. All engine fuels produced from the production of biomass are called bio-fuels (Advisory Council on International Affairs of the Netherlands, 2008). This research further focuses on liquid bio-fuels used in the transport sector, namely bio-diesel and bio-ethanol, because the transport sector is growing tremendously in China indicating numerous business opportunities.

4.1. Government position & targets

To prevent the transport sector from becoming too dependent on oil imports and to diminish air pollution, bio-fuels receive severe attention from the Chinese government. The government is very clear on the usage of feedstock for fuel. As stated in the Medium and Long-Term Development Plan for Renewable Energy in China: "a lot of attention should be given in the case of the development of biomass energy to the relationship with both grain and the ecological environment. Cultivated land should not be illegally occupied, food grains should not be excessively consumed, and the ecological environment should not be destroyed" (NDRC, 2007). In other words, food security is more important than fuel (China Daily, June 2008).

The Chinese government is conducting research on the large-scale production of bio-fuel that potentially replaces bio-fuel that threatens food security and arable land (Koizumi & Ogha, 2007). From 2007 onwards, new projects are only approved if they produce other than so-called first generation bio-fuel, based on resources not competing with food. Plants that are currently involved with the production of first generation bio-fuel are allowed to maintain their operations, but are expected to be outnumbered by their so-called second generation fuel competitors within the next years.

In 2005, the annual usage of bio-diesel was approximately 50.000 tons. The usage of bio-ethanol in 2005 equaled about 1 million tons bio-ethanol. The government target for 2010 is set at 200.000 tons for bio-diesel. This target has anno 2009 already exceeded 300.000 tons annual output. The target for bio-ethanol is 2 million tons in 2010. For 2020, the annual consumption of bio-diesel is targeted at 2 million tons, and for bio-ethanol at 10 million tons. This market clearly shows large potential in the long term (Roland Berger, 2009). However, currently bio-ethanol is backed up with government support policies, stringent production standards and regulations. Bio-diesel on the other hand enjoys much fewer incentives. This is probably due to the lack of resources in China, which are needed for the production of bio-diesel.

4.2. Generations of bio-fuel

Bio-fuels can be classified into generations (Ministries of Housing, Spatial Planning & Environment, Economic Affairs, Development Cooperation and Transport & Water, 2007; Advisory Council on International Affairs of the Netherlands, 2008). The first generation is produced with relatively simple techniques, derived from feedstock harvested for their ready available sugar and oil content. Examples are maize, wheat, rapeseed, palm- and vegetable oil, and sugar beet. Compared to traditional fossil fuels, the first generation bio-fuel results in 50% (in case of maize, vegetable oil, sugar beet or wheat) to 80% (in case of sugar cane) lower CO_2 emissions (TWA/Tijs, 2008).

A mid-term solution for first generation bio-fuel is the use of crops that do not endanger food security in China. Chinese cereals, oils and food company COFCO classifies this as generation 1,5, i.e. a mid-term solution between the first and the second generation. Examples are cassava and sweet sorghum for bio-ethanol production (interview with Lin Hailong, COFCO ltd., 2009).

The second generation is based on ligno-cellulosic biomass, in which sugar and oil content is not readily available, but obtained through a biochemical or thermo chemical process. The difference with the first generation is that the second generation resources are not obtained from food crops, but from crop residues, agricultural waste products, grasses and wood chips. Ligno-cellulose is a process which breaks down cellulose of the feedstock into sugar through fermentation and converts it into glucose (Interview with W. Sun, 2009). It needs less fertilizer and water which makes it more efficient on the cost side. Technology in the second generation makes it possible to use more low quality soil to grow biomass, which is why these generate a more positive energy and CO_2 trade-off; greenhouse emissions are about 90% lower compared to traditional fossil fuels (TWA/Tijs, 2008).

The second generation is still developing globally. As for the Chinese government expressed its view on the first generation by saying that it was absolutely implausible to use biomass that competes with food security, the opportunities in China are only present in developing technology supporting second generation bio-fuel. Challenges persist mainly in creating more efficient production processes that are less costly. Government subsidies on R&D are a precondition for the second generation to become highly commercially viable (Pretorius, 2007).

The third generation bio-fuel is produced through energy crops that are genetically engineered. The difference with the second generation is that the crops are genetically manipulated to be better energy crops, i.e. contain more sugar and low lignin contents for more highly efficient production (Pretorius, 2007). An example is the production of varieties of corn that contain certain enzymes that are essential for breaking down cellulose in the plants' leaves into sugar. These leaves used to be considered as a waste-product. These varieties of corn facilitate the production of ethanol by making it more efficient and cost-effective (Biopact, 2007). In addition, the genetically engineered crops can be engineered to produce more waste, which can be used for biomass energy.

The third generation is still less developed compared to the second generation bio-fuels. When it becomes commercially viable, it might be of interest to China because it can make the country more independent of import of resources to produce biomass energy. In other words, compared to the previous generations, the third generation makes countries less reliant on the type of biomass traditionally grown at their soil.

Generally, the use of algae is also classified as third generation bio-fuel. The oil content of algae can be converted into diesel, but algae can also produce ethanol gas in a natural way. This makes it possible to capture ethanol gas that is released by algae, without killing the algae. Another advantage of algae is that they are biodegradable and have high oil content. In general, the commercial application of algae is still in development. However, some firms are able to produce algae on a large scale. An example is the company Algenol Fuels based in Florida, which have the facilities to produce a billion gallon ethanol per year. “Algae are grown in flat, desert areas where land is cheap but is near seawater”. This means arable land is not required for the production of algae and can be used other wise. The process involves “algae, sunlight, carbon dioxide and seawater”. Water is pumped into containers. Due to the use of plastic that still allows sunlight to come through, the algae are able to grow in the containers and convert carbon dioxide into ethanol. When more carbon dioxide is pumped into the containers, the process of producing ethanol accelerates (Gulf Coast Business Review, 2008). Since algae have a high oil content that is useful for the production of bio-diesel, can produce ethanol in a natural way, and the production of ethanol from algae spares arable land, it seems a promising alternative for future energy demand.

4.3. Bio-diesel

Bio-diesel is the green variant of diesel, consisting out of a mixture of diesel and oils from plant seeds, trees etc. It can be used in cars driving on diesel. Bio-diesel is produced through chemical processes. The technology of producing bio-diesel is much less complicated compared to bio-ethanol (Yuan et al., 2008).

4.3.1. The supply chain of bio-diesel

In order for biomass to become bio-diesel, several steps should be taken. Figure four represents the supply chain of bio-diesel. First, the resources are collected and brought to the plant for fuel production. After distribution to the oil companies, bio-diesel is mixed with diesel and ready for service stations.

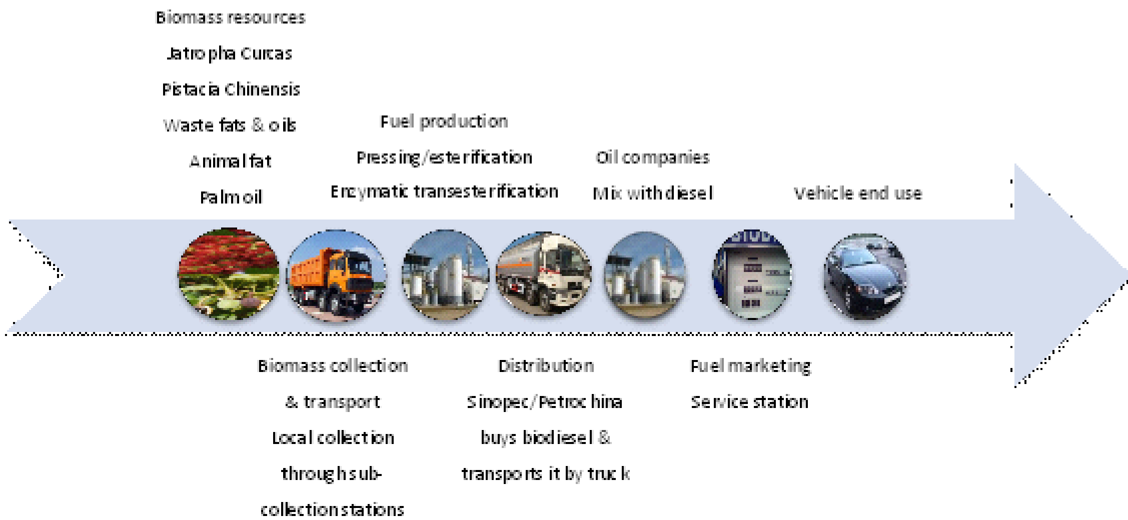


Figure 4 - Supply chain of bio-diesel

Resources

Up to 2006, first-generation bio-diesel was produced mainly based on rapeseed oil and imported palm- and soybean oil. Today, the Chinese government only approves new plants if they are producing second generation fuel. The plants producing first generation fuel are still allowed to operate. The input for second generation bio-diesel in China is mainly from cooking oil residues, animal fat and seeds from the oil crops Jatropha Curcas and tree species Pistacia Chinensis. Jatropha Curcas and Pistacia Chinensis biomass resources contain high oil percentages that are needed for bio-diesel production, varying from 40-60%. Jatropha Curcas is grown in Sichuan and Yunnan province. Pistacia Chinensis is grown in north, south, south-west and central China (TWA/Tijs, 2008). Today, the resources endowments for bio-diesel are not sufficient to support a big industry. Therefore, the development of Jatropha Tree forests is gaining more attention in China today. Jatropha Tree is a favorable biomass resource because its ability to grow on low quality soil. The development of the forests is already planned in Guanxi Province, Guizhou and Fujian Provinces, Sichuan and Yunnan. In Guanxi Province, the 165.000 acres Jatropha Forest is expected to generate 160.000 MT of bio-diesel (China Strategies, 2008). However, to what extent this will develop in the future seems uncertain since China lacks land for bio-diesel crop production.

Collection & transport

The biomass resources are collected locally, i.e. near farms or forests. Transport cost advantages are realized when the resources are available near the fuel production plant. After collection in sub-collection stations, the biomass is transported to the production plant by truck. Collection is still decentralized and therefore inefficient (interview with Biomass Technology Group, 28 January 2009).

Production

Up to June 2007, the main producers of bio-diesel in China were Hainan Zenghe Bio Energy, Sichuan Guchen Youzhi Chemical and Fujian Zhuoyue New Energy. Since 2006, there are also biodiesel plants build in Shanghai, Jiangsu, Anhui, Chongqing, Xinjiang and Guizhou. These new plants are aiming at outputs of more than 600.000 tons per year. Compared to the current total annual output of 300.000 tons (ranging from 100 to 20.000 metric tons per plant), this increase promises a large growing market. However, these figures are still based on first generation bio-fuel production, mainly palm- and rapeseed oil.

Distribution to oil companies

After production of bio-diesel in the fuel production plant, it is directly bought by Chinese oil companies Sinopec and Petrochina. An estimated amount of 10% of the bio-diesel is mixed into their diesel. After completing this process, it is ready for retail at service stations. Storage of bio-diesel is still problematic, because of the oxygen contained in it (interview with W. Sun, 2009).

Figure 5 - Bio-diesel production in Chinese provinces

Marketing & end-use

The bio-diesel market is not yet a developed market. This is mainly caused by low technology levels (Roland Berger, 2009), lack of uniform quality, low developed management and standards, and marketing/sales channels that do not function well (TWA/Tijs, 2008). Compared to bio-ethanol the annual output of bio-diesel is still very small. However, government statistics shows that it is targeted to grow from an annual output of 0,05 million tons in 2006 to 2 million tons in 2020 (40 times as much compared to 2006 when the 11th Five-Year Plan started) according to government targets, which makes its market growth higher compared to bio-ethanol (10 times compared to 2006). However, because China lacks sufficient suitable resources for bio-diesel production the future is still to determine if these targets can be accomplished.

Conclusion

Although bio-diesel is targeted at an annual usage of 200.000 tons, it has anno 2009 already exceeded this target by 100.000 ton to an annual output of 300.000 tons. This does not implicate the bio-diesel market is fully developed. The market is characterized by insufficient available resources, low technology levels, lack of uniform quality, low developed management and standards, and marketing/sales channels that do not function well. Research & Development on second-generation bio-diesel still need to come up with a commercial production solution. The development of Jatropha Tree forests is promising for production of second-generation biodiesel.

4.4. Bio-ethanol

Bio-ethanol is the sustainable variant of gasoline, consisting of a mixture of bio-ethanol and gasoline. It can be used in cars driving on petrol. Today the second generation bio-ethanol is in development. In 2008, there was still only one plant producing 1,5 generation bio-ethanol in China (and no plants producing second or third generation bio-ethanol). This operation is based on burning cassava (interview with COFCO, 7 April 2009).

4.4.1. The supply chain of bio-ethanol

For biomass to become bio-ethanol several steps are taken, as can be seen in the supply chain. These steps are the same as bio-diesel, but the difference is that the biomass resources are different as well as the fuel production process.

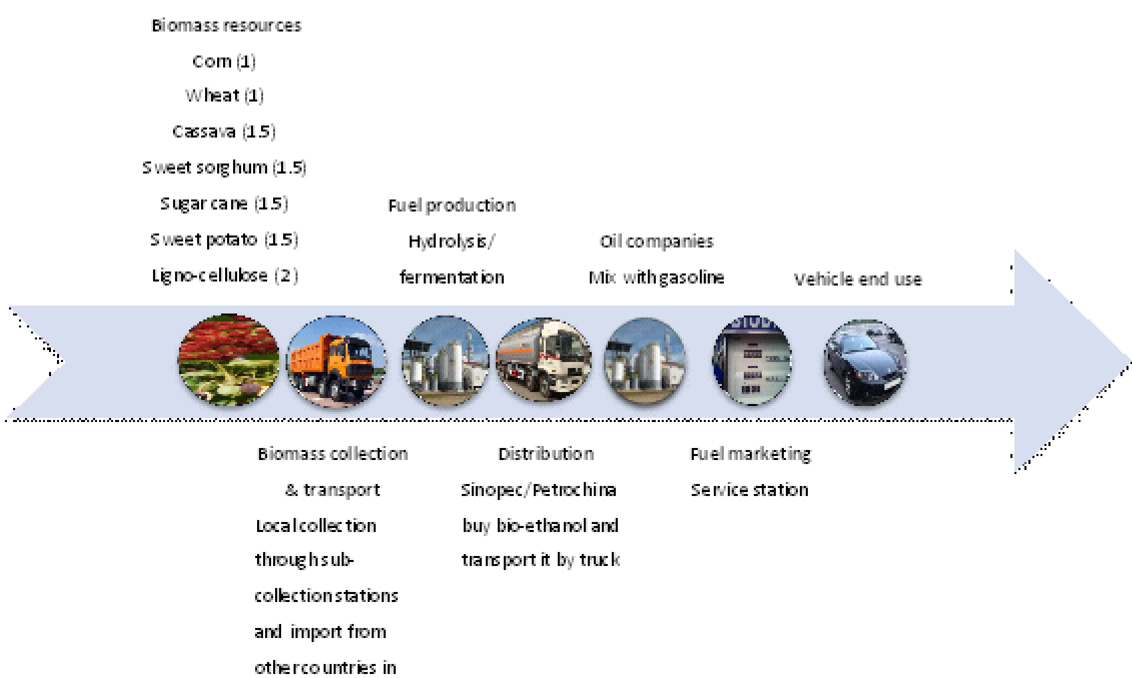


Figure 6 - The supply chain of bio-ethanol

Resources

Because of rising oil prices, ethanol from grain became in 2002 a popular substitute for oil. Up to September 2007, bio-ethanol was mainly produced from corn and wheat (Koizumi & Ogha, 2007). However, this first generation bio-fuel had a negative impact on food supplies (Schwartz, 2008). Mainly cassava, sweet potatoes, sweet sorghum and yam, are expected to be the mid-term future focus of China for ethanol production. Although these resources can be classified under the first generation bio-fuel, the resources are often widely available in China and are grown on wasteland which cannot be used for growing crops for food purposes. Therefore it should not pose any danger to food security. In addition, for instance for sweet sorghum, farmers can use the grain from the plant for food purposes and sell the sugary liquid in the stalks for bio-fuel purposes (Energy Current, 2008). Therefore these resources are classified under generation 1,5 feedstock. Cassava is mainly grown in Guangxi, Guangdong, Yunnan, Hainan and Taiwan. Sweet potato is mainly grown in Sichuan, Henan, Shandong and Anhui. Sweet sorghum is mainly grown in the north east of China, in Beijing, Tianjin and Inner Mongolia (TWA/Tijs, 2008).

According to the China National Center for Biotechnology Development the potential generation 1,5 bio-ethanol production is from the following resources (China National Centre for Biotechnology Development, 2008):

Potential ethanol production from other than first generation crops	Plant area (x 10^4 ha)	Yield (t/ha/y)	Productivity of ethanol (kg/ha/y)	Potential yield of ethanol (x 10^4 t/y)
Sweet sorghum	300	60	6106	1800
Cassava	150	40	6000	900
Sugar cane	120	70	4900	580

Table 1 - Potential ethanol production from other than first generation crops
Source: CNCBD

The problem with generation this 1,5 feedstock, i.e. sweet potatoes and sweet sorghum, is that it is generally difficult to preserve. However, cassava does not bring along preservation problems and is already used for bio-ethanol production in one COFCO production plant in Guangxi Province. Guangxi Province is China's main tropical region and therefore a suitable place to grow cassava. According to COFCO, the Chinese market leader in bio-ethanol production for transport purposes, production from cassava and sweet sorghum is a mid-term solution. The long term solution is the second generation ligno-cellulose bio-ethanol from agricultural residues and forestry residues. COFCO's experiments with ligno-cellulose crops started in 2006 and are now pilot running for three years (interview with COFCO, 7 April 2009). Figure 10 represents COFCO's view on mid-term and long-term solutions for bio-ethanol production.

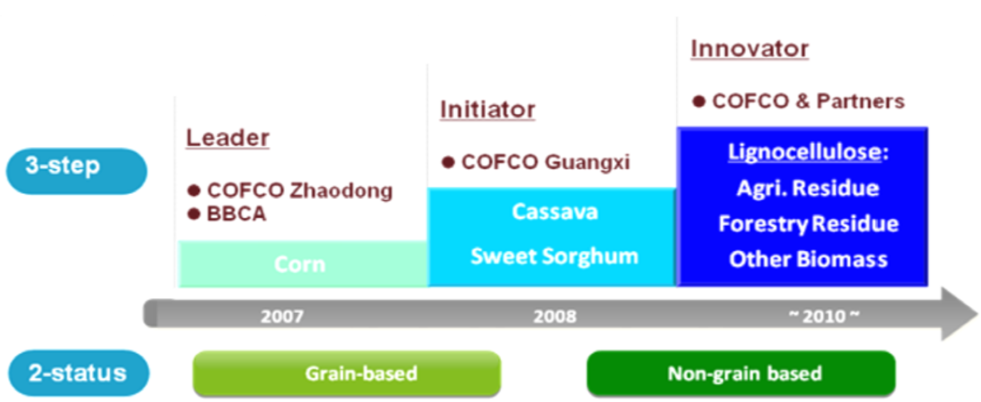


Figure 7 - Bio-ethanol from cassava, a mid-term solution
Source: Interview with COFCO

Collection & transport

Biomass is collected from farmers. The collection depends on the agreement between farmers, local government and the bio-ethanol production plant. The price farmers get for their biomass resources depends on the water content. The price for fresh cassava is RMB 500/ton and for dry cassava RMB 1000/ton. Import from other countries in South Asia is also an option**,** for instance cassava from Vietnam. Short distance transport is done by truck, while long-distance transport is mainly done by train ((interview with COFCO, 7 April 2009).

Production

With a production of about 1,3 million tons of fuel ethanol in 2006, China was the third largest producer in the world and still is the largest ethanol producer in Asia (Koizumi & Ogha, 2007).

The production of bio-fuel in China is done by large companies, namely COFCO, China Grain Oils Joint Stock Co., Ltd. (Zhongguo Liangyou), Sinopec and PetroChina (Schwartz, 2008). However, the production of bio-ethanol has just started and is generally behind Western standards, particularly technology equipment and automation (TWA/Tijs, 2008). Today, there are five plants all over China that produce bio-ethanol for transport. These are in Heilongjiang province (COFCO Zhaodong, COFCO owns 100%), Jilin province (Jilin Fuel Ethanol, COFCO owns 20%), Henan province (Henan Tianguan), Anhui province (BBCA, COFCO owns 20.74%) and Guangxi province (COFCO Guangxi, COFCO owns 85%). As the biggest player in the market with a market share of 52% in 2008, COFCO produced up to 2008 820.000 million ton bio-ethanol, about half of the total amount of bio-ethanol that was produced in total (1,58 million ton) (interview with COFCO, 7 April 2009). COFCO has shares in four out of five fuel-ethanol refineries, of which one obtained in 2008 in Guangxi Province adding a capacity of 200.000 TPY. The COFCO plant called the Beihai Fuel Ethanol Plant in Guangxi Province the first that operates on 1,5 generation feedstock, namely cassava. In October 2008, this was still the only plant in China producing 1,5 generation bio-ethanol (China Strategies, October 2008; acknowledged by COFCO in an interview on 7 April 2009).

In 2008, the NDRC targeted five areas where second generation ethanol production from cassava and sweet potato have commercial potential in the mid-term future. Because cost advantages are realized when the plant is near the resource, production is paired with regions where suitable biomass is available. These are Hubei province (sweet potatoes), Hebei province (lot of available wasteland), Jiangsu province, Jiangxi province (lot of available wasteland/experience in cassava and sweet potatoes) and Chongqing (third largest sweet potato producer, about 20 million

Figure 8 - Bio-ethanol production per province and five potential areas

tons per year) (Schwartz, 2008). These potential areas are highlighted with the **light blue** color on the map below. Today's bio-fuel ethanol plants are situated in the **dark blue** provinces. The plant in Guangxi producing ethanol from cassava is highlighted **purple**.

The cost of ethanol production from corn is approximately RMB 4.500/ton. Ethanol from sweet sorghum and cassava is estimated at RMB 4.000/ton cost. Compared to oil, Chinese ethanol is economically profitable when the oil price is about RMB 6/liter (Koizumi & Ogha, 2007). For comparison, the average oil price in February 2008 was around RMB 5,12/liter and the second half of March 2008 it has risen to RMB 5,5/liter (W. Sun, 2009). In August 2009, the oil price is approximately RMB 2,9/liter (Based on New York Mercantile Exchange data). These low oil prices are expected to rise again after the economic crisis.

In 2006, the government promoted ethanol from cassava because knowledge on the production techniques was developing rapidly. Opportunities for China are in cellulose-based ethanol, but this technique needs to be commercially expanded first. This commercial application of bio-ethanol from second generation inputs is targeted at 2010-2015. According to COFCO, China claims a top-five position in the research & development of lignocelluloses techniques in bio-ethanol (interview with COFCO, 7 April 2009).

Distribution to oil companies

As with bio-diesel, bio-ethanol is bought directly by oil companies Sinopec and Petrochina after production in fuel plants. These companies are also shareholder of the fuel plants. Government subsidy equals about 20-30% on the total sale price from the fuel plant to the oil companies Petrochina and Sinopec. Short distance transport is done by truck, and long-distance transport is generally done by train (interview with W. Sun, 2009). The oil companies handle the bio-ethanol by mixing it into their gasoline fuel. The end-product contains 10% bio-ethanol, and is ready for vehicle end-use (interview with COFCO, 7 April 2009).

Marketing & end-use

With a production of 1,3 million tons bio-ethanol in 2006, China was the third largest producer in the world. In 2007 and 2007 China remained this position (the European Union produces more, but is a region in which single countries cannot reach the volume China produces). The commercial market for bio-ethanol is targeted to grow from 1,3 million ton to 10 million ton bio-ethanol production in 2020. The market growth is mainly based on expansion of 1,5 and second generation bio-ethanol in the future.

A problem is that market prices are rising nowadays for several biomass resources. For example, the price of cassava has doubled in 2 years from about RMB 300-600 per MT. At the same time the price of fuel like oil, gas and electricity is kept below international market level by the government. This means the market prices of the biomass resources exceed the price of fossil fuels. Therefore companies experience losses, and are merely staying in business because the government provides high subsidies (approximately RMB 1.373/MT in 2006) to compensate this. In addition some of the target areas experience shortage in biomass resources, so import is needed (Schwartz, 2008).

Conclusion

With a production of about 1,3 million tons for fuel ethanol in 2006, China was the third largest producer in the world and still the largest ethanol producer in Asia. Today, much of the production is still first generation bio-fuel, although this is a worldwide trend. The International Energy Agency expects second generation to become commercially viable on a large scale between 2015-2020. Second generation bio-ethanol production is still not developing at fast pace in China because of the absence of efficient and effective technology for application on commercial scale. However, because of stimulation of the government through subsidies, this development might go more rapidly in the coming years. In addition, China has a lot of resources available for the mid-term 1,5 generation production, although cassava is sometimes imported from Taiwan. China claims a top-five position in the research & development of lignocelluloses techniques in bio-ethanol and claims to be ahead of most other countries. The production of ethanol is strongly dependent of government subsidies.

4.5. Opportunities in the supply chain

Particularly the bio-ethanol market seems a potential market, because China is said to be the third largest ethanol producer of the world, although this is mainly based on the production of first generation bio-ethanol.

Globally, efficient second generation bio-fuel techniques are still at a research stage and far from commercialized. Because of the growing number of cars in China and CO_2 emissions, the government is very eager on developing second generation bio-fuel for transport purposes on a larger scale. According to COFCO, the focus of Chinese bio-fuel is not on the development of the third generation before the second generation is commercialized (interview with COFCO, 7 April 2009). Opportunities for foreign investment in the mid-term are mainly in technology and investment (finance) of second generation projects. However, in the long-term future, third generation development might shift China's focus.

The introduction of standards for uniform quality and macro economic policy is promising for fuel production in the future to be more sustainable. The state is already working on this by developing 'Standards for the Use and Adjustment of Bio-diesel fuels' (TWA/Tijs, 2008).

One of the main problems in the current biomass market in general is that the demand is highly driven by government subsidies. In the liquid bio-fuel market government support also drives the future development road for second and third generation bio-fuel. This starts with the availability of biomass resources. Farmers seem to only produce what the government provides subsidies for, because this is where they can get money from, as is the case with cassava. The result is that for instance for bio-ethanol merely focus is on the resource that engenders most profit for the farmers. The short-term focus endangers development other biomass resources for future fuel production. From a Chinese perspective, opportunities for foreign firms are in technology development and investment from abroad (interview with W. Sun, 2009).

Generally, opportunities regarding the bio-diesel and bio-ethanol market occur mainly in:

- Developing 2nd generation fuel in the mid-term future
    - Developing technology for advanced and more efficient ligno-cellulosic processes, that are less costly and more commercial

- Developing and introducing 3rd generation fuel in the long-term future
- Developing better management systems, like the management of residues
- Resources bio-diesel: providing a solution for the insufficient feedstock present for large scale production (interview with COFCO, 7 April 2009)
- Resources: Training technical, commercial and management personnel for the development of a bio-fuel industry based on certain feedstock, for instance Jatropha (Schwartz, 2007)
- Collection & transport: providing a solution for the fragmented collection of biomass from farmers (interview with Biomass Technology Group, 28 January 2009)
- Fuel production: Techniques are behind the worldwide standards, especially technical equipment and automation: need for better conversion technology (TWA/Tijs, 2008)
- Fuel marketing: The proper functioning of market and sales channels (Sun, 2009)

The areas are highlighted in the supply chain below (and are the same for bio-diesel):

Figure 9 - Opportunities to improve the supply chain

4.6. Adding value through competitive advantage

As we have determined in the literary review that opportunities do not necessarily imply a market. It is very important to keep in mind what the position of the Netherlands is in the European Union regarding biomass energy. When the Netherlands do not have a market leading position in a certain area containing biomass energy, a European approach might be more beneficial for the country. In principle, the Dutch government aims at a European approach to clean energy. However, they acknowledge that when this approach does not work efficiently and effectively, for instance because of conflicting interests among EU members, preferably an approach with several other EU countries with the same interests should be considered (Energy Report Dutch Ministry of Economic Affairs, 2008).

Bio-fuel production in the European Union has grown tremendously in the last years. The biggest ethanol-producers are France, Spain and Sweden. The production of bio-diesel (700.000 ton in 2000) is much larger than that of bio-ethanol (190.000 ton in 2000). The largest bio-diesel producers are France, Germany and Italy (TWA Special Renewable Energy, 2004). This indicates that the Netherlands is not a market leader when it comes to production of bio-fuel. We could therefore state that the Netherlands do not have competitive advantage as opposed to other European countries in the area of production. In China, competitive advantage is needed to obtain a large share of the market. China wants to do business with the country or organization that is obtained as the expert in the subject (informal interview with Gabrielle Nuytens, Agricultural Ministry at the Dutch Embassy). Competitive advantage is thus important.

However, there are sufficient opportunities in the bio-fuel market in China because of its large scope. Because competitive advantage is related to adding value in a market, we hereby search for strengths of Dutch organizations. It is important that Dutch organizations are perceived as experts by the Chinese government and companies as knowledgeable before doing business in China (interview with Henk van Duijn – Head Agricultural, Nature and Food Department of the Dutch Embassy, 9 April 2009). Although the production of bio-fuel does not offer the Netherlands a leading position in the world, we will focus on the role of the Netherlands regarding knowledge on bio-fuel. To provide an idea of the activities that are undertaken on bio-fuel in the Netherlands we will continue to display a profile of bio-fuel production and knowledge in the Netherlands

4.6.1. Production of bio-fuel in the Netherlands

As of 1 January 2007, 2% of the total fuel supplied by players in the Dutch fuel market is supposed to be bio-fuel. The target for 2010 is raised to 5,75%. In 2006 1.979 TJ bio-fuel (67 million liter, consisting out of 29 million liter bio-diesel and 38 million liter ethanol/ETBE (ethyl tertiary butyl ether)) was used in the Dutch market, this was 0,4% of the total fuel market, compared to a share of 0,02% in 2005. This emergence is mainly due to the abolition of excise-duty (duty on consumables) on bio-fuel. The European Commission suggested a directive in January 2008 prescribing a 10% target already, and the Dutch program 'Clean & Efficient' (Schoon & Zuinig) is even investigating a 20% bio-fuel share in 2020. In addition, as of January 2008, the quality of bio-fuel is investigated by the European Commission. A minimum is set for sustainability requirements of bio-fuel. This is to ensure biomass resources, like the controversial palm-oil, are fully sustainable according to certification (Senternovem, 2007).

Not all liquid bio-fuel used in the Netherlands is produced in the country. Up to 2008, there were four bio-diesel producers in the Netherlands, with a total capacity of 220 million liter. 6 plants were planned to be built in 2008/2009. This raises the capacity level from 220 million to 1.6 billion liter. Up to 2008 there were no Dutch bio-ethanol producers for the transport sector. In 2008/2009 2 ethanol plants were built, one of Abengoa with a production capacity of 480 million liter. ETBE is produced in the Netherlands, however, only by 2 companies are involved. In addition, on a small scale pure plant oil

(‘Pure Plantaardige Olie’) is produced. Yet, only first generation bio-fuel is produced at bio-fuel plants in the Netherlands.

In the Netherlands, bio-fuel is recognized as a market with large potential. Dutch companies are eager on developing bio-fuel. In March 2009, Peter de Wit, president CEO of Shell Netherlands announced: “Shell is very willing to invest in alternative energy sources and CO_2 solutions. But we focus on more. For the coming years we aim at the growth of bio-fuels and continue with CO_2-storage; we keep solar energy, wind energy and hydrogen as where it is now.” (Announcement P. de Wit, Shell, March 2009).

Some key players in the Dutch bio-fuel sector are Shell and DSM. Both are already active in China. In an attempt to become one of the biggest bio-diesel producers of the future in Europe, the Association Dutch Bio-diesel Industry (‘Vereniging Nederlandse Biodiesel Industrie’ of VNBI) was established to combine Dutch powers, creating a capacity of 1.5 million tons biodiesel. VNBI consists out of 8 Dutch biodiesel producers having a plant in operation in 2007 or planning for a biodiesel plant in the nearby future (Persbericht Energieraad, 2007).

4.6.2. Research & development on second generation bio-fuel

The production of second generation bio-fuel is still limited in the Netherlands. The absence of large amounts of forests or agricultural ground makes the position of the Netherlands regarding the production of bio-fuel not the most favorable one. However, the know-how and technology of second generation bio-fuel is advanced in the Netherlands (Advisory Council on International Affairs of The Netherlands, 2008).

The Dutch focus is on the development of the second generation. The process is still not cost-effective and not ready for commercialization up till now. According to Shell, the second generation is projected to be commercial in 5 to 10 years. The Dutch government invests EUR 12 million in developing techniques for the second generation in a program called ‘Innovative Bio-Fuels’ (Innovatieve Brandstoffen). This money is also to be used for other purposes such as the use of waste as biomass resource for fuel and integration of energy and material streams within and between companies (Senternovem, 2007).

The Dutch Research platform Renewable Energy also know as NODE (‘Nederlands Onderzoeksplatform Duurzame Energie’) represents and unites Dutch researchers from different organizations and institutes that conduct research on renewable energy. With respect to bio-fuel, there are several institutions that obtain know-how on bio-fuel. Energy Centre Netherlands (ECN) focuses on the development of knowledge and technology to convert biomass into bio-fuel and chemicals through thermal processes. TNO is an independent research centre that applies scientific knowledge to enlarge the innovative capacity of Dutch organizations and government. One of their research areas is the development of new process for the conversion of biomass. Furthermore, RU Groningen conducts research on fast-pyrolyis oil, vegetable- and animal oils and fats. TU Delft focuses on thermochemical biomass conversion, for example the generation of syngas for liquid bio-fuel production and metabolism and genetics for microbial production of bio-ethanol. The University of Twente and their research institute IMPACT conduct research on fast pyrolysis. In 2009, the University of Twente won the Leo-Petrus-Innovation-

Trophy (LPIT) for their innovative idea on converting biomass waste from various locations to oil, which can generate fuel and chemicals through syngas in one centralized location (website LPIT, 2009). The research at Wageningen University aims at the development of (bio-)chemical, enzymatic and biological conversion and fermentation processes based on plant raw materials. These can be the basis for transport fuels (among others). One of the key focus points is to fully exploit available and uncovered cheap resources of agricultural (waste) streams (website NODE, 2009).

Other knowledge centers are consultancy company KEMA and Senternovem. The latter is an agency of the Ministry of Economic Affairs that offers support through knowledge and financial incentives concerning sustainability and innovation to organizations, knowledge institutes and government.

Dutch company BTG is developing bio-oil through pyrolysis, a thermo chemical process which decomposes material in the absence of oxygen. This bio-oil is projected in the long term to be promising for diesel engines after upgrading. In this, research in China is booming and Dutch knowledge in this can offer opportunities in the Chinese market (interview Biomass Technology Group, 28 January 2009).

In addition, Dutch cooperation policy is aimed at strengthening the agricultural and forestry sectors in developing countries with respect to second generation bio-fuels, sharing available know-how for economic development in these countries and reinforcing local energy supplies mainly on small scale. The Netherlands could play an important role by setting up logistics chains in today's production systems from which raw materials are derived (Advisory Council on International Affairs of The Netherlands, 2008).

Although knowledge in the development of the second generation bio-fuel is relatively advanced in the Netherlands, the production is still based on first generation bio-fuel. In addition, there is too much competition of other countries in this generation that have far more extended R&D. Chinese bio-ethanol producer COFCO has agreed to cooperate with Denmark on the R&D of the second generation bio-ethanol from ligno-cellulose, because Denmark is perceived to have the most advanced R&D in this matter. It remains ambiguous if opportunities for the Netherlands in China are in the second generation bio-fuel. On the one hand, a top-five research position for China and severe competition from other foreign countries with more advanced knowledge, like Denmark, limit opportunities for the Netherlands. On the other hand, because of an increasing motorizing Chinese middle class, the second generation bio-fuel will already emerge in a large commercial market in the mid-term future providing sufficient market opportunities for the Netherlands and other foreign countries, regardless of their non-leading position on second generation biomass.

However, in an interview with Chinese bio-ethanol market leader COFCO, TU Delft was named as a leading R&D institute on bio-energy. This reputation presents opportunities for cooperation on R&D, mainly on second and third generation bio-fuel.

4.6.3. Research potential in third generation bio-fuel

The Netherlands can be a potential large player in the development of a third generation bio-fuel market. The new production method for bio-diesel based on algae is expected to offer chances for the Netherlands in the international bio-diesel market. In 2007, TU Delft and DSM won the Leo-Petrus-

Innovation-Trophy for their research on an advanced production method for bio-diesel based on algae. Challenges are in making this production method more commercial (TWA report on biobased economy in the Netherlands, 2008).

In China, organizations also conduct research on the utilization of algae for the production of bio-diesel, but the progress is behind western R&D. Dutch accomplishments in this sector offer opportunities for cooperation with China. There already have been some requests of Chinese companies who showed their interest in Dutch technology. For instance Chinese company Guangzhou Nansha Assets Operation Co., Ltd. is willing to get in touch with AlgaeLink N.V., a Dutch company that designs and manufactures algae growing equipment for bio-fuel, pharmaceutical products, animal feed etc. AlgaeLink already has industrialized production demo bases in Spain. The Chinese interest seems mainly in the potential of importing technologies. However, this can bring along problems of copyright infringement. Generally, technology is hard to protect diminishing foreign competitive advantage. If the Netherlands wants to be a pioneer in this Chinese market, it is very important that China also perceives the Netherlands as a country that has extended knowledge in third generation bio-fuel. Hence, promotion of the Dutch R&D is very important.

Furthermore, the Netherlands is a world leader in the processing of new plant species, i.e. genetic manipulation of seeds. Today seed processing is done for ornamental use and agricultural use like plants for potatoes and vegetables. In this research intensive market about 15% of the EUR 2,5 billion yearly turnover of is spend on R&D. Key players in genetic seed engineering are Plantum NL which represents Dutch companies, Top institute Green Genetics which bridges between research institutes and companies, and Wageningen University.

Technological Top institute Green Genetics is established to connect research institutes and companies operating in this market in a four year research program. The budget of this research program is EUR 40 million; half is paid by research institutes and the other half by companies. Companies in this sector are generally small-medium enterprises and some large enterprises. 95% of these companies are represented by umbrella organization Plantum-NL, which has 430 members (website Plantum-NL, April 2009).

Research institutes focus on the fundamental R&D of green genetics. For example, in Wageningen a research program has started that focuses on genetics of potatoes so that the use of pesticides and energy for potato breeding is reduced (TWA report on biobased economy in the Netherlands, 2008). Today, genetically manipulating seeds is mainly done for food purposes, for instance making crops more resistant to bacteria, improvement of taste, quality and quantity. In China food is scarce, so genetic manipulation of seeds for food purposes is very likely to be of interest. From a bio-energy perspective, this technique could offer opportunities as well. For instance, genetic manipulation of seeds can create more crop waste or seeds that contain more oil for bio-fuel production. The creation of ‘better seeds’ can also offer a solution to the storage problems of biomass resources, like sweet sorghum.

4.7. Conclusion

Dutch strengths in bio-fuels are mainly in knowledge rather than production. Because of the high potential of third generation bio-fuel, a focus on the development of this generation might give the Netherlands a competitive advantage in the long term future since the advanced knowledge on algae breeding and plant genetics. To be successful in the Chinese market it is important that China acknowledges these Dutch strengths. It remains ambiguous if opportunities for the Netherlands are also in the second generation bio-fuel. On the one hand, a top-five research position for China and severe competition from other foreign countries with more advanced knowledge, like Denmark, limit opportunities for the Netherlands. On the other hand, because of an increasing motorizing Chinese middle class, the second generation bio-fuel will already emerge in a large commercial market in the mid-term future providing sufficient market opportunities for the Netherlands and other foreign countries, regardless of their non-leading position on second generation biomass.

5. Conclusion

This research has provided an answer to the main question; *'Where in the supply chain of bio-diesel and bio-ethanol are opportunities for Dutch organizations in China within a political context?'.* The main question was derived from the literary review, which narrowed down the scope of the Chinese biomass market into a focus on the bio-fuel market. In order to answer the main question we have focused on the *conditio sine qua non* to enter the bio-fuel market; government influence, a need for a certain product or service, and competitive advantage.

Government targets on renewable energy are an important factor that indicates the growth of the bio-fuel market. Since subsidies are given to stimulate renewable energy according to renewable energy targets, contacts within the government are needed when Dutch organizations want to make their bio-fuel business profitable in China. In other words, since government influence is so heavy within the bio-fuel market, Dutch organizations cannot enter the supply chain of bio-diesel and bio-fuel without the right government contacts. Furthermore, opportunities arise from inconsistencies within the supply chain of bio-ethanol and bio-diesel. Competitive advantage is obtained through fulfilling this need for improvement. However, an important factor in obtaining competitive advantage in the Chinese bio-fuel market is that Dutch organizations need to be perceived as the experts on the subject. Therefore, opportunities for Dutch organizations in China are mainly in providing a solution for inconsistencies in the supply chain, based on Dutch strengths. When the Netherlands does not have competitive advantage regarding knowledge or technology, chances of accessing the Chinese market are less significant.

Compared to other European countries, like France, Germany and Italy, production of bio-fuel does not offer the Netherlands a leading position in the world. Therefore, opportunities are mainly on knowledge level.

After an overview of the activities in the supply chain of bio-diesel and bio-ethanol, "needs" or gaps were discovered which make the supply chain inefficient and ineffective. These were mainly in the inadequate provision of resources, fragmented collection of biomass from farmers, fuel production techniques and technical equipment is behind worldwide standards. Besides that, marketing and sales channels do not function well. Based on the premise that China would want an efficient and effective supply chain, we have argued these gaps present opportunities for organizations in China and other countries; (a) developing better management systems, like the management of residues; (b) providing a solution for the insufficient feedstock present for large scale production; (c) training technical, commercial and management personnel for the development of a bio-fuel industry based on certain feedstock, for instance Jatropha; (d) providing a solution for the fragmented collection of biomass from farmers, for instance by creating central collection sites; (e) introducing more advanced technical equipment and automation that result in a better conversion technology; (f) the proper functioning of marketing and sales channels, for instance by creating a green image on bio-fuel. Furthermore, the development of second generation bio-fuel can offer opportunities in the mid-term future; there is particularly a need for developing technology that is less costly and more commercially viable. The development and introduction of third generation bio-fuel offers opportunities in the long-term future.

There are three areas in the supply chain of bio-diesel and bio-ethanol that provide opportunities for Dutch organizations in China based on available knowledge in the Netherlands. These areas of opportunity are: resources, collection & transport, and fuel production. Since fuel marketing involves the proper functioning of marketing and sales channels in China, for instance by creating a green image on bio-fuel, this seems more a matter of the Chinese government or the large Chinese oil and distribution companies like Petrochina and Sinopec.

To provide a solution for the insufficient feedstock in China, Dutch knowledge on genetic manipulation of seeds can offer them competitive advantage in the long-term future, since the Netherlands, i.e. Top Institute Green Genetics, is regarded as world leader in green genetics. Although genetic manipulation is still done for food purposes today, the experience of the Netherlands makes them a world leader in this area and presents opportunities to apply this in one of the largest growing markets in the world. The research at Wageningen University aims at the development of (bio-)chemical, enzymatic and biological conversion and fermentation processes based on plant raw materials. These can be the basis for transport fuels (among others). One of the key focus points is to fully exploit available and uncovered cheap resources of agricultural (waste) streams (website NODE, 2009). Furthermore, the development of algae breeding as a resource for bio-ethanol gas and bio-diesel presents opportunities. For instance, TU Delft has already conducted research on bio-diesel from algae, and Dutch company AlgaeLink can already provide algae-growing equipment.

For fragmented collection & transport problems, the Netherlands could play an important role in setting up logistics chains in today's production systems from which raw materials are derived. This is based on Dutch cooperation policy is aimed at strengthening the agricultural and forestry sectors in developing countries with respect to second generation bio-fuels, sharing available know-how for economic development in these countries and reinforcing local energy supplies mainly on small scale. The right solution to collection & transport problems is however unknown, since drastic changes should be made in China's decentralized farming structure.

The main focus of Dutch research institutes and universities in the Dutch Research platform Renewable Energy (NODE), is on improving fuel production and conversion techniques. This know-how can be applied to fulfill the Chinese need for more advanced technology and conversion processes for the second generation bio-fuel. For instance, ECN focuses on the development of knowledge and technology to convert biomass into bio-fuel and chemicals through thermal processes. Another example is TU Delft, which focuses on thermo chemical biomass conversion, for example the generation of syngas for liquid bio-fuel production and metabolism and genetics for microbial production of bio-ethanol.

Because the Netherlands is a pioneer in the third generation bio-fuel, particularly genetic manipulation of seeds, they can obtain competitive advantage in China. Although the second and third generation bio-fuels co-evolve, the development of the third generation is behind the second generation. The second generation already involves large scale production in small numbers, while the third generation is still at development stage. The latter offers opportunities in the long-term. It would not be wise to miss out on the market opportunities regarding the second generation; indeed, in such a vast country, the pie is big enough for everyone. It remains ambiguous if the Netherlands can obtain competitive advantage in the second generation bio-fuel. On the one hand, a top-five research position for China and severe competition from other foreign countries with more advanced R&D and production techniques, like Denmark, limits opportunities for the Netherlands. On the other hand, because of an increasing motorizing Chinese middle class, the second generation bio-fuel will already emerge in a large commercial market in the mid-term future providing sufficient market opportunities for the Netherlands and other foreign countries, regardless of their non-leading position on second generation biomass.

6. Recommendations

Based on the conclusions, I will make recommendations for the Embassy and Dutch organizations, as well as for the academic world.

First of all, I would like to recommend to the Dutch Embassy in Beijing, to further investigate the following topics regarding bio-fuel:

- Because of the highly technologically characterized biomass market, an in-depth study is needed on specific technology activities desired in the liquid bio-fuel market. This report provides a general overview of opportunity areas in the supply chain. Mainly in the area of technology, the report still gives a shallow overview of knowledge on production techniques etc. An in-depth study on second and third generation bio-fuel technology for instance might show a more specific niche in this market.
- R&D on bio-oil upgrade for use in diesel engines was shortly named in this report. According to information from the Biomass Technology Group in the Netherlands, their R&D in bio-oil is promising for the second generation bio-diesel and could be world-leading. This report shortly names bio-oil. However, to determine the Dutch position in this and the opportunities in China, the subject should be studied more.
- An in-depth study on specific government policies that influence the Chinese bio-fuel market, and organizations that shape the energy environment (like the NDRC) should be conducted to get more insight into how far government influence reaches specifically and which government contacts should be cherished.
- A study on successful business models for cooperation between the Netherlands and China should be conducted. For instance; R&D cooperation, technology transfer possibilities and limitations coming to that. An example as transferring Dutch technology to China, brings along risks like copyright infringement.
- Mapping (potential) competition in the Chinese bio-fuel market, i.e. mapping the amount of (potential) competitors in the home market and other countries in the world, the activities they perform, and their strengths and weaknesses. This will provide a stronger foundation for drawing conclusion on the competitiveness of Dutch organizations.

Based on this research into the bio-fuel market, the Dutch Embassy in the Beijing can give the following advice to Dutch (research) organizations:

- Since the Netherlands is a pioneer in the third generation bio-fuel, particularly genetic manipulation of seeds, they can obtain competitive advantage in China. This means, Dutch organizations that are active in green genetics, like University of Wageningen and Top Institute Green Genetics, should 'sell' their knowledge or technology to China so that they are perceived by China as world leading. In this way, competitive advantage in the Chinese market in third generation bio-fuel can be realized in the long-term.
- The second generation bio-fuel market provides enough opportunities for Dutch organizations to apply their knowledge in China, for instance through cooperation with a Chinese organization or setting up a consultancy facility in China.

- Since China is a large and geographically diverse country, test pilots can be run in China to test the feasibility of second- and third generation resources and production processes in diverse regions.
- There is large potential in providing a solution to the inefficient collection and transport in China. Since farms are small and decentralized, Dutch (research) organizations that can provide a more centralized collection process can be very successful in the Chinese market since decentralization is one of the main problems in the success of large scale bio-fuel production.

At last I will make recommendations for the academic world. To my surprise, scientific research on the Chinese bio-fuel market was very limited even though we deal with an upcoming market in a fast growing country that could play a large in the reduction of CO_2 emissions. Although, this is a more practical study, I had great troubles finding academic evidence of bio-fuel research in China. Furthermore, it was very hard to find academic models and/or frameworks that can serve as a basis for determining competitive advantage in the Chinese energy market. Since specific academic prove on how to successfully operate in the Chinese biomass market was absent, I had to make assumptions when it comes to *conditio sine qua non* to enter the Chinese biomass market. Since biomass energy is just emerging, and therefore relatively new to the academic world, this is understandable. However, I would like to make recommendations on conducting (further) research on:

- Success factors for foreign companies to enter the Chinese bio-fuel market. For example, a continued study that provides more specific and well-built evidence of the relation of competitive advantage to supply chain analysis in emerging markets like China.
- Production techniques for third generation bio-fuel.
- The prevention of energy loss because of storage problems of biomass resources.
- Making biomass more compressed (e.g. pellets) to facilitate transportation.

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