INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

ENVIRONMENTAL TECHNOLOGY TRANSFER: A CASE STUDY OF QUEBEC ENVIRONMENTAL FIRMS IN CHINA

Paul Gervais

Department of Political Science

McGill University, Montreal

October 1999

"A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillement of the requirements of the degree of Master's in Political Science"

ABSTRACT

As developing countries have grown aware of the effects of pollution and resource depletion, industrialized countries that produce environmental goods and services have secured new markets where to export them. In this manner, increased concerns over environmental degradation have led to the growth of the green technology sector which is currently in full expansion. The purpose of the thesis is, therefore, to uncover the dynamics of such exchanges by exploring the interactions of Quebec environmnetal firms in the People's Republic of China (PRC).

Results indicate that the PRC presents accommodative structures that are compatible with those found in Quebec, but an inappropriate level of protection of intellectual property rights (IPRs). This scenario gives the PRC a certain advantage since most local firms are able to reproduce foreign technologies without being constrained by issues of intellectual property. Combining theoretical and practical approaches, the thesis uncovers that accommodative conditions do not supersede the question of IPRs when attempting to ensure transfers. Even though the current state of these factors affects the nature of the agreements, the environmental aspect of these technologies seems to facilitate the transactions.

SOMMAIRE

Face aux défis que représentent les problèmes environnementaux, les nouvelles technologies environnementales constituent un secteur d'activité en pleine expansion dans les pays industrialisés. Leur commercialisation permet d'accéder à de nouveaux marchés, particulièrement dans les pays en voie de développement. Ainsi, l'intêret de ce mémoire réside dans la compréhension de la dynamique des échanges de technologies environnementales impliquant des firmes québécoises et chinoises.

La recherche démontre que la Chine présente des structures d'accommodation et un savoir-faire compatibles à ceux du Québec, mais un régime de protection des droits de propriété intellectuelle qui reste à élaborer. Ceci met rarement la Chine en situation compromettante puisqu'elle est dotée de la capacité de reproduire des technologies sans être assujettie à des conventions contraignantes. Ayant confronté une approche théorique à une approche pratique reposant sur des entrevues auprès de compagnies québécoises, on observe que non seulement les conditions d'accomodation doivent être satisfaites pour assurer la réussite d'un transfert, mais également celles d'un cadre légal qui assure le respect des droits de propriété intellectuelle. Toutefois, même si l'état actuel de ces deux variables affecte respectivement la signature d'accords, le caractère environnemental des technologies semble faciliter les échanges.

ACKNOWLEDGEMENTS

I would like to thank my thesis supervisors, Professor Michel Duquette and Professor Samuel J. Noumoff, for their precious support and keen advice.

I would also like to thank all the company executives that participated in the interviews, as well as the Mayor of Montreal's Assistant to Pacific Affairs. Without their positive attitude this thesis could not have been completed.

Table of Contents

Chapter 2: Environmental Technologies in Canada and Quebec

Chapter 3: The People's Republic of China's Environmental Challenge

Chapter 4: An Overview of the Involvement of Quebec Environmental Firms in the People's Republic of China

ABBREVIATIONS

CAS	Chinese Academy of Science
CAST	Chinese Association for Science and Technology
CCP	Chinese Communist Party
CFCs	Chlorofluorocarbons
CIDA	Canadian International Development Agency
CRIQ	Centre de Recherche Industrielle du Québec
DFAIT	Department of Foreign Affairs and International Trade
EC	Environment Canada
ECU	Environmental Control Units
EI	Environmental Industry
EPE	End of Pipe Equipment
ETT	Environmental Technology Transfer
FRDT-E	Fond de recherche et développement technologique en environnement
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
G&S	Goods and Services
IBRD	International Bank for Reconstruction and Development
IC	Industry Canada
IDA	International Development Association
IFC	International Finance Corporation
IFI	International Financial Institution
IP	Intellectual Property
IPR	Intellectual Property Rights
ISO	International Standard Organisation
KTRD	Key Task Research and Development
NAFTA	North American Free Trade Agreement
MAIIC	Ministère des Affaires Extérieures, de l'Immigration et des Communautés Culturelles
MEF	Ministère de la Faune et de l'Environnement
MFN	Most Favorite Nation
MNC	Multinational Corporations
MOFTEC	Ministry of Foreign Trade and Economic Cooperation
NECEC	North East China Electric Company
NEPA	National Environmental Protection Agency (PRC)
NGO	Non Government Organization
NResC	Natural Resources Canada
NSTAS	National Science and Technology Achievement Spreading Program
ODS	Ozone Depleting Substances
PARDE	Programme d'Aide à la Recherche et au Développement en Environnement
PRC	People's Republic of China
R&D	Research and Development

SAIC	State Administration for Industry and Commerce
SD	Sustainable Development
SDI	Société du Développement Industriel du Québec
SPC	State Planning Commission
SEZ	Special Economic Zone
SETC	State Economic and Trade Commission
SME	Small and Medium Sized Enterprises
SOE	State Owned Enterprises
SSTC	State Science and Technology Commission
S&T	Science and Technology
TRIPS	Trade Related Intellectual Property Agreement
TSP	Total Suspended Paticles
TT	Technology Transfer
TVE	Township and Village Enterprises
UN	United Nations
UNCED	United Nations Conference on Environment and Development
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

INTRODUCTION

I. The Challenge

Regardless of any perspectives that favor or oppose the emergence of global markets, it seems likely that the upcoming century will be marked by greater attempts to "harmonize" relations between developed nations from the North and developing nations from the South. Of itself, some have argued, internationalization of trade requires this cooperation among states in order to bring about and secure the conditions that sustain it. However, this is by no means an easy task. Throughout history, relations between North and South have been less than equal since they have combined exploitation, abuse, bitterness and antagonism. In recent decades, the North has sought greater harmony by imposing its developmental patterns on the South. However, more often than not this has been either fixed to some conditionality or outright counter to the aspirations of southern countries. In turn, the South has asserted - notably with the stand taken by the Group of 77 (the assembly of developing nations) - that it has the right to follow its own development path.

Accommodating both positions requires, consequently, the facing of a set of universal challenges (such as poverty, inequality, pollution, insecurity, illiteracy and developmental unevenness) that are present in any developmental venture. The result is a series of common problems whose solutions can be shared in both zones. However, this is once again jeopardized by the fact that the North can take advantage of the South's dependency, or the South can entrench its dependency through the North's "benevolence". Hence, what remains crucial and yet troublesome is to convince both sides to cooperate on equitable terms.

Sustainable development may offer one such framework where diverging views come together on the abstract premise of ensuring that the current path of economic development does not jeopardize the future of succeeding generations. To illustrate this, the thesis will shed some light on environmental technology transfer (ETT); a measure proposed by this ideal.

II. The Environment, Technology Transfer and International Cooperation

Initially, environmental issues relate to problems of pollution and degradation of natural resources which are increasingly linked to global economic and political stability. In the past two decades, concerns over these have led to the enactment of norms and measures which have generated a new long term tendency for all industries to offer integrated and comprehensive approaches that internalize environmental cost, incorporate clean processes, and aim for lower rates of discharge according to increasingly universal standards. In turn, technology transfer represents one of the many solutions that leads to greater understanding and cooperation between developed and developing countries. Initially addressing the problem of technological backwardness, it sets out to transplant advanced means of production in order to improve the efficiency and productive capacity of any given industrial sector. However, in this perspective, technology does not only provide the means to counter an environmental challenge, but also generates a new standard which gives those who posses it a certain comparative advantage. Consequently, the incorporation of environmental technologies becomes crucial to all industrial sectors and key to the economic sustainability of the North and the South since it has the potential to even out the quality of growth.

In this realm, international cooperation translates into making available the various technologies that ensure clean production. Recognizing the relevance and importance of sustainable development represents a first step towards confronting environmental problems. The second and more complex step is the simplification of the means of confronting the challenge; in this case facilitating environmental technology transfer procedures. This is not an easy task since technology transfers do not always succeed and are themselves challenged by a number of inherent obstacles which this thesis sets out to identify and analyze.

From the start, technology transfers involve problems that relate to knowledge. On the one hand, transfer requires the recipient country to have receiving structures that can accommodate foreign know-how. These not only relate to conditions that are immediately linked to the technology in question, but

also secondary social, legal, cultural, political and economic conditions which are part of the broader process. On the other hand, one of the reasons why knowledge represents a tradeable commodity is because it is protected by the status of intellectual property (IP). As such, the fact that this status protects by law the owner's rights over a certain invention prevents, to a certain extent, the pirating of ideas. Without a legal framework that offers proper protection, owners of knowledge are disinclined to compromise it and thus engage in transfer ventures. Even if both issues represent considerable obstacles to technology transfer, issues regarding accommodation are more likely to hinder the overall quality of the transfer process than are issues of improper IP protection.

Another factor that determines transfers is the shape they embrace. According to Jacques Perrin[1] there are three types of technology transfer: international subcontracting (granting partial or full production responsibility - and accompanying technology - to a foreign firm), foreign direct investment (investing technology in a subsidiary or a joint-venture) and turn key projects (providing a finished product but not the know-how). With this in mind, transfer ventures will adopt any of the above mentioned strategies according to the level of consonance provided by the recipient country's structure of accommodation. The less developed these structures are, therefore, the less technology transfer projects will involve local expertise in order to ensure a greater success rate. This reverberates on the quality of the transfer where, logically, the less involved local structures will not benefit from the advantage of hands on experience provided by another type of transfer. In the same perspective, the degree of IP rights (IPR) protection will influence the type of technology transfer. The less protection there is, the less such projects will involve local expertise. Consequently, the higher IPR protection, the more firms will be willing to make technologies available.

Finally, the specific character of any given technology will, with everything else being equal, have an impact on its transfer. For example knowledge affiliated to sensitive areas - such as defense and security or high-tech electronics - are presumably in high demand, but are less likely to be exported

[1] Perrin Jacques, Les transferts de technologie, Paris, La Découverte, 1983.

out of fear of losing a certain advantage. In a similar way, conventional technologies have a wide array of suppliers who are willing to export them, but may find the entry to developing markets barred out of fear of them threatening local producers. Ultimately, however, the transfer of a technology will depend on how it is perceived by both producer and buyer. The better perceived are the advantages, the easier will be the transfer. Consequently, with regard to sustainable development, the more a technology provides benefits that incorporate environmental sustainability, the easier it will be accepted since it ensures desired results. In this thesis, it will be important to determine whether the environmental - and hence sustainable - character of green technologies are likely to facilitate their adoption.

III. Purpose of the Thesis

The purpose of this thesis is to understand the above mentioned dynamics within the context of environmental technology transfer. The focus is set on the interactions between Quebec based firms and firms located in the People's Republic of China (PRC). The PRC presents a significant case due to its numerous environmental problems, its subsequent need for environmental goods and services (G&S) and its poor record of IPR protection. In turn, the choice of Quebec comes from the accessibility to information from firms that comprise this industry and a perceived lack of potentially beneficial business transactions between Quebec and the PRC.

Foremost, at a practical level, the thesis attempts to establish the patterns that might facilitate transactions of environmental technologies between Quebec and China. Thereupon, at a theoretical level, the paper attempts to uncover the way in which the above mentioned obstacles influence the flow of environmental G&S.

The thesis is divided into four chapters. The first chapter defines what is meant by environmental technology transfer (ETT) by providing an overview of the environmental industry and detailing the links that exist between sustainable development and technology transfer. In this fashion, it first sets out to contextualize and to explore in greater detail the theory and the problems that

are part of ETT. Subsequently, I will address both how incompatible structures and disregard of IPR represent the main obstacles. The second chapter sheds light on the environmental industry in Quebec and Canada. The state of the industry in Quebec will be contrasted with the industries of developed countries and those found in Canada in order to determine its export potential.

The third chapter details the PRC's environmental needs and its capacity to accommodate foreign know-how. Hence, the chapter will portray the main problems that rural and urban areas face and assess the PRC's potential for receiving new technologies by evaluating both structures and IPRs. Finally, the last chapter will present the results of interviews with Quebec companies that have worked in the PRC. Special attention will be paid to the issues of IP and accommodating structures in order to determine if one or the other, or both, is a major impediment.

CHAPTER 1: ENVIRONMENTAL TECHNOLOGY TRANSFER

Environmental technology transfer (ETT) designates the varying mechanisms through which knowledge and know-how are shared between countries that produce environmentally friendly technologies and countries that desire them. The process logically shares certain features with other forms of technology transfer (TT), but yet differs slightly from them by responding to conditions that affect the acquisition of "green goods and services" (G&S). The following chapter will attempt to detail common and specific characteristics of this type of transfer by relying on concepts present in both the sustainable development (SD) and TT literature.

I. The Link Between Sustainable Development and Environmental Technology Transfer

Within the framework of SD, ETT is mainly regarded as a means to an end. As such, placing ETT within the context of sustainability proves useful since SD prescribes the guidelines for the preservation of the environment. Originally, the first formal manifestation of global concern over environmental degradation came about with the 1972 *United Nations'* (UN) *Conference on the Human Environment* in Stockholm. Even if this conference secured no real guarantees to protect the environment, it represented the first step in placing environmental claims on the international agenda[2]. Over the next twenty years, environmental movements would gradually gain both the necessary momentum and political leverage to raise the awareness of environmental issues in advanced industrial countries[3]. As environmental groups consolidated their position in the early eighties[4], widespread public awareness of the harmful effects of human activities

---

[2] Runnalls David, "Environment and Development", in United Nations Reforms , Fawcett E., Toronto, Science for Peace Publication, 1995, p.202.

[3] This politicization of the environment was in part made possible by what Ronald Inglehart depicts as the emergence of individual-level political values that characterized the "post-materialist generation" in the sixties. This resulted in the mobilization of young middle-class people in search of a political identity, into a variety of movements (student coalitions, women's rights, green movements, flower children, and activists) that strove to channel idealistic concerns such as peace, altruism, equality and, notably, protection of nature (Scharf T., The German Greens, Oxford, Berg Publishers, 1994, p.51).

[4] In North America, pressure groups - such as Greenpeace - reached maturity, while in Europe *green parties* were wining seats in political assemblies.

on the environment and a series of dramatic environmental accidents, such as the 1986 nuclear plant meltdown in Tchernobyl, inscribed environmental concerns on the political agenda.

1) The Bruntland Report and the Birth of Sustainable Development

The UN charged the **Bruntland Commission**, the *World Commission on Environment and Development*, with the task of assessing the effects of environmental degradation on human activities, and providing a "global agenda for change"[5]. In 1987, the Commission's appraisal - laid out in the report entitled Our Common Future - revealed that future generations might face serious problems if the current generation does not account for the complex link that binds the natural environment and the economy. It hence stressed the need to change the quality of growth that has dominated the twentieth century by, on the one hand, decreasing the intensity of primary resources and energy use and, on the other hand, increasing equity across the planet[6].

The solution, enclosed in the term SD, calls for the incorporation of environmental concerns into the broader economic context. The concept can thus be defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs"[7]. This proposed path of development complicates the "development job"[8] along the lines of: *population growth and poverty, environment degradation,* and *economic growth and competitiveness*. As such, it cannot dissociate economic concerns from environmental ones. It invokes a certain balance between the North and the South, where the former reduces costs of consumption in order to provide some space for the latter. Overall, it states that pollution must be reduced drastically in

---

[5]World Commission on Environment and Development (WCED), Our Common Future, Oxford, 1987, p.ix.

[6]Considering the current rate of resource use and technological capabilities, it exposes the Malthusian fear of not being able to meet the production and consumption needs of our planet which will hold ten billion people by the middle of the next century. (Matthews R.O., "On Reforming the Global Environment Facility", in Fawcett E., op.cit., p.218).

[7]WCED, op.cit, p.8.

[8]Rischard, J.F., "Forces Reshaping the World Economy", in World Bank and National Research Council (U.S.), Marshaling Technology for Development , National Academy Press, Washington D.C, 1995, p.12.

both hemispheres in order to improve the environmental conditions, redistribute income and reduce vulnerability to economic and ecological crises[9].

2) Environmental Technology Transfer as a Path for Sustainable Development

Among other solutions, ETT incorporates all dimensions into the broader scheme of minimizing disparate and squandered growth. This transfer represents a viable path since it incorporates both economic and environmental aspects by maintaining current levels of production and reducing and/or eliminating harmful products. This double effect offers those who possess this technology a competitive advantage since they can be determinant in any long term economic strategy which accounts for an increasingly environmentally conscious market.

As such, environmental technologies bring forth benefits for both those who acquire them as well as for those who initially own them. For receiving countries, ETT provides a certain advantage if a particular technology has been previously operational. It represents a relative shortcut for advancement, since the recipient is given access to expensive and tedious R&D work which most would be incapable of independently reproducing, or find otherwise costly in time and resources. It thus allows the recipient to modernize industrial and economic foundations in less time and with less effort than was the case for developed countries. For exporting countries, it offers the opportunity to reap substantial benefit either from sales of technology or taking advantage of lower production costs in off-shore technology installations.

3) The Main Obstacles to Sustainable Development and ETT

The definition of SD varies according to the level of development found in a region. The needs of an industrialized society differ from those of an industrializing one, and hence so does **environmental sustainability** since it may be defined as a community's ability to pursue development without contradicting either its aspirations or the ecological balance of its environment.

---

[9] The 1992 *United Nations Conference on Environment and Development* (UNCED) held in Rio de Janeiro, Brazil, reviewed the progress made towards SD and raised environmental degradation to the top of the international agenda as a principal political and economic issue. However, the Rio Summit did not yield initiatives that could fill the need for clean, efficient and equitable development. The absence of will and leadership left developing countries with an

While industrialized societies face the task of designing measures to render their industries "sustainable", predominantly rural ones must fulfill the double task of developing their industrial basis and achieving sustainability. The level of development of such societies often inhibits the attainment of this dual ambition, especially if access to technologies that can accomplish this dual task are barred. Moreover, as opposed to developed countries that have relatively few problems in adopting new technologies, developing nations find that without proper assistance SD often undermines their economic development[10].

In turn, transactions involving technology are also plagued by two inherent obstacles. First, developed nations fear the loss of a certain comparative advantage that technology provides since abiding by, and respect for legal constraints that cover intellectual property rights (IPR) are not yet guaranteed by many developing countries. Efforts to import foreign technology are therefore often discouraged by insufficient IPR protection mechanisms. Second, there are the intrinsic problems related to the process of transferring technology. Initially, TT transposes a certain know-how from one area of industry (public or private) to another, or from one country to another[11]. However, such transactions do not only embrace technology, but also social, economic, cultural and political mechanisms that go beyond mere commodity trade, since many developing countries do not have the structures to accept or accommodate foreign know-how. Moreover, the process embraces social, economic and political mechanisms that also surpass mere commodity market transactions. Developing countries must consequently provide physical and cognitive prerequisites on to which foreign know-how can be transposed in order to avoid dependency - a problem much too often entrenched as the result of TT[12].

---

agenda that charged them with fixing the problems created by developed countries without financial resources nor the technology to cope with them (Runnalls, op.cit, p.203).

[10]This was clearly shown in the negotiations that led to the 1990 London amendment of the 1987 Montreal Protocol on reduction of Ozone Depleting Substances. Therein, by refusing to sign the agreement because such measures would hinder their nascent industries, China convinced western countries to facilitate the access to ozone friendly alternatives that would ease the transition.

[11] "The Globalization of Knowledge and Technology", in World Bank & NRC, op.cit., p.19.

[12]Additional complications come in the form of problems of coordination, finance and relations inside and outside the Bretton Woods institutions (Padbury P., "UNCED and the Globalization of

On the whole, the transition to SD is not easy. The large financial and human investments required to fill the developing world's environmental needs within the guidelines of SD, must be obtained through cooperation. Knowing that the North and the South are interdependent, neither patronage from the North nor free-riding from the South will ensure environmental sustainability. Regarding ETT, this implies the need to strengthen IPR measures and accommodation structures in developing countries, while reducing the conditionality set by developed countries.

II. The Environmental Industry: Overview of Products and Technologies

Having detailed the relation between SD and ETT, it is now worthwhile to portray the many facets of environmental technologies (ET). By definition, the environmental industry embraces the various firms that produce G&S that aim to protect and manage the environment. Even if the OECD (1992) estimated that "end - of - pipe equipment" (EPE) represented seventy five percent of the industry's whole production[13], ET have been increasingly integrated into various industrial processes in order to meet tougher environmental standards. Since environmental G&S are often accounted for in other industries, the best way to

---

Civil Society", in E. Fawcett, op.cit, p.207). These obstacles can be traced back to the Stockholm Conference when a great divide was set between developed and developing countries over the responsibility for environmental degradation. Led by China, the former rejected the advanced countries' implicit argument that it is up to developing countries to clean up after developed countries by compromising their development. Hence, any initiative imposed on the South would have had to be sustained with financial and technological assistance which the North was unwilling to share. Even if the changes in societal attitudes have managed to raise the file on the environment on the political agenda, this divide is yet to be closed. The UNCED session made it clear that environmental concerns were not a priority, but rather that the economic ones that are usually linked to them are (UN Publications, Earth Summit-Agenda 21: The United Nations Program of Action from Rio de Janeiro 1992, pp.276-277). Five years later, the Third Conference of the Parties (COP3) to the Framework Convention on Climate Change (FCCC) yielded a positive step towards SD by reducing emissions levels and ensuring ETT with the Kyoto Protocol. Acceptance was facilitated by several novel "flexibility instruments", out of which the most interesting for the North was *emissions trading*. This instrument offered developed countries the ability to buy themselves out of their obligations by exchanging "financial or technological assistance" for emission rights from developing countries. (Pizer W.A., The Kyoto Protocol to the UN Framework Convention on Climate Change - Finished and Unfinished Business, http://www.cicero.uio.no/eindex.html 1998, p.2).

[13] L'industrie de l'environnment dans les pays de l'OCDE: situation, perspective et politiques gouvernmentales, Paris, Organisation de Cooperation et de Développement Economiques, 1992, p.5-19.

sort ET is to do so according to the elements they target - i.e. water, solid waste, air, soil, and noise[14].

1) Water Treatment

The biggest segment of the industry concerns water treatment. Civil engineering works and urban growth have helped this sector reach a certain maturity for both distributing and manufacturing. Hence, it is not surprising that the largest markets are municipalities. In essence, water treatment equipment eliminates pollutants from aqueous fluxes or transforms them into non polluting agents before using or disposing of them[15]. Currently, the most advanced methods involve aerobic settings, ion exchangers and organic membranes. Water quality control instruments are also an important part of this sector[16].

2) Waste Management

Waste management involves the equipment that ensures collection, transportation, treatment and evacuation of domestic, municipal, commercial and industrial waste. It encompasses the management equipment for solid waste (vehicles, isolation methods), liquid waste (vehicles, chemical products for

---

[14] In 1990, OECD estimated that the environmental industry ranked between the aerospace industry (which took in US$180 billion) and the chemical industry (which in turn grossed US$500 billion) with US$200 billion in gains. Currently, the industry earns over US$300 billion a year, of which about eighty-five percent is derived within OECD countries, at an average expense of 1.2% to 1.5% of GDP. The main purchasers of these G&S are municipalities, electric plants, water plants, extractive industries and traditional industries (The Global Environmental Goods and Services Industry, OECD, Paris, 1996, p.19).

[15] Procedures usually entail three treatments which begin by isolating solid particles with the help of filters and clarifiers, then removing bacteria through biological treatment and/or chlorination, and finally removing chemical compounds (notably heavy metals) with inverted osmosis or chemical product recuperation. The hardware involved in these processes can either be mechanical (rake grids, gravity isolators, sand removers, decanting basins, flotation pools) or physico-chemical (centrifugation, ultra violet treatment, neutralization, precipitation, absorption) (Ibid.,p.6).

[16] Among the top ranking firms one finds Sweden's *Alfa Laval*, with over 500 water treatment installations including their latest sewage plants and corresponding dung recycling sludge plants in Beverwijk, Netherlands (Alfa Laval Homepage, www.automation.alfalaval.se/30r.htm); France's *Suez-Lyonaise des Eaux* and their engineering division *Dégremont*, which were both considered world leaders in 1997 with more than $6 billion in profits with infrastructure projects in the Philippines, Hungary, Argentina, Bolivia and China, and - more recently - filter plants in Bogota and in Mexico (Suez-Lyonnaise des Eaux HP, www.suez-lyonnaise-eaux.fr/french/metier/index.htm); and finally Germany's *BASF*, whose "PT BASF-Indonesia" plant represents a good example of a cooperative ETT venture by not only producing polymer dispersors, processed chemicals for pulp and paper, textile and leather industries, and environmentally friendly pigment preparation processes, but also training more than 700 employees (BASF Home Page, www.basf.com/asia/indones/ adress/ltd.htm).

treatment), toxic or hazardous waste (discharge procedures & incinerators) and recycling equipment. The most active firms in this field are the U.S's *Waste Management*, Germany's *Hoechst* and, once again, France's *Suez-Lyonnaise des Eaux*, who recently purchased US$4 billion worth of international contracts from American leader *Browning Ferris*[17].

3) Air Quality Control

In turn, **air quality control** equipment either serves the function of eliminating the pollutants that lie in gaseous currents or transforming them into less polluting products before releasing them. Such pollutants comprise solid matter, gases, liquid and vaporous matter[18]. Overall, particle collectors represent about 60% of this market. Energy efficient technologies may be regarded as a sub-category of air quality control equipment. Usually integrated into production processes, these technologies must: (1) make use of plentiful fuels to moderate cost increases, (2) minimize environmental impact and (3) improve the efficiency of power generation and delivery[19].

A second generation of electrical equipment, such as load management systems and controls, high efficiency lighting, co-generation and high efficiency heating, ventilation systems and appliances, also incorporate efficient technologies[20]. The firms that drive this sector not only include firms that provide boilers, clean up equipment, training, engineering work and consulting such as Germany's *Steinmuller*[21] , *Handel* and *Lurgi*; and Japan's *Mitsubishi* and *Hitachi*,

---

[17]Suez-Lyonaise des Eaux, op.cit

[18]Hence, special equipment is designed to stop particles (tissue filters, electrostatic precipitators and mechanical collectors), acid emissions resulting from combustion (purifiers, catalytic or electron flux installations), and gas and vapors (desulfuration, oxidation and active carbon adsorption).

[19] Major industrial outputs include: high technology products such as combustion controls, energy management systems and instrumentation; medium technology products such as boiler equipment; and low technology products such as insulation (Eibenschutz, J.; Gray, J.E.; Hyde, R.P & Porter, W. M., "Energy Technology Transfer and Trade", in Guertin et.al., op.cit, p.113).

[20]Among these we find: **clean coal technologies** (e.g. *atmospheric fluidized bed boiler* (AFBC)), **high efficiency combustion turbines** (e.g. combined cycle generators (IGCC)), **fuel cells**, **renewable energy sources** (hydro and solar-thermal power systems, photovoltaic cells, wind power generators, biomass, or geothermal energy), **storage procedures**, and **transmission and distribution systems** (power control systems) (ibid., pp.114-123).

[21]Steinmuller Homepage, www.steinmuller.co.za

but also firms such as *Dupont*[22], which played a key role in 1987 in establishing the "Montreal Protocol" to phase out CFCs by providing substitute compounds.

4) Other Specialties

The **other category** denotes soil treatment; noise reduction; and monitoring, scientific, research and laboratory instruments related to natural resource conservation and protection[23]. Soil treatment involves regeneration, cleansing, and collection of polluted soil. This calls upon absorption, cleaning, stabilization and biological treatment of soils[24]. As for noise reduction, it involves ways of isolating or reducing various kinds of noises ranging from interior noises, such as factory noise, to external noises, such as highway noise. Finally, the last sub-category corresponds to the demand for specific equipment and the need for protection techniques and programs[25].

5) The Environmental Service Industry

In each category, environmental consulting services lie at the nexus of concerns over sustainability and immediately applicable solutions, by providing the strategies to manage environmental problems according to a particular country's agreed standards. They thus involve three types of activities in all of the above mentioned sectors: *technical studies* (site evaluation, conception of processes, adoption of methods and project management), *counseling services* (impact assessment, environmental audits, surveillance, risk management) and *management services* (expert systems and financial and database analysis)[26].

Consulting firms employ experts that solve environmental problems, provide information on the best techniques available to comply with a wide range of environmental norms and test the effects of products on the environment. They are assisted by more than a hundred software programs that can be

---

[22]Dupont Homepage, www.dupont.com/corp/gbl-company/history.html

[23] The Global Environmental Goods and Services Industry, Paris, OECD, 1996, p.5.

[24]Britain's consulting giant *Foster Wheeler* - which has gathered up to US$50 billion in capital investment for over 1000 clients in government and industry (Foster Wheeler Homepage, www.fwenc.com).

[25]*Hewlett Packard* heads the list with laboratory equipment followed by *Honeywell*, *Metallgesellshaft* and *Siemens* (Siemens Homepage, www.siemens.com/) with production of environmental protection equipment such as control and measurement instrumentation, new material components, and tailored turnkey projects.

[26]OECD 1992, op.cit, p.8.

applied to different aspects of environmental protection such as estimation of installation costs or produce impact studies[27].

III. Major Characteristics of Environmental Technology Transfers

Initially, ETT may present as another form of TT. Indeed, it shares some characteristics with other types of TT, yet not others. The following section will provide the analytical grid for chapter three by detailing both sets of characteristics.

1. The Different Forms of ETT

According to Daud Beg, TTs usually embody different forms of institutional interdependence. At the highest level of commitment one finds joint ventures, joint research corporations and joint R&D agreements among firms. In turn the middle level relates to technology exchange agreements, direct investment, licensing, second-sourcing agreements, subcontracting, production sharing, and suppliers networks. Finally, at a low level of interdependence there are research associations, government sponsored joint research programs, computerized data-banks, value-added networks for S&T exchange, and informal and only partially sanctioned information sharing among technicians[28].

The resulting variations of disclosure leads Jacques Perrin to distinguish three ways in which firms transfer technology: **international subcontracting, FDI** and **turn key projects**[29]. The first relates to international agreements between a providing firm and a recipient firm, where the latter is granted partial or full responsibility for production of a given good or service. Disclosure will depend on the level of responsibility. Even if they usually serve a need to exploit cheaper labor, such ventures bring about successful TT. Nonetheless, this only takes place when the recipient is able to absorb the foreign technology. Finally, since such projects often comprise specific know-how, they require a high level of conformity to IPRs.

---

[27]Most of the above mentioned firms also provide services in their particular field. However, there are firms that specialize solely in services. The *Dames Corporation* is well reputed for this. It is currently charged with a coal mine rehabilitation assessment project in Santa Catalina, Brazil, after drainage severely polluted the local water base (Dames Homepage, www.dames.com/dmg_home/).

[28]Beg D., "Privatization in Developing Countries", , in Guertin et.al., p.71.

The second way in which technology is transferred is by investing directly in a subsidiary or by creating a joint venture. This binds an investor with a share of the risk proportionate to the investment. Disclosure also follows a similar pattern since it will rely on the degree of involvement. Introduction of such ventures varies according to each country's legislation. Knowledge, is in this case, transferred through the acquisition of foreign technology with the invested capital or simply its donation. Such transfers prove successful since local technicians work along with, and learn directly from foreign technicians. The third type of technology transfer allows quick construction and transfer of industrial infrastructure from developed to developing nations. It includes the sale of equipment and services which show no participation from local technicians but result in the finished product. This type of transfer provides a finished product but does not grant either the right to reproduce nor sell. Implicit is the assumption that the recepient country does not have the capacity to reverse engineer the process, or that if it has the capacity it will not be exercised. Not much is revealed in such processes but the hardware itself. By granting the builder all prerogatives on decision making, choice of suppliers, services and materials, the receiving country does not partake in the process. Hence, in most cases it represents a one shot deal that has little impact on the global modernizing strategy of a country. In this typology, the issues of investment, local and foreign involvement, respect of IPRs, secrecy, transfer and cognition overlap. One can consequently infer a series of correlations among them. First, the proportion of local or foreign investment will correspondingly determine the degree of local or foreign involvement. The degree of involvement will in turn influence the disclosure of secrets on behalf of foreign firms. The more involvement these have, the more they may be inclined to achieve all that is needed to succeed, including divulging secrets. However, foreign firms also seek a controlled environment where their IP is protected. Finally, the amount of involvement of a foreign firm will influence the quality of transfer and the amount of cognition (e.g.

---

[29]Perrin J., op.cit, p.56.

a turn key transaction will be less fruitful than an ambitious long term joint venture with regard to cognition), but also prolong dependency.

This remains an important issue for the PRC since it is believed that its main striving is to cut the ties of dependency on western countries. Hypothetically, this translates into two patterns; the first relates to the type of projects that will be favored - from this perspective turn-key projects - while the second relates to the level of IPR protection - which would translate into lax protection of IPR.

2) What are the Main Prerequisites for a Successful Environmental Technology Transfer?

Two types of conditions influence all TT; receiving, and inciting ones. While the former relates to conjunctures that are needed for a country to adapt and incorporate new technologies, the latter refers to conditions that the country provides to encourage foreign technology investments. In the end, both come together in the nation's global plan for industrialization. The following section provides a grid that shall later serve to measure the PRC's capacity to absorb foreign technologies by outlining these conditions.

a. Receiving Conditions

Receiving conditions relate to the degree of correspondence between foreign and local know-how. According to Richard Nelson: *"...technology involves not only specific designs and practices but also generic understanding [...] that provides knowledge of how and why things work, and of what are the most promising approaches to further advances, including the nature of currently binding constraints"*[30]. This implies that ETT not only involves the hardware, but also the mechanisms that facilitate cognizance. At the macro level these involve the compatibility between economic philosophies which provides a common ground for negotiations. In turn, at the micro level they involve a country's physical and intellectual infrastructure which serves as a means for accommodating new knowledge.

---

[30]Brooks, H., "What We Know and Do Not Know About Technology Transfer: Linking Knowledge to Action", in ibid., p.84.

According to the Asian Development Bank, receiving countries have to fulfill the following prerequisites in order to maximize the benefits of technology transfer[31]. First, technology transfer requires a number of **technical components** that provide a certain congruence between local and foreign expertise. They include technical hardware, human abilities, recorded information and organizational components. Second, transfer projects also call for a level of **technological capabilities** in the receiving country. These allow for a certain autonomy once foreign technology is acquired. As demonstrated by Japan in the sixties, these encompass the competency to operate and maintain components; upgrade them; execute projects of business and technology; and adapt, assimilate and generate technology. Third, there is the need for an **innovation triangle** that creates a network between academic institutions, R&D centers and engineering production units.

On to this, George Bugliarello adds a series of criteria that determine a country's **national system of innovation**[32], that is a government's ability to control and guide technology. These can be divided into *practical* and *ideational* preconditions. The former invokes the incorporation of a technology while the latter provides a direction and projection for its use. Among the practical conditions can be found the need for rigid national standards for agriculture, industry, telecommunications and accounting; communications (roads, railways, airports) and soft service (accounting, patent lawyers, and legal services) infrastructure; and information databases on science, technology, management and trade. In turn, ideational ones involve national institutions that assess and screen imported technology, promote local technologies, provide direction and opportunity for self reliance, and advise on technology transfer[33]. Chapter three

---

[31]ASIAN DEVELOPMENT BANK, Technology Transfer and development, Asian Development Bank Publication, 1995, p. xvi.

[32]Bugliarello, G., "The Global Generation, Transmission and Diffusion of Knowledge: How Can the Developing Countries Benefit?" , pp. 71-74, in World Bank & NRC, op.cit.

[33]These include (1) organization of science and technology (S&T) and R&D policies; (2) public investment in technological observatories, joint ventures and other arrangements; (3) a focus on production efficiency; (4) a planning center for adopted technologies; (5) encouragement of investment from abroad and creation of clusters of research-production-marketing activities (institutes); and (6) encouragement of markets and the private sector.

will illustrate how the PRC's system of innovation accounts for these conditions. This will be interesting especially when looking at how the former meld with the PRC's economic ideology of a "socialist market economy".

b. Inciting Conditions

According to Daud Beg, TT *"is encouraged by privatization which allows market forces to operate, and it supports efforts by foreign investors to adopt up-to-date technologies and management techniques for profitable operations."*[34]. Therefore, since ETT represents in some way a form of foreign direct investment (FDI), recipient countries must exhibit a profile that is hospitable to investors. All in all, foreign capital expects a receiving country to sustain a **technology climate** which warrants cordial relations between owners and suppliers of enterprises, assured demand levels and customer sophistication, societal preferences that are in tune with the product, market competition, modern infrastructure, and relevant policies[35].

For Daud Beg, countries that wish to attract new technologies must provide the following five elements. First of all, to harbor transfer processes, receiving governments must offer a **sound legal framework** that is sustained by an upright judiciary that will not change with governments. Second, the recipient must ensure a relatively **healthy economic environment** headed by a sound banking system and financial institutions, freedom from custom duties, corporate tax exemptions, repatriation of foreign exchange guarantees, as well as indexation of specific costs. Third, countries must provide **assured rate of return on equity**. This involves adequate internal rate of return and the imposition of penalties for inefficient operations. Fourth, governments must have **good credit rating or provide some** insurance in order to assure investors. Finally, the recipient must have a **relatively stable political environment** since transfer projects can span 20 to 30 years. Even if these may be dubbed as ideal, in essence they represent a desired profile for investors. Investments are therefore based on a minimum threshold set about subjectively by companies.

---

[34]Beg, D., op.cit., p.91.
[35]Asian Development Bank, op.cit, p.10.

Moreover, each element is not attributed the same importance by all investors. In the final consideration some may outweigh others, notably those that assure returns.

c. Specific Conditions of ETT

In specific cases, such as ETT, countries may be expected to modify their legislation in order to protect a nascent technology. The sustainable character of ETT requires the existence of a political will in the recipient country that provides import incentives. This shows a willingness to abide by the principles of SD which overrides these technologies, inherent high costs and ineffectiveness if not widely adopted.

The main influence on the market is emission regulations. Even if *environmental regulations* vary from one country to another, the fact remains that they determine what environmental problems are dealt with and stimulate the demand for "clean G&S". The most technically advanced countries in this field are those where regulations were both diversified and efficient. Even if industries and municipalities are the main consumers of such technologies, it is up to central governments to stimulate the market through the proper environmental standards. As a result, variations in environmental policies create specific markets within OECD countries[36]. Since the environmental market is increasingly determined by technology, the same can be said of the most advanced techniques.

Currently, the World Bank advises governments to encourage this type of transfer by setting environmental emission standards, codes, taxes, laws and regulations; monitoring pollution; dealing with IPR issues; introducing investment incentives for new technologies; providing for the sharing of risks; and ensuring

[36] Take for instance the way both Germany and France dealt with nuclear energy. In the mid seventies, while in France those who opposed the government's injunction to make of nuclear power the backbone of the electric power sector were swept aside, in Germany blatant opposition made the government seek alternatives means that would meet the growing environmental concerns of the population (Government of Germany, La Actualidad de Alemania, Societats-Verlag, 1992, p.297). What resulted in Germany was a mixture of highly advanced thermal stations which took advantage of large coal deposits along the Ruhr, whereas France's inflexible stand and meager energy resources left no recourse but to resort to nuclear energy (OECD 1996, op.cit, p.14).

public awareness programs, and national and international political commitments[37]. As will later be shown, increased environmental concerns in the PRC have led to considerable changes in the distribution of prerogatives, notably when the National Environmental Protection Agency was instituted in the 80's.

3) The Delicate Issue of Intellectual Property Rights (IPRs)

Intellectual property (IP) plays a pivotal role in technology exchanges. In this area, the OECD countries' experience with the PRC has been somewhat problematic. In fact, the PRC has been labeled a black sheep on the matter as proven by the litigious relationship that it has had with the U.S throughout the nineties, notably on matters of copyright of music, movies and, most noteworthy, software[38]. Chapter Three will portray the PRC's record of IP protection, while chapter Four will portray the experience of Quebec environmental firms in the matter.

a. What is Intellectual Property?

Regardless of specific technical hardware and components, technology embodies knowledge. As such, it becomes a public good whose stock does not diminish with its consumption and consequently its marginal cost after being disseminated is zero. This means that "from a static efficiency perspective the optimal allocation of resources requires that such goods have a zero price"[39]. The ensuing sub-optimal price implies that the creation of knowledge entails costs that do not encourage investment and improvements. Moreover, its abstract character makes it difficult to bind with physical constraints. This situation brings about free-riding by those who have the capacity to reproduce the same technology at lower costs. It is argued that the only way to nurture technological development and diffusion is to provide a legal framework that will protect the developer either by ensuring returns for the use of his knowledge or by offering constraining measures that forbid its illicit duplication. The level of

[37] "Rising to the Challenge: Priorities for the Developing Countries and the International Development", World Bank, p.55.
[38] Potter, P.B. & Oksenberg, M., "A Patchwork of IPR Protection", China Business Review, www.nbr.org/regional-studies/ipr/cbrarticle .html
[39] Hoekman, B.M. & Kostecki, M., op.cit, p.147.

protection has thus a direct impact on profits, which in turn influence investments in R&D and rate of production.

b. The Foundations of IPR Protection

Concerns over IP protection are not new; in fact international efforts to legally shield it date back the to nineteenth century with the *1883 Paris Convention on Patents and Trademarks*. In itself, protection within a country is easy to implement since legislation and institutions exhibit internal cohesion. However, this is not the case at the international level where ideologies and doctrines vary from one country to another, and there is no overarching authority that can effectively impose standards. Even if developed countries are concerned with the loss of their competitive edge without proper safeguards, protection of IP in turn overrides other ambitions which are central to developing countries. Thus, stolen IP becomes an "increasingly contentious" issue which requires multilateral cooperation among sovereign nations in order to draft universal enforceable intellectual property rights (IPRs).

The latest manifestation of such a regime comes about with the creation of the World Trade Organization (WTO). Besides accounting for both the GATT and the GATS agreements, the WTO provides rules and mechanisms of enforcement for a broad range of "trade related IP issues" in the **Trade Related Intellectual Property Rights Agreement** (**TRIPs**). This accord imposes obligations upon governments to pursue specific similar policies in order to mitigate unwarranted unilateral trade sanctions induced by violation of IPRs[40]. Presently, the PRC's exclusion from the WTO does not facilitate the institutionalization of IPR.

So far, IP owners must still file for IPRs in each country where protection is sought, yet the TRIPs might in the near future induce the creation of standard protection[41]. Currently, they present a complex seven part 73 Article agreement

---

[40] Until now, IPRs are administered by WIPO (World Intellectual Property Organization), a Geneva based UN body (Hoekman, B.M. & Kostecki, M., op.cit, p.144).

[41] Negotiations that lead to the agreement saw differences between both OECD and developing countries. The former stated that violation of IPRs constituted piracy and theft, while the latter, led by India, opposed IPRs strongly by stating that the adoption of OECD levels of protection constituted an infringement to their development process. Developing nations would later accept the OECD nations' proposal as a result of pressure of the local interest which wanted to grab a share of the, up to then, conditional benefits in FDI that proper IPRs would yield, fear of unilateral

which covers copyrights and related rights, layout-designs of integrated circuits, geographical origin indications, trademarks, industrial designs, and patents[42].

c. Different Types of Knowledge require Different Types of Protection

All types of TT are influenced by the degree of protection which is in turn determined by the way knowledge is stored. Since technological innovations evolve from both scientific research and practical experience, the different types of knowledge these generate require corresponding forms of protection. One can categorize three types of knowledge[43]. Foremost, there is **general knowledge** which relates to the technology held by all firms in a particular industry such as basic arithmetic skills, blueprint reading, tool design and computer abilities. Then comes **specific knowledge**, which refers to the development of a particular system that distinguishes one firm from another and provides a competitive advantage. Finally, **specific know-how** entails the overall experience gathered by a firm and consequently the factor that differentiates it from others. The first two can be physically recorded but the third relates to the unrecorded every day experience of engineers and technicians. In turn, protection of the former two is based on the legal coverage of published research, while protection of the latter is less tangible since it involves interpersonal secrets[44].

With respect to the PRC, it is important to remember that, even if it offers IPR protection inspired from western IPR legislation, the Chinese legal tradition

---

arm twisting, potential technological gains and the possibility to free ride on most favorite nation (MFN) principles while not paying membership fees nor being bound by tariffs.

[42]First, it establishes minimum substantive standards of protection of the above rights. Second, it prescribes procedures and remedies which should be available in Member States to enforce rights. Third, it makes the general dispute settlement mechanism of WTO available to address TRIPs-related conflicts. Finally, fourth, it extends basic GATT principles such as transparency, national treatment and MFN to IPRs. However, as stated above, there remains the problem of full adherence (Hoekman & Kostecki, op.cit, p.153).

[43]Ibid., p.308.

[44]General and specific knowledge are often sold to offer short cuts to other firms that would eventually discover them. The best type of protection is **patent protection** since it prevents others from copying the invention or producing similar applications. This provides the owner with exclusive rights to make, construct, use or sell the invention in the country of issuance for a certain period of time and ensure a statutory right. In turn, specific know-how is rarely sold since it provides a competitive advantage. Its protection is granted by the legal status of **trade secrets** and bound to legal principles of equity, property and contract law. These regard information that is disclosed under circumstances that bind to confidentiality and present actual or threatened unauthorized use as confidential (Mckay-Carey, op.cit, p.158-165).

With respect to the PRC, it is important to remember that, even if it offers IPR protection inspired from western IPR legislation, the Chinese legal tradition differs and hence interprets laws differently. This will once again be a topic for discussion in chapter three.

IV. Conclusion

This chapter has illustrated that ETT does not only involve hardware but also social planning. The relevance of political science in fostering technology transfer is here confirmed not only in analyzing the problems, but in providing solutions that facilitate the process. By detailing the relation between ETT and SD, this chapter has placed ETT beyond mere simple market transactions, within a larger reality that affects all nations. From this perspective, ETT becomes a useful tool to counter poverty and inequality, and a means to improve the quality of production mechanisms. However, environmental sustainability by means of technology is to be secured through cooperation by both donors and recipients on issues of cognitive parity and IPR protection. It thus involves the adaptation to new information and values which in turn can lead to new levels of consciousness.

The principles developed in this chapter will later be tested when the issue of ETT to the PRC will be examined in Chapters Three and Four. With respect to the PRC, the following hypotheses will be tested. First, it is believed that issues regarding accommodation of technology are more likely to hinder the transfer process than are issues of IP. Second, the less developed the accommodative structures will be, the less technology transfer processes will involve local expertise. Third, the less IPR will be protected, the more foreign firms will protect their secrets by using less the local expertise and/or by selling a technology rather than licensing it. Fourth, due to diverging ideologies, the PRC will favor the types of transfers that do not compromise the ideology of the CCP. Ultimately, the sustainable character of certain technologies will facilitate their adoption in the recipient country.

CHAPTER 2: ENVIRONMENTAL TECHNOLOGIES

According to the Asian Development Bank, regardless of the level of expertise, firms follow one of the following four strategies[1]. Small scale enterprises that import low-tech products in low value markets are considered *technology extenders*. Medium sized enterprises that develop through joint ventures, offer cheap labor and input substitutes, produce standard technologies and uniform quality, compete for price leadership, and import low and medium technologies that are adapted for innovation and export are considered *technology exploiters*. In turn, firms that try to seep into international markets by imitating licensed technologies, ensure adaptive research and reverse engineering, do well in economies of scale, provide high quality and employ advanced technology capabilities are labeled *technology followers*. Finally, large firms that introduce self-developed technologies and use both economies of scale and scope are defined as *technology leaders*[2].

In the environmental industry (EI), the market is shared by a small number of technology leaders that hold fifty percent of the production in each sector and a large number of technology followers, exploiters and extenders that share the rest. However, the diversity of the market offers many entry points and a fertile ground for new technology followers. In 1992, the OECD estimated that there were about 30 000 of such firms in North America, 20 000 in Europe and 9 000 in Japan[3].

Germany is the leading exporter with forty percent of its production leaving the country[4]. Foreign penetration is weak since it does not surpass five percent and dwells mostly in low tech equipment. Forty percent of exports are related to water and thirty five percent to air. Half stay in Europe and the rest is equally

---

[1]Asian Development Bank, op.cit, p.44.
[2]Respectively, the various SME that subcontract derivative components for larger firms represent the first group. Firms such as **Hart Environmental Inc.** - which produces air pollution control equipment (atomizing nozzles, filters, and hot gas cooling systems) (HEI Homepage, www.artenv.com/:) operate with the second strategy. Firms such as **Anglian Power Generators** - which specialize in combined cycle generators - comprise the third group. Finally, multinational corporations such as **Dupont** or **General Electric** close the list.
[3]OECD 1996, op.cit, p.5.
[4]Ibid., p.20.

distributed between North America, Eastern Europe, South West Asia and Africa. Asian markets are new. Europe shows a positive export balance. The UK, France, Sweden and the Netherlands export between fourteen and twenty percent of their production. In turn, the U.S exports ten percent of its overall production, but has a ten percent negative trade balance in clean air technologies. Finally, while Canada is a net importer, Japan's high-tech exports reach six percent of total production[5].

I. The Environmental Industry in Canada and Quebec

1. General Overview of the Canadian Environmental Industry

The Canadian environmental industry is currently made up of 4,500 firms and 150 000 knowledge and science based jobs[6]. Just as in the international market, a majority of SMEs also characterize the industry. On the whole, sixty five percent of firms provide services while the remainder manufacture goods. In 1995, the former grossed over CA$5 billion, while the latter accounted for CA$6 billion. Regarding exports, they are estimated at about CA$1 billion a year with 80 percent of them going to the U.S.. In 1997, Sergio Marchi, then Federal Minister of Environment, declared that this industry was the fifth-largest industrial sector in Canada with an annual growth rate of approximately 10 percent and a total worth of CA$14 billion[7].

According to Supply and Services Canada, the Canadian environmental industry is mainly involved in, and well reputed for, monitoring and measurement instrumentation, emission prevention and control technologies, and solid and

---

[5] A sign of future spread of such technologies comes about with the creation of the ISO 14000. This new standard relates to environmental concerns by establishing the requirements for environmental management system and quality control. From the start, certification by the INTERNATIONAL STANDARDS ORGANIZATION (ISO) is essential for firms that seek rapid growth in the international market. Most MNC only do business with subcontractors that satisfy ISO. Core elements are referred as ISO 14001. They involve identification of environmental issues, appointing priorities according to local regulations, developing an environmental policy statement, setting performance targets, implementing environmental management systems, and measuring performance. So far, ISO 14000 is being implemented in Europe and Japan. The U.S will have to follow. In developing countries Mexico has incorporated the standards, while Indonesia and the Philippines are planning to implement them (Clear Water, Blue Skies, World Bank, Washington D.C, 1997, p.69).

[6] Canadian Environmental Industry Strategy, Environment Canada, http://www.wc.gc.ca/press/ceis_b_e.htm, 1997.

[7] "Environmental Industry Virtual Office Opens in Alberta", Industry Canada,

liquid waste handling equipment (incinerators, shredders, compactors, recycling systems and equipment)[8]. Presently, Canada's strength lies in the solid R&D background that exists in companies, universities and provincial and federal governments. Moreover, Canada also benefits from being seen internationally as an environmental leader. Even if Canadian environmental regulations lag behind those found in Germany and Scandinavian countries, the fact remains that the Canadian Government has placed SD as a cornerstone of Canadian foreign policy along with conflict prevention, trade negotiations and development assistance[9]. This has led the federal government to make strategic investments in technological development projects to increase international competitiveness and ultimately, Canada's reputation[10].

2.Overview of Quebec's Environmental Industry

Quebec's environmental industry is one of the leaders in Canada behind Ontario. Even though the industry has not fully exploited its export capacity, a good sign of maturity is the fact that it is able to provide for the Province's environmental needs. Currently, Quebec's strength lies in water management, biotechnology, agricultural waste management and a solid R&D infrastructure; however, it lags behind in air pollution and solid waste management.

On the whole, the industry totals 900 enterprises, 15,000 jobs (76% in services and 24% in production), U.S$1.7 billion in revenues (6% in exports) and an expected growth of 10-12% per year[11]. Presently, the most developed remains **waste water management**. It includes producers and distributors of

---

http://info.ic.gc.ca/cmb/welcomeic.nsf/Pages/searchfr.ht, 1997

[8]The industry also produces derivative components such as attachments for pumps and valves, separators and filters. In turn, services include auditing, engineering, technical and scientific services. They consist mainly of studies, plans and projects for resource conservation and protection; water supply, sewage collection and treatment; solid waste disposal; industrial waste water treatment; air pollution controls; and energy conservation. Consulting engineers, software developers, solid waste management developers and recyclers, private laboratories and research establishments are all included in this group. (The International Trade Business Plan: Environmental Equipment and Services 1995/1996, Supply and Services Canada, Ottawa, Government of Canada, 1995, p.3).

[9] Sustainable Development Homepage, Department of Foreign Affairs and International Trade, http://www.dfait-maeci.gc.ca/sustain/menu-e.asp.

[10] "Technology Partnerships Canada", Industry Canada , http:/strategis.ic.gc.ca/sc_mangb /tp/engdoc/homepage.html.

[11] Point de mire sur l'industrie de l'environnement, Ministère de l'Industrie du Commerce de la

materials for decanters, water treatment, ventilation, dosing, mud management, measuring and control instruments, disinfecting and biofiltration technology, leak detection and repair systems, and computer software and hardware . By 1994, there were about thirty five producers and thirty three distributors of such technologies, eighteen concentrating on potable water[12]. The main customers are governments, municipalities, pulp and paper, metal and chemical industries, and oil refineries[13].

In the service sector there are approximately fifty counsulting firms, thirty two laboratories and forty five R&D institutions that deal with (1) distribution networks of water and sewage, (2) design, construction, and exploitation of filtration facilities, as well as (3) laboratories for control and analysis[14]. From 1980 to 1991 the percentage of "Quebec made equipment" for water treatment facilities jumped from twenty five percent to seventy five percent for small and medium size facilities. This meant that these enterprises had established a business network, and thus found themselves in a position to export some equipment (filters, biotechnological components & decantation and oil removing material).

Overall, water management firms benefit from a high level of expertise, proper production facilities, support from government research centers and universities (Institut Maurice LaMontagne, INRS-Eau, University of Sherbrooke, McGill, École Polytechnique and the CRIQ), the most developed training programs in Canada (including graduate courses on water management), and the assistance of the *Association Québécoise des Techniques de l'EAU* . However, firms lack representation at the national level, offer limited international competition (when compared to MNC), receive little funding due to their small

---

Science et de la Technologie, Québec, 1995, p.2.

[12]Seventy percent of these belong to Quebec owners (Ibid., p.13).

[13]Municipalities represent the biggest clients for clean water treatment facilities (coagulation, flocculation, decantation, filtration (sand and anthracite), and chlorine disinfectants), waste water treatment (active mud, pools, biodiscs, marshes and septic tanks) and equipment for sewage and water distribution.

[14] Dumais, Marie Christine, Le potentiel d'intervention internationale pour les entreprises québécoises en environnement, Centre de recherche industrielle du Quebec (CRIQ), Quebec, 1994, p.12.

size (only one third of them can do their own R&D), and are disadvantaged by the non implementation of regulations found in the Industrial Waste Reduction Program.

The **air management sector** in Quebec also offers G&S that treat interior and exterior air according to norms. In 1994, the sector gathered twenty six builders and twenty four distributors of industrial ventilation equipment, dust-removers, separators, filters, air measuring analysis and control instruments and consulting firms. These also offered different instruments to control air quality such as electrostatic precipitators, cloth tissue filters, dry or humid filters and cyclones[15]. In Quebec, seventy five percent of these systems are bought from local enterprises, of which sixty five percent are owned by Quebec interests. Likewise, services divide into twenty three expert-consulting firms, seventeen laboratories and fifteen R&D firms. Individually, expert firms comprise engineering firms that do not build, firms that create and build equipment, and producers specialized in certain components.

In Quebec, the air sector lacks human resources and expertise. This is probably due to partial instruction of technicians and engineers (e.g. one course on basic knowledge of atmospheric chemistry at the graduate level in all universities). Nevertheless, such training can be obtained in Ontario where Environment Canada has concentrated most R&D efforts. Meanwhile, most of the research that both federal and provincial governments invest in Quebec is fundamental since it concentrates mainly on meteorological aspects and forecasts, and cross boundary phenomena related to acid rain. Insufficient government action to uphold regulations and develop programs also represent a problem for the sector[16]. Lastly, the industrial association is smaller and less active than its American counterpart, the Air Waste Management Association.

---

[15]Note that common air pollution control equipment has relatively few high tech components and its construction does not require specialized tools or individuals (Dumais, op.cit., p.11).

[16]There are no real controls for atmospheric pollution in Quebec except for (1) emissions from the aluminum industry, (2) measure and treatment of odors through the development of olfactometers and biofiltration equipment established in some firms, and (3) the fabrication quality of interior air management.

Solid waste management and recycling in Quebec presents a variety of builders and distributors of storage, collection, treatment, elimination and recycling equipment and systems for domestic, industrial and commercial residues. Many of these enterprises also work on waste transportation, analysis, monitoring and handling equipment. Others have created procedures and materials for monitoring, measuring, controlling, validating, and conditioning waste[17]. Out of the fifty Quebec enterprises in 1994, thirty four were owned by local interests (74%). The same year service firms amounted to fifty two counsulting firms, twenty laboratories, twenty R&D institutions and between fifty and seventy executing firms.

Like water management, this sector benefits from government and university research facilities for the development of biotechnology (CRIZ, Armand Frappier & Institut de Recherche en biotechnologie). It also presents a unique and diverse expertise for defining decontamination procedures and monitoring criteria. There are in Quebec two sites for treating and eliminating organic and non organic waste. On the down side, the following can be noted: the absence of enforced regulations, the need for training programs both for technicians and engineers (since most experience is acquired on the job), limited R&D for new ways to recuperate and recycle waste, few important industrial associations, and difficult access to financing[18].

Quebec also provides G&S for **protection and rehabilitation of soils.** This sector differs from industrial hazardous waste management since it often combines solid, liquid and gaseous phases. Moreover, each site is particular since its physical, chemical and biological components differ. It is therefore difficult to identify one single technique which takes into account and respects economic, environmental and social norms. So far there is no plant that can

---

[17]Quebec excels mainly in services and materials related to collection and transportation, monitoring and measurement and treatment and elimination (Ibid., p.15).

[18]Furthermore, solid waste management faces little use of recuperated and recycled materials, and no local production of specialized equipment for recycling plants (magnetic sorters, blowers and grinders). In turn, hazardous waste management lacks mobile equipment suppliers that would allow to treat the waste on site and see difficulties arise when filing for permit acquisition of new procedures (notably due to long delay periods).

eliminate all types of contaminated soils in Quebec[19]. However, certain firms have the capacity to treat polluted soils on location - in situ (extraction, bleaching, immobilizing, chemical degradation, biodegradation and thermal volatilization) - or after excavation - ex situ (thermal procedures, biodegradation, physical procedures, chemical extraction, stabilization, and solidification).

An agreement signed between federal and provincial governments led to the creation of the *Programme d'Assainissement des Lieux Contaminés à Risques Élevés* . The funds for this program were to serve the purpose of demonstrating Quebec's clean up technologies[20]. Still, this sector faces limited funds for enterprise development and lacks incoherence, since no partnerships are found between producers of goods and service providers. In addition, no respected trademark has been established in this sector and there is no harmony between federal, provincial and municipal regulations.

Other sectors present in Quebec are: **treatment of chemical compounds**, **agricultural waste matter** and **biotechnologies**. The first one pertains to producers and distributors of air and water treatment, absorbents, and agglomeration and granulation products[21]. In turn, the second one relates to the small number of enterprises, counseling firms, and research centers that deal with cattle raising and air, water and soil pollutants such as fertilizers, suspension particles and pesticides[22]. Here, the fact that Quebec's environmental legislation regarding agricultural activities remains the strictest in North America has yielded relatively advanced techniques[23]. Finally, the third sector proves of relevance for the clean up and recycling of residues (bioenvironment), displays applications in forestry[24] and provides materials that are essential for the other two.

---

[19]The NIMBY phenomenon also manifests itself in Quebec. The ecological disaster in St-Basile Le Grand has reinforced it.

[20]Dumais, op.cit, p.17.

[21]Ibid., p.20.

[22]Most of these are funded by the *Programme d'Aide a la Recherche et au Développement en Environnement* (PARDE),

[23]However these techniques remain 25 years behind those employed in Europe (Ibid., p.21).

[24]Biotechnology offers the possibility to increase yields in forestry through regeneration procedures that include cloning of species, and insect repellents. Moreover, it provides the pulp and paper industry with a means to bleach Kraft pulp with mushrooms (trametes versicolor) and develop biomass with the industry's residues (Les biotechnologies dans la région de Montréal,

II. Strategies for Growth and Environmental Aid Programs

1. Canadian Strategies and Aid Programs

Having to consolidate Canada's commitment to sustainable development, the federal government has in recent years launched a series of programs to further develop the industry. Among these there is the **Strategy for the Canadian Environmental Industry**[25]. This project aims for greater exposure of Canadian technologies through agreements, facilitating market-entry, planning for strategic networks among SMEs, gaining environmental market intelligence and transferring management expertise to developing countries. The best example of this venture has been the various environmental technology transfer workshops held by Industry Canada (IC), Environment Canada (EC), National Resources Canada (NResC), the Canadian International Development Agency (CIDA) and the Department of Foreign Affairs and International Trade (DFAIT)[26].

Each of these entities is responsible for a series of programs designed to encourage the industry. For example, IC offers both information and support for technologies and investments that are deemed "sustainable"[27] with programs such as the **Canadian Office for Technology Exchange in the Environment**[28], the **Environmental Industry Virtual Office Program** and the **Canadian Business Environmental Performance Office**[29]. In turn, EC offers technical expertise for the application of techniques, conception methods and

---

Conseil de la Science et la Technologie, Government of Québec, 1994, p.20).

[25] Supply and Services Canada, op.cit, p.1.

[26] Canada has signed about 50 bilateral agreements that are destined to improve the environmental conditions of many countries with different degrees of involvement. Among these, CIDA has signed two memoranda of understanding with China, EC four with China's NEPA - including a course on environmental management for NEPA officials in 1996 - and Natural Resources Canada has signed one ("Canada's International Agreements for the Environment", Industry Canada, http:/strategis.ic.gc.ca, 1997.)

[27] Canada-China: Environmental Solutions, Industry Canada, 1997, p.81.

[28] This office assists public organizations and private companies from countries around the world by linking them to their Canadian counterparts with the purpose of developing their own technological capacity and contributing to global sustainable development. Among its most recent initiative is that of *Environmental Technology Transfer Fund for Poland* which consisted of demonstration projects and technological modernization. ("Canadian Office for Technology Exchange in the Environment" (COTE), Industry Canada, http:/strategis.ic.gc.ca/SSG/ea01593e.html)

[29] The last two offer Canadian firms basic information on the existing aid programs and packages at both levels of government.

management, and has access to public sector know-how since it finances a large part of the federal R&D on environment. The fact that many developing countries often call upon the Ministry's objective expertise on regulations of technology and R&D offers many firms the possibility for subcontracting projects[30].

Correspondingly, **NResC** provides a geo-science knowledge base on environmental protection, public safety and economic development, while CIDA is responsible for the **Canadian Industrial Cooperation Program** which offers a bridge between commercial and development interests[31]. Finally, additional support comes from DEFAIT's trade commissioners - who offer assistance to export-ready Canadian companies venturing in the developing countries -, the **Société pour l'Expansion des Exportations**, the **Federal Bank of Development**, the **Federal Bureaus of Regional Development**, the **Asia Pacific foundation of Canada** - and its link to APEC - , and the **Canada-China Business Council**[32].

2.Quebec Strategies and Aid Programs

Contracts that are secured through IFIs come from developing nations that have borrowed funds to develop infrastructure. These borrowing countries

---

[30]EC instituted in 1992 the **Canadian Environmental Training Program** which teaches foreign public officials environmental management. It also links up the industry, the state R&D network, the ministries involved in the protection of the environment and/or international business and community colleges that train environmental technicians. The most recent illustration of this program was the training of Mexican public officials from the city of Monterey in Hamilton's Waste Water Technical Center (Le rôle d'Environnement Canada dans l'élaboration de nouvelles approches a la cooperation technologique dans les marches naissants, Environnement Canada, 1995, p.4.)

[31]Since 1978, this program reduces the risk for Canadian firms by sharing the cost of doing business in developing countries and enhancing the positive developmental impact of private initiatives. Since CIDA administers most of the Canadian aid budget, after examining proposals, it shares the costs at the viability study stage, contributes towards reducing the costs of the developmental components of the project at the implementation stage and contributes to the training in both social and environmental aspects (Industry Canada, op.cit, 1997, p.85).

[32]The main IFIs that deal with environmental programs are the World Bank Group (IBRD, IDA, IFS and AMGI), the World Environmental Fund, and the Asian Development Bank. With respect to the latter, Canada is a significant contributor to the World Bank and regional development banks. Canadian firms are eligible for CA$40 billion in projects funded annually in developing countries. These contracts can be obtained through the IFIs programs. Back in 1993, the World bank awarded CA$2 billion and the Asian Development Bank awarded CA$154 million for baseline studies, water supply projects, training and characterization of environmental situations. In turn, the Inter-American Development Bank awarded CA$1.2 billion for natural resource conservation, improvement of the urban environment, pollution control and local government institution strengthening. (Supply and Services Canada, op.cit, p.2)

publish ads in the UN's bimonthly magazine *Development Business*. Notices include the beneficiaries, the amount of the loan, the nature of the work required and the deadline for submission. Even if sixty to eighty percent of the contract is based on the entrepreneur's cost estimate, time schedule, local participation, possibility to acquire single parts, compatibility and reputation are also accounted for. The borrowing country awards the contract but the IFI is responsible for paying. To show their interest in such matters, firms must contact the Ministry of Foreign Affairs in both levels of government.

Besides being eligible for all Canadian programs, Quebec firms can count on the various provincial aid programs. The largest aid is provided by the *Ministère des Affaires Extérieures, de l'Immigration et des Communautés Culturelles* (MAIIC). It initially provides the technical assistance by giving advice on foreign trade and on finance procedures, in addition to offering the SAM program which involves a contact network with over 25, 000 U.S. firms. Another type of aid it provides takes the form of training programs involving private organizations that are actively involved in international trade[33]. Finally, the MAIIC provides three way financial assistance to firms through the APEX program[34], through group missions (financial support to rent space, build stands, pay for promotional material, invite buyers or transport samples to fairs and expositions), as well as through the ACTIM-MAIIC treaty which promotes cooperation with France's Agence pour la Cooperation Technique, Industrielle et Economique (ACTIM) in the Atlantic region.

Finally, the *Société de Développement Industriel du Québec* (SDI) stimulates economic development through the financial assistance of its export-aid program[35] and the *Ministère de la Faune et de l'Environnement* (MEF)

---

[33] The courses offered here include: Introduction to Foreign Trade, International Negotiations, Transportation and Marketing, Importance of Cultural Context in International Business, and How to Export Abilities. Some seminars are also offered on how to: Prepare for Export Markets, Develop International Business and Prepare Fairs (Dumais, op.cit, p.201).

[34] It involves individual prospecting missions in the U.S and Europe (max. CA$5 000), aid for expositions and fairs (max. CA$10 000), studies and strategies for marketing (CA$ 15 000 -$25 000), aids for market adaptation of promotional material to new markets (max. $ 25 000), employment grants, and special programs (max. CA$50 000).

[35] This has three aspects: implantation of credit (loans at market rate that can cover feasibility

presents the "Fonds de recherche et de développement technologique en environnement" (FRDT-E), which is exclusively related to clean technologies and holds credits of CA$50 million for five years available for exploration research projects and technological innovation projects.

III. Prospectives for the Environmental Industry in Canada and Quebec

According to the OECD, Canada remains a secondary producer of environmental technologies; nevertheless, conditions to expand the market seem well in place. The main prerequisite for exports is domestic dominance and this is being achieved by many firms. Between 1991 and 1996, Canadian exporters have doubled to 600 firms and there are about 1200 others that are export ready[36]. Besides comprehensive Federal government programs, Canadian firms benefit from a good reputation and major treaties with regional groups. Moreover, most Canadian missions abroad place environment within the top three prioritized industries[37]. Overall, it can be said that the Canadian strategy is focused on building momentum in markets in the developing world by providing good quality market-responsive environmental G&S at a reasonable price.

In turn, Quebec firms also show strong potential. Ten years ago, all of Quebec's SMEs began to generate an export culture. Out of the 13,000 firms, thirty to thirty five percent sold in foreign markets. About half of them exported less than 10% of their production, many however exported passively by responding to external demand without a particular export strategy. The American Atlantic region remains until now the main market. Exports to it constitute mainly telecommunications, paper, and aluminum. Europe follows suit with precious metals, alloys and aluminum. Finally, Asia, Africa, Latin America

---

studies, legal fees, travel, employee wages outside Quebec, cost of stocks and samples), financing exports (consists of a warranty that covers up to 80% of loan retribution for any firm that requires it to export goods and services) and finally, consortium formation (loans that can become shares, up-front returns for shareholders or warranties, that are given to enterprises which seek alliances to obtain contracts or sales outside of Quebec).

[36]Supply and Services Canada, op.cit., p.2.

[37]According to the Canadian Ministry of Supply and Services, Canada continues to support the "activities in this industry that are aimed at enlarging the shares of established markets innovative technologies and capabilities targeted at niche market opportunities, and pursuing opportunities with international financial and donor organizations in developing countries" (The International Trade Business Plan: Environmental Equipment and Services 1995/1996, Supply and Services

and Oceania top receive asbestos, instruments (measuring, control, laboratory and medical) and paper (Table 1 below shows the value of exports by geographic area).

Regarding environmental G&S, the majority of firms (98%) sold their goods in Quebec. Some had markets in Canada (Ontario 30%, Maritimes 20 % and the West 16%), and few sold outside of Canada (US 10%, Europe 3%, Asia and Latin America 3%, and Africa 2.2%). There was a clear absence of Quebec environmental firms in foreign markets. Most exporting firms selected the recipient country after having participated in fairs, or after exploring the potential market[38]. Others simply responded to international orders or reacted to opportunities set simply by regional proximity. Finally, some benefited from aid programs of International Finance Institutions (IFI) or of provincial and federal governments.

Table 1 Value of Quebec exports per geographic area 1992 (thousand $)

Region	Value	Proportion
US	20 799 000	76.0%
Europe	3 965 513	14.5%
Latin America	498 195	1.8%
Africa & M.E	244 370	0.9%
Asia & Oceania	1 452 904	5.7%
TOTAL	27 248 970	100

Source: Dumais, Le potentiel d'intervention internationale pour les entreprises québécoises en environnement, Centre de recherche industrielle du Québec (CRIQ), Québec, 1994, op.cit, p.23.

Canada, Ottawa, 1995, p.4).

[38]Numerous trade fairs are held by the different industries from all environmental sectors. Firms that wish to open up to international trade can purchase floor space in these fairs in order to develop new contacts or simply offer their G&S in new markets. Participation is however expensive.

IV. Conclusion

From a broad perspective, Quebec and Canada offer technologies and services that are comparable to the ones offered in the international market, yet they offer no significant technological lead nor renown when compared to Japan, Germany, and the U.S.. Globally, Quebec firms started opening up to international markets in the mid-nineties. Most profits came from counsulting firms. As in any other market, local firms must learn to comply with the business mentality and culture of the importer. This process can be as complex as the transfer of technology itself, since one must adopt the business ethic of another country (management, language, laws, culture, and customs). Consequently, the development of an export market represents a medium and long term investment, and requires considerable human and financial resources.

Overall, the Environmental industry in Quebec accounts for an important number of specialized small and medium size enterprises that fall into the *technology follower* category. Since they are young, their level of experience is limited in the international arena where the U.S, Germany and Japan have become the main providers. However, the important size of this new industry (U.S$150 billion in North America), its estimated growth and its need for increasingly sophisticated products, offers Quebec firms a window of opportunity. In fact Quebec's participation in various trading spheres (NAFTA, la Francophonie, the Commonwealth and the ASEAN), its qualified and skilled labor and public R&D centers that work with the industry, its competitive fiscal policy for enterprises, and -as the following section will show - its Government's support for new technologies constitute considerable assets.

CHAPTER 3: THE PEOPLE'S REPUBLIC OF CHINA'S ENVIRONMENTAL CHALLENGE

I. Environmental Problems in China

The history of Chinese civilization is marked by several serious environmental disasters which repeatedly demonstrated the intricate and yet fragile link that binds human activities to nature. In China, the threshold of sustainability, defined in terms of meeting one's own needs while preserving resources for future generations, has often been surpassed. In fact, historians have shown that socioeconomic and political forces - resulting from overpopulation in China - have accelerated the rate of environmental degradation by suffocating internal productive forces[1].

Environmental disasters are also embedded in Chinese consciousness and tradition. Chinese Civilization finds itself caught in an everlasting oscillation between respecting nature and plundering it[2]. This endless loss of equilibrium remains problematic since it has been incorporated as an inevitable part of life. Presently, the PRC faces some of the world's biggest environmental challenges. Matters are further complicated by the size of the population which is thought to be between 1.2 and 1.4 billion people[3]. The sheer size of the population and the agricultural character of the economy imply the country can be compromised at any time by *environmental degradation*. Defined in terms of exhaustion and/or contamination of

---

[1]For example, under the West Zhou dynasty (1115 - 1079 BC), during the *Pre-Qin period* (2205 - 221 BC), the ruler of the Qi state developed and sustained a ratio for growth based on the number of people per unit of arable land in order to avoid shortages. Moreover, during the *Qin to West-Han period* (221BC - 57 AD), large scale projects - such as the Great Wall, the Clay Guards and the E-Fang Palace, unsound policies that supported high birth rates, and expansion of paper making and iron smelting industries - contributed to extensive deforestation and land degradation, change in river courses and demographic decline. Relative prosperity which characterized the two following periods, the *East-Han to Sui period* (57 - 618 AD) and the *Tang to Yuan period* (618 - 1368 AD), set the foundations for droughts and civil unrest. Lastly, the *Ming to PRC period* (1368 -1949 AD) also replicated these patterns. Current Chinese population problems are seeded in this period since land distribution followed closely the number of family members. In 1650 population reached 100 million in coastal regions. By 1820 it reached 400 million. Finally, when the PRC was instituted, China's population comprises approximately a hundred million more (Qu, Geping, Population and Environment in China, London, Paul Chapman Publications., 1994, p.17-26).

[2]Edmonds R.L., Patterns of China's Lost Harmony, New York, Routledge, 1994, p.23.

[3]Most settlements are found in the country's eastern divide that is characterized by the plains of the deltas. About 70 percent of the population live in rural areas, and of this fraction, 75 percent are involved in agricultural activities (China 2020, The World Bank, Washington D.C., 1997, p.6).

resources, this phenomena results from the increased demand that human development brings about on a living space. In this perspective, overpopulation is not to be seen as a function of number but rather a relationship between scarcity of resources and population growth[4]. The dynamics of modernization amplify enormously the strain that this relationship generates on the environment, notably in loss of bio-diversity, land degradation, pollution and global issues.

1.Biodiversity

As urban centers have emerged and expanded, human development has compromised many of the "30,000 plant species and 2,340 species of terrestrial vertebrae"[5] present in China by augmenting competition for resources and space, and increasing pollution. According to official statistics, China has 131 million hectares of forest cover representing 13.6 percent of the territory (1ha=10 km^2)[6]. The main cause of forest stocks depletion (set at 5,000 km^2/year) remains the need for farmland and fuel, but activities of timber industries - which respond to the expanding construction industry - also take their toll. Both the Government's limited control of the former phenomenon and the lack of adequate alternative sources of energy and food has resulted in more than 50 percent forest reduction since 1949[7]. Currently, even if reforestation has set a goal to create 66 million hectares of new forests in China - notably in the North[8] - and China has signed the *RAMSAR*

---

[4]In the PRC, the ratio reaches extreme proportions. With 22 percent of the world's population living on 7 percent of the world's farmland, the PRC has resorted since 1949 to highly intensified farming methods which have reduced arable land by half while doubling production. This sets the available land per person ratio at 36 percent below world levels Moreover, available forests are 13 percent below world levels, reaching in 1991 a store of forest capacity per capita of 9.3(cu m)[a] when the world ratio was set at 56.60(cu m)[a]. Water supply is also scarce notably in the North. Even if China is sixth in world surface run off volume, it places 17th in per capita run off (25 percent below world levels). This is further complicated by pollution of available sources. Finally, the effective access to mineral and energy resources is also influenced by the size of the population. China has 11 percent of the world's coal reserves, yet only 40 percent of the world average in terms of exploitable coal per capita. It is estimated that 70 million households suffer severe fuel shortages, leading to combustion of straw, animal excrements and wood. Meanwhile, oil, uranium and hydropower are available energy sources that are yet to be fully exploited (Edmonds, op.cit, p.6-12).

[5] "Global Environmental Issues: Biodiversity", in Current Environmental Problems and Initiatives, UNDP, April 1997, www.edu.un/undp//book

[6]This reserve yields about 10 900 million cubic meters of wood. Remote censoring has nevertheless shown that this number falls to 74.5 million ha or 8 percent of the territory (Edmonds, op.cit, p.42).

[7] "Global Environmental Issues: Forests", in op.cit, UNDP.

[8]Programs such as *Obligatory Tree planting* (since 1981 every citizen must plant 3 to 5 trees (1000 million trees/year)), *the Great Plains Project* (replanting in the Northeastern, the River and the North

Convention for the Protection of Wetlands in 1992, future solutions must consider treating the problem at the source with both policies and infrastructure.

2.Land Degradation

Induced by soil erosion, desertification and urbanization, this phenomenon results from both natural processes and human activity. China's productive land decreased from 111.9 to 94.91 million hectares between 1956 and 1995[9]. The need for simple techniques that counter each factor wearing effect is therefore urgent. The most significant factor remains soil erosion. This natural phenomenon offsets an ecosystem that suffers no stress when the rate of reconstruction is out distanced by erosion[10].

To a lesser extent **desertification** and **urbanization** also threaten the fragile equilibrium between land and population. The former is a purely physical process which can be accelerated by over cultivation, overgrazing, forestry, mining, urbanization and excessive use of limited water supply. Presently, 11 percent of

---

China Plains in order to integrate agriculture by setting trees around 33 M ha of cropland), *Greening Taihang Mountain* (planting 3.95 M ha), *the Three Norths Shelter Project* (plant trees from Kaxgar in Xinjiang to the Great Hinggan Mountains in Inner Mongolia), *the Coastal Protective Forest Project* (plant along 18 000km in the coast line) and *the Chang River Protective Forest* (which projects 20M ha) have all been implemented (Edmonds, op.cit, p.45).

[9] "Global Environmental Issues: Land Degradation", op.cit, UNDP.

[10]Soil erosion occurs when unsound human activities, such as the removal of vegetation, operate and expose top soil, amplify the effects of rain, hail, and wind, increase the rate of evaporation, and finally, wash out natural fertilizers such as nitrogen, phosphors and potassium. In China, cultivation on slopes, over-grazing, and poor management menace 1/5 of the land area. (Edmonds, op.cit, p.62). The worst erosion can be observed in the Huang River Valley. Every year the river carries 1600 million tones of silt (a rich soil nutrient), creating every year 23.5 Km^2 of silt deposits in the Delta. The greatest loss occurs in the Loess plateau with 5000 tones per km^2; the equivalent of 1 cm of topsoil a year (Ibid., p.64). The situation has seen a 33 percent increase of erosion between the 1950's and the 1980's. The Chiang River Valley in turn sees the loss of 600 million tons of silt every year. This poses a problem notably in the Sichuan Basin where the soil above bedrock is only 17 cm thick. Between 1957 and 1986, population in this region has doubled and cultivation on slopes and deforestation accelerated soil erosion. This phenomenon is linked to floods since it increases the riverbeds, causes water shortage in the North by blocking canals, shuts down hydroelectric units and reduces water efficiency for travel. Soil erosion also affects the Northeast. Half of Inner Mongolia is menaced and 1/4 of arable lands have lost 70 - 80 cm of thick black soil. In the South, the expansion of the economy sees overproduction. It is estimated that annually the equivalent of the total amount of chemical fertilizer consumed in the PRC is lost due to erosion. Combat efforts have reforested 1/2 the eroded land area since 1950's and have terraced 1/3 of the land. In China's Ninth Five Year Plan, priority has been given to soil erosion prevention and control over China's potential erosion area of 920,000 km^2(Ibid., p.71).

China's territory is desert while 3.4 percent of it is menaced, notably in the North[11]. In turn, urbanization is responsible for the loss of 2.64 million ha of farmland between 1987 and 1995. While this has led policy makers to put 50% of the nation's total farmland under protection, notably in the central provinces, the Government plans on reclaiming new land, such as abandoned mine sites, for agricultural purposes in order to prevent the net loss of arable land. This will require soil remediation expertise.

3. Water, Air and Soil Pollution

The PRC's transition from an agricultural society to an urban-industrial one has brought about excessive ambient concentrations of pollutants in both air and water that have induced large economic and human costs that add up to 3 to 8 percent of GDP a year (±US$ 50 billion)[12].

The extent of the damage is evident when one looks at the issue of **water pollution**. Having remained a serious problem since the 1970's, surface and ground water pollution is directly related to increased industrial development in both urban and rural centers, and backward water treatment facilities[13]. Less than 20 percent of municipal waste receives any form of treatment compared to 3/4 of industrial waste[14]. Nationwide, municipal waste has tripled between 1981 and 1995 and accounts presently for 40 percent of total wastewater[15]. Lack of response for such discharges raise the cost of providing drinking water, as observed when pollution from the Huangpu River forced the Shanghai municipality to move the water sources upstream at an estimated cost of US$300 million[16].

---

[11] According to UNDP estimates, 180 million Chinese in the North suffer from water shortage. In the South, nearly 21 million ha of farmland are also threatened by it. Moreover, UNDP estimates US$200 to US$300 million per year in losses due to sandstorms that block thousands of kilometers of railway and highways every year ("Global Environmental Issues: Desertification", in op.cit, UNDP).

[12] Clear Water, Blue Skies, World Bank, Washington D.C, 1997, p.104.

[13] In 1994, the total volume of waste water in the PRC was 40.82 billion tones, including 24.08 billion from industrial use and 4.3 billion tones from township and village enterprises (TVEs) ("Urban and Rural Pollution: Water Pollution", in op.cit, UNDP).

[14] China 2020, World Bank, p.75.

[15] Compared to 1993, the quantity of oxygen needed to oxidize pollutants into environmentally safe substances increased by 9.4 percent, heavy metals (mercury, cadmium chromate & lead) increased by 4.7 percent, arsenic chemicals increased by 14.4 percent, cyanide increased by 2.8 percent and volatile phenols increased by 8.9 percent, while petroleum related pollutants declined 10.1 percent.

[16] World Bank, op.cit, p.75.

In the North, half the monitored water does not meet the lowest ambient standards (grade 5) and only 8 percent of the water meets the standards for human contact (< Grade 3). In turn, the South is less polluted since rivers there can absorb more[17]. The most severely affected area is the 4,300 km long and densely populated (160 million people) Huaihe River Basin. Untreated waste water discharged directly into the Huaihe River from Town and Village Enterprises (TVEs) such as paper mills, printing shops, tanneries, breweries, and chemical plants which still rely on outdated equipment[18]. The most severe cases of water pollution can be found in the Heihe River. Almost 70 percent of this tributary's water flow comprises waste; the death rate in surrounding areas was 30 percent higher and the malignant tumor rate was more than twice the national average[19].

Pollution has also yielded a series of anoxic lakes and rivers. Discharges of phosphors and nitrogen from night soil and detergents have eutrophied major lakes. One such example is that of Lake Taihu in Jiangsu Province. It has been severely polluted by thousands of small chemical and dye factories that account for 1/8 of the country's GNP. The nitrogen and phosphorus content of China's 18,000 km long coastal waters also poses a serious problem. Finally, aqua-culture is threatened by high concentration of nutrient salts. The primary cause of marine water pollution remains the direct discharge of untreated industrial and municipal waste water[20].

In turn, **Air pollution** has also resulted from the nation's efforts to raise the living standard. China's energy consumption rose 309 percent between 1980 and

---

[17]This means that the Yangtze and Pearl rivers are fairly clean while the Yellow, Huai, Huaihe and Luan rivers are unsuitable as raw sources of water. Currently, 24 percent of the population is said to be drinking *very polluted* water and 79 percent is drinking *somewhat polluted* water. Even if 75 percent of industrial waste water received some treatment in 1994, only 40 percent of the treated waste water met China's effluence standards (Edmonds, op.cit., p.135).

[18]UNDP, op.cit.

[19]The situation has become so critical in the lower reaches of the Huaihe River Valley Basin that local administrations have resorted to water rationing to manage potable water shortage. This environmental crisis led the State Council to promulgate in August 1995 the "Interim Ordinance of Water Pollution Prevention and Control For Huaihe River Basin" which stipulated tighter control and harsher measures for waste water discharges starting 1 January 1996. Since then, Anhui Province has closed 54 TVEs responsible for 8.8 million tons of waste water and ordered 30 major enterprises to establish waste water treatment facilities (Ibid.).

[20] "Urban and Rural Pollution: Lakes", in op.cit, UNDP.

1994[21]. To this day, China has relied heavily on fossil fuels, generating almost 75 percent of the energy from coal[22]. The consequences of this modernization have been very problematic. Inefficient combustion technologies and the high sulfur content of coal have yielded high levels of carbon dioxide and total suspended particles (TSP) emissions which have become the leading cause of respiratory diseases such as chronic bronchitis and emphysema[23]. Presently, Beijing, Shenyang and Xian are among the ten most polluted cities in the world. Air quality in more than 500 major Chinese cities is below WHO's criteria. In Beijing, particulate and sulfur concentrations reach 300 micrograms/cubic meter, while those found in New York are estimated at 50 mg/cm. This probaly accounts for a 130 percent difference in mortality rate due to the higher concentrations[24]. The need to reduce emissions and increase efficiency is hence pressing, however, solutions must consider that it is unrealistic to believe that coal will be substituted in the short or medium term[25].

Air pollution has also resulted from the development of the automobile industry in the late 1980s. By the end of 1995, China had 11.5 million automobiles and 116 million motorcycles and scooters. This distribution has had a negative impact on the environment since motor scooters are more harmful to air quality than regular cars[26]. Production has doubled between 1991 and 1995 but no equivalent growth in pollution control technology has been observed. Pollution has also increased due to traffic congestion and leaded gasoline use. High ambient lead

---

[21] "Urban and Rural Pollution: Urban Air Pollution", in op.cit, UNDP.

[22]Low quality coal complicates things. Only 20 percent of mined coal is washed and most of it ends up in metallurgy. In turn, less than 10 percent of steam coal is washed implying a heating value that is 25 times less than internationally traded steam coal. Moreover, Chinese steam coal contains 25-50 percent more sulfur and 50 percent more ash (Clear Water, Blue Skies, World Bank, p.46).

[23]These have become the leading cause of death in China with an estimated 289 000 deaths a year (Ibid., p.71).

[24]This also involves enormous strain on the health care system with 566 000 hospital admissions and 11 million emergency room visits every year (ibid., p.1).

[25]Note that coal combustion also produces high levels of sulfur dioxide (SO4) which leads to acid rain both within China and its neighboring countries. There is a higher emission in the North, but the biggest problem lies in the South where half the rain is acidic. The problem is that coal in the South has higher sulfur levels and the hot climate accelerates the bonding of SO4 particles. Coal production is also responsible for water pollution and land degradation through processing and mining (Edmonds, op.cit, p.166).

levels have also risen, causing stunted growth, neurological disorders and IQ deficiencies in children[27]. It is estimated that as much as half the children in Shanghai suffer from high levels of lead in their blood. Presently, measures have been implemented to eradicate leaded gasoline.

Lastly, ***soil pollution*** results from water, air and solid pollutants that degrade soil quality, induce salinization and accelerate erosion. Agro-chemicals such as pesticides, fertilizers and antiseptics threaten current high production levels. Furthermore, these tend to remain in the system since they contaminate underground water sources and rivers which are used for irrigation. Since the 1950's, use of agro-chemical has increased 600 percent and grain production has gone from 110 million tons to 465 million tons[28]. As a result, 1/5 (10 million ha) of the nation's arable land area is polluted. In 1993, one million tons of grain were lost when 8 percent of agricultural land received polluted water that was unfit for use[29]. This stresses the need to increase wastewater treatment, which according to estimates could increase grain yields from 20-50 percent[30].

Solid waste is the most visible type of soil pollution. The emission of solid waste jumped from 380 million tones in 1981 to 800 million tones in 1995. Of this amount about 80 percent is packed in the country side. Waste sites occupy 55 700 ha of land, 5 209 ha of which were agricultural lands. In 1991, the State implemented enforced solid waste registration requirements in 17 big cities. In June 1994, it began a nationwide out-reach program to provide people with basic data on solid waste composition, production, and treatment options. On the positive side, even if production of industrial solid waste has risen, the total emission has gradually decreased since 1986. It goes from 132.8 million tones to 25.9 M T in 1992[31].

---

[26] "Urban and Rural Pollution: Urban Air Pollution", in op.cit, UNDP.
[27] Clear Water, Blue Skies, World Bank, p.2.
[28] Edmonds, op.cit, p.146.
[29] China 2020, World Bank, p.74.
[30] Pollution related to agrochemicals not only relates to application, their production is extremely hazardous, as is their transportation in unsafe packages. New agricultural technologies, such as the widely used plastic green houses, have brought severe pollution. These green houses create a residue on crops that is harmful to human health and the unsound disposal of the plastic films has killed several animal and aquatic species who ate them ("Urban and Rural Pollution: Agricultural Pollution", in op.cit, UNDP).
[31] Edmonds, op.cit, p.152.

Currently quantitative goals are to contain water waste and air emissions to 14 percent between 1995 and 2010[32]. By that time drinking water and urban air are expected to meet national standards. Here there is not only a need for new technologies but coordinated efforts such as central chlorinating to reduce water boiling in every household or increases in the prices of water to reduce waste.

4.Global Issues

Besides posing an internal threat to the PRC, environmental degradation is also linked to global environmental issues. There is clear evidence that climate change has occurred in the PRC. Since the 1940's temperatures have increased notably in Northern China, where temperature has become warmer (1.0° - 2.5°C increase) and dryer[33]. This implies an increased rate of evaporation that can be translated in the following manner: a 2°C rise produces a 5 percent decrease in productivity. Recurring floods are also proof of warmer weather. Since the 1960's, the level of the sea has increased by 0.115cm/yr. It causes a problem since most of the population lives in the coast. An increase of 15 cm of the sea level sinks 1/4 of the Chang River Delta.

Finally, the heavy reliance on coal, biomass (organic waste) and CFC's makes of the PRC a key player in the issue of global warming since these activities contribute to the Greenhouse effect. Between 1970 and 1988, CO_2 emissions increased two and a half times. This follows the simple pattern that as the economy evolves there is an increase in demand for available sources of energy. The challenge lies therefore in adapting sustainable technologies in future growth.

II. Technology Transfer in the People's Republic of China

The following section assesses the PRC's climate for environmental technology transfer. First, it explores the receiving conditions that were raised in chapter one as well as the inciting conditions which attract this form of foreign investment. In this second part, particular attention will be paid to IP issues.

[32] Clear Water, Blue Skies, World Bank, p.29.
[33] Edmonds, op.cit, p.220.

1. Receiving Conditions

Briefly, one can recall receiving conditions as those that create a certain correspondence between foreign and local know-how. Consequently, these relate to a country's physical and intellectual structures. Each of these will be evaluated for the PRC.

a. The PRC's Technical Components and Technological Capabilities

Initially, while conditions that relate to **technical components** create correspondence between local and foreign expertise, **technological capabilities** allow for a certain autonomy once foreign technologies are acquired. According to the UNDP estimates, half of all industrial production in China is concentrated in SOE managed by sector ministries[34]. Since the reforms, non-state owned industries, including TVEs, have been spurred to develop across the nation. Finally, the introduction of foreign firms and joint ventures in Special Economic Zones (SEZ) can also be observed. By 1993, the World Bank lists about 9000 SEZ in all shapes and sizes[35]. What is revealed by this portrait of the PRC's industry is that the technical components are clearly available but in different regions and different fields of expertise. The same can be said of practical preconditions such as production standards, communication and soft service infrastructure; and information databases. In this fashion, it can be said that the PRC offers technical hardware, human abilities, recorded information and organizational components that can accommodate any productive means ranging from simple carpentry to advanced telecommunications. However, the issue of unequal development favors advanced technology transfer to urban centers in the East Coast, and more so to SEZ that are more numerous in the South.

Regarding environmental technologies, the PRC has a small but growing environmental products and services industry. In 1996, the government accounted for 8,651 units engaged in the environmental protection industry, involving 1.9 million people and boasting US$5 billion worth of fixed assets and an annual output US$3.7

[34] "Urban and Rural Pollution: Commercial Sector", in op.cit, UNDP.
[35] China 2020, World Bank, p.8.

billion[36]. Mainly supported by the Ministry of Machine Industry, the industry is expected to foster science and technology, adjust existing structures, improve quality and orient the market according to environmental norms.

As for **technological capabilities**, the PRC shows sufficient S&T personnel in universities and institutes (16 million scientists and technicians), and also funding to support innovative linkages[37]. Likewise, an overarching scientific watch composed of the Chinese Academy of Sciences (CAS), competent departments of different sectors, universities, and the environmental protection departments has been set up for environmental technologies[38]. In 1995, this added up to some 390 scientific research bodies engaged in environmental protection, staffed by more than 20,000 research and managerial personnel. Concretely, changes induced by open door policy have left the government in control of the scientific and technological system, but have subjected the policies to market forces Consequently, R&D is subjected to governmental planning, but is moved from government institutes to industrial enterprises and NGO's and managed by non-state enterprise[39].

---

[36]Information Office of the State Council of the People's Republic of China (IOSCPRC), White Paper--Environmental Protection in China, June 1996, Beijing, p.18.

[37]ASIAN DEVELOPMENT BANK, op.cit, p.66.

[38]Ibid., p17.

[39]In this scope, technological developments can be transferred as commodities in the nascent market. To accelerate the diffusion of technology, the PRC instituted in 1985 the *Sparks Program* to promote advanced technologies in rural areas, and the *Torch Program* (1988) to promote the commercialization of high and new technology. These were followed in the early nineties by the plan for *Popularization of the Scientific and Technical Results* and the *State plan for the Popularization of Key Technologies* (XIAOJUAN Jiang, "Chinese Government Policy Towards Science and Technology and its Influence on the Technical Development of Industrial Enterprises", in Chinese Technology Transfer in the 1990's, Feinstein & Howe, Cheltenham, Edward Elgar, 1997, p.136-139). The *Torch Program* - which commercializes technology by directing research into applied fields, and internationalizes it by importing technology by various means such as cooperating with foreign researchers and producing technological exports - has created favorable conditions to upgrade and generate technologies in **High-Technology Industrial Development Zones** (HTIDZ- 52 at the national level in 1993). Unlike SEZ, which absorb foreign investment in coastal areas to stimulate the national economic development, HTIDZ foster Chinese technologies and exports by depending solely on Chinese scientific personnel and fancying hi-tech domestic or foreign industrial enterprises. This favors the importation of licenses as opposed to hardware, and secures exemptions of import tariffs for specialized equipment, export tax exemption to hi-tech enterprises, and special finance provisions that facilitate the acquisition of funds (risk investment). Similar provisions are granted to hi-tech enterprises by provincial governments (Wall, David and Xiangshuo, Yin, " Technology development and export performance: is China a frog or a goose?", in ibid., p. 172-173).

Finally, incentives for scientist and engineers are another means by which the PRC has tried to improve its capabilities. On the one hand it has instituted "Natural Science Awards for Outstanding Work" (sometimes handed with prizes), while on the other it has planned monetary compensations resulting form surplus sales of technical developments[40].

b. The PRC's Innovative Triangle and System of Innovation

The **innovative triangle** links academic institutions, R&D centers and engineering production units to maximize the efficiency of technology development and ensure its coordination. In turn, the **system of innovation** provides a framework that warrants direction and projection for technology. As shown above the Chinese government has ensured linkage between the three axioms and shown political will to put together a comprehensive technological strategy. However, this is not surprising since the nature of the regime itself integrates all segments of society. What is then important is to unravel whether the government establishes measures and policies that override and reduce bureaucracy which is characteristic of the PRC's political apparatus.

Above all, the PRC has devised an overarching coordination system for technology-based development. Before 1979, technology transfer expenditures were controlled by the central government. However, as the volume of imports increased, the PRC sought to decentralize the transfer of technology. The first successful attempt came in 1988 when, in addition to simplifying the management branches - notably by abolishing the *State Economic Commission* and replacing it with the *State Planning Commission* (SPC) -, greater leeway was achieved by relegating the modernization of SOEs to provincial and municipal management and implementing systems that allowed localities to retain budgetary funds and foreign exchange than agreed[41]. These reforms removed central authority to permit the use of foreign exchange, while still requiring the SPC's approval. Foreign exchange quotas were instituted according to the regions in order to mark the line between local and central governments (e.g. above US$10 million in

[40]XIAOJUAN Jiang, op.cit, p.139.

Shanghai or US$5 million in Beijing). Hence, localities could spend any amounts below the quotas, but additional foreign currencies needed central government approval.

As economic development and capital flows grew, the scale of local competence also increased. By 1992, the State Economic and Trade Commission (SETC) is created to accommodate the SPC prerogatives over technology transformation. Within SETC, the *Bureau of Technology Transformation* became responsible for arrangements to sponsor approval procedures and the practical applications of importing[42]. Presently, the system of innovation is headed by the SPC, the *State Science and Technology Commission* (SSTC) and the SETC. These commissions ensure interest coordination by jointly formulating the national policies. Since all receive their mandate directly from the *State Council*, they can guarantee the cooperation of the state administrative machinery in the provinces, regions and municipalities. Moreover, the potential for pursuing the issued technology policies is strong since most ministries under the State Council also have S&T departments[43]. Currently, even if weak macro-control and poor administrative instruments have allowed excessive duplication, technological imports have been beneficial for renovating the major sectors of the economy (machinery, electronics, petrochemical, electricity, communications), increasing overall productivity, bringing about structural change and creating a network of industries[44].

With respect to the **innovation triangle**, all three commissions formulate and plan S&T policy with inputs from such agencies as the Chinese Association for Science and Technology (CAST) and the CAS. In effect, linkages in the triangle are favored by the *Key Task Research and Development Program* (KTRD), the *National Science and Technology Achievement Spreading Program*

---

[41] JINGPING Ding, "Using imported technology to transform existing enterprises in China", in, op.cit, p.106.
[42] JINGPING Ding, op.cit., p.108.
[43] Asian Development Bank, op.cit, p.59.
[44] JIANGPING Xu, "China's International Technology Transfer: the Current Situation, Problems and Future Prospects", in Feinstein & Howe, op.cit, p.88.

(NSTAS) and the *Torch Program* which set out to commercialize technologies[45]. Legal back-up is also available in the *Technology Contract Law* and in *Intellectual Property Protection Law* which will later be explored. Finally, the PRC's "open-door policy" encourages the linkages by establishing state, collective and private owned business systems involving universities, industries and research institutes. These are often found in technology parks and SEZ. Cooperation between the three forms of institutions is fostered and indirectly propelled by the gradual elimination of subsidies and the emergence of internal competition[46]. The fact that the government requires that large-scale R&D projects involve universities, R&D institutes and industry either as partners or sub-contractors is also a good means to favor this cooperation.

c. The PRC's Technological Infrastructure

The last condition for accommodation of foreign technologies is a proper **technological infrastructure**. Briefly, this relates to a country's ability to harbor and disseminate new technology through national institutions. Attempts to assimilate production skills are visible all throughout the *open door policy era*. Since its enactment, three stages mark the PRC's technology transfer strategy[47]. The first stage characterized by **large-scale imports** (1981-1987) introduced US$11 billion dollars worth of technology for energy, raw materials, machinery, electronics, light industry and textile from G-7 countries[48]. The second stage marked by the **period of stagnation** (1988-1991) sees a contradictory macroeconomic policy reduced import contracts from 437 in 1988 to 359 by 1991(as compared to 581 in 1987). Sanctions related to the Tiannamen incident also accounted for decreased technology imports[49]. The government's focus on hardware and turn-key projects for the primary industries and the oil industry made it difficult for plants that only wanted to simply upgrade their facilities.

---

[45]Asian Development Bank, op.cit, p.65.
[46]Ibid., p.65.
[47]Jiangping, op.cit, p.83.
[48]This stage was headed by the "3 000 item plan" (1983-1985) and the "twelve production lines plan" (1986/ TV's, metallurgy, ship building, locomotives, synthetic equipment, excavators, cement, weaving machines, clothes, beer and lean meat pigs) (Ibid., p.82).
[49]Jiangping, op.cit., p.90.

Finally, the present phase which began in 1992 is characterized by high speed growth. At this point, the establishment of the socialist market system became the main objective of institutional reforms by decreasing the central government's direct intervention in the interior market. Since implemented, enterprises have gained more autonomy but also the assumption of risks[50]. Presently, integration of technology with socioeconomic considerations depends on the 1992 "*National Medium - and Long-term Science and Technology Development Program*" which provides guidance for the advancement of S&T in concert with economic and social development up to the year 2020. This plan supervises the import of technology by combining self-reliance and "open-door policy"[51].

With respect to environmental technology infrastructure, the PRC created in 1994 the *National Clean Production Center* (NCPC). This center was charged with promoting environmental G&S (technologies, auditing, training), while ensuring international exchanges[52]. Working with NEPA, it has achieved a series of seminars and demonstration projects that presented the successful accommodation of such technologies (including breweries, tanneries, refineries

---

[50]While software imports have remained significantly lower than hardware, focus has remained on electronics, optical communications, biotechnologies, textiles, motor vehicles, machinery and light industry. With respect to large and medium size SOE, over 50 % of them have improved their standard by importing technology, equipment and technical services both for management and production. Overall, FDI has become the main form of technology transfer (Ibid., p.88).

[51]The former can be observed in any of the above mentioned programs which try to commercialize technologies. The purpose of these is to make R&D institutes become self-financing over time by satisfying the industry's needs. Fiscal and financial incentives are being applied to encourage the development of *non-governmental science and technology entities* operating on a commercial basis. Currently, many of these have taken root close to major technical universities and institutes in technology parks like the **Zhonggyancun Electronics Street** in Beijing (Asian Development Bank, op.cit, p.55). In turn, the latter relates to the apparatus that manages the entry of foreign technology into the PRC. Presently, there are over 3 000 information centers employing 60 000 full-time and 100 000 part-time staff nation-wide. Linked to ministries and different levels of government, these centers are charged with filtering local and foreign documents and reports before submitting any high-tech related proposals to their respective technology departments. These then help local buyers of technology to determine the suitability of offered G&S, negotiate reasonable prices and screen technology transfer agreements to guard against the inclusion of unfavorable clauses. Furthermore, since 1986, the SCST sponsored *863 Program* tracks the most advanced technology in the world. Paired to the KTRD program, which addresses technological problems in the national Five-Year Plans, it provides a means to receive and accommodate technology into the PRC's modernization drive (Wall & Xiangshuo, op.cit, p.171).

and industry of dye, cement, chromate and sulfur), as well as the desire to import new ones (as shown in the International Seminar on Economic Benefits of Clean Production held in September 1995). Finally, the PRC has allowed increased involvement of international organizations and NGOs. Lending for environmental protection is presently the fastest growing area of the World Bank's program for China with lending totaling US$720 million[53]. Dozens of environmental NGOs promote academic, scientific and technological exchanges to increase public awareness on the issue or to forewarn investors from buying over priced or outdated technologies.

According to Xu Jiangping, assimilation is a crucial step towards full modernization. Korea and Japan showed a 3:1 ratio of absorption which means that in China for every Yuan spent on imports, there should be three spent on assimilation[54]. This has not been the case since the estimated ratio sits at 0.5:1. The overemphasis on material transfers instead of less tangible forms of transfer such as licenses and consulting clearly indicates this. About "eighty percent of import expenditure" [55] in China goes to hardware. With the responsibility system, the government has been sponsoring imports but not absorption. This has made individual businesses adopt short term strategies which have often had inappropriate preparation and overlooked transfer through FDI in joint ventures. Finally, at the macro level, China has to deal with intellectual capital flight and faces serious problems of accommodation such as a 20 percent illiteracy rate and only 2.1percent university level enrollment[56].

2.Inciting Conditions

Knowing that technology transfer represents a form of FDI, inciting conditions may be regarded as those that attract foreign investors. They relate to a particular country's scientific, economic, political, legal and social profiles which indicate its technology climate. As opposed to accommodating conditions which must be

---

[52] "Urban and Rural Pollution: Commercial Sector", UNDP, op.cit.
[53] "Environment", Country Brief: China, World Bank, 1997, ftp://monarch.worldbank.org/pub/decweb.
[54] JIANGPING Xu, op.cit, p.91.
[55] Ibid.
[56] China 2020, World Bank, p.v.

present in absolute terms, "climatic conditions" have a relative character which converge - to varying degrees - with investor's interests and values.

a. The PRC's Economic Environment

For most investors, economic issues supersede political, environmental and social ones. The importance of a healthy economic environment then relates to the business conditions which favor investments. Besides macro-indicators such as stable GDP growth and inflation, it involves healthy banking system and financial institutions, freedom from custom duties, corporate tax exemptions, repatriation of foreign exchange guarantees, and indexation of specific costs.

In the PRC, these conditions are favorable for technological investment. On the one hand, the PRC's transition towards a market based economy provides environmental technology licensers with numerous avenues for investment, notably in infrastructure and upgrading. Tremendous GDP growth averaging 7.5 percent a year since 1978 has made the PRC the fastest growing economy[57]. Growth is not the only strength for the PRC also presents relative stability - which has been demonstrated during the recent Asian economic crisis -, a remarkably high savings rate - which is among the highest in the world (37 percent) -, a strong record of pragmatic reforms - which has quadrupled per capita income -, a disciplined labor force, a supportive Diaspora and growing administrative capacity[58].

Even if the CCP still controls a great deal of the economy, sufficient liberalization has been achieved to encourage the purchase of technology without the central governments interference. Besides giving provinces and municipalities a ceiling for expenditure, the banking system has allowed other banks than the Bank of China to hold foreign exchange[59]. Since 1995, banking reforms have seen commercialization of state banks (Bank of China, Industrial and Commercial Bank of China, Agricultural Bank of China and China Construction Bank), the emergence of new commercial banks (regional banks modeled on western

[57]World Bank, op.cit, p.iix.

[58]Currently, structural changes are trying to accommodate the unemployed farmers into a growing private sector. Accounts suggest that there are both under-reports for both production and employment, yet income inequality still separate rich urban areas from rural ones (Ibid., p.6).

banks) and non bank financial institutions (trust deposits, investment companies, insurance companies, finance companies and securities companies), credit cooperatives (account for 55 200 offices), and foreign and joint venture banks (400 offices across China)[60]. Even if reforms of the banking system are not complete, what has so far been achieved fills the needs for capital and show the governments will to facilitate the circulation of an estimated US$220 billion a year[61].

Finally, contract and tax legislation are quite favorable for technology transfer. According to the *Interim Regulations Concerning Technology Transfer* (1985), for any type of transaction in the PRC - be it licensing, sale of goods or services, equity and cooperative joint ventures, contracted projects (turn-key), or establishment of a foreign firm - the technology or equipment contributed by any foreign participant must be truly advanced and appropriate to China's needs. This means that imported technology is required to produce a new product, raise the quality of products, further efficiency, expand product exports, protect the environment, increase safety standards, improve management and/or raise the Chinese S&T level[62]. No permit is required to do business in China but all commercial contracts require approval of the SETC and the *Ministry of Foreign Trade and Economic Cooperation* (MOFTEC). Once approved, companies must immediately register at the *State Administration for Industry and Commerce* (SAIC) and declare themselves - if they establish offices, enterprises or contractual projects in China - to their local tax bureaus[63].

Presently, transfers are ruled by the Foreign Economic Contract Law. This law has many traits that are typical to Chinese including the need for equality, mutual benefit and consultation. Breach leads to compensation by liquidation

---

[59]World Bank, op.cit, p.9.
[60]Tambunan, A., China's Banking System, pacificrim.bx.com/asianbank/chinabank.htm
[61]FT financial Publishing, Banking in China, www.live.co.uk/china.htm
[62]Goosen, R.J., Technology Transfer in the People's Republic of China: Law and Practice, Boston, Martinus Nijhoff Pub., 1987, p.46.
[63]Moser, M.J., Business Strategies for the PRC, Hong Kong, China Intelligence Reports, 1986, p.4.

damages or penalty and signatories agree to the possibility of arbitration[64]. Except for equity joint ventures that are governed by a complete legal regime, regulations are silent and must be specified in the contract[65]. This gives signing parties plenty of leeway to push their concerns during negotiations. Furthermore, fees for technology depend either on the market price of the technology or the price agreed by the parties. In all cases, the purpose of the regulations is to facilitate the modernization drive by allowing both nationals and foreigners to agree on the terms of their contract.

Regarding taxation, the *Foreign Enterprise Income Tax Law of the PRC* identifies two types of payers: established firms and temporary ones.
All established business within China is taxable according to a progressive rate located between 20 and 40 percent to which one adds 10 percent in local taxes[66]. Temporary firms are subject to a 20 percent withholding tax, which is to be paid on interest, rent, dividends, and royalties since they represent a virtual establishment. This amount can be reduced by half if the technology is deemed advanced and the terms are preferential[67]. Investor must forward demands for exemptions after examination of the contract by a national department. The approval is to be given by the Ministry of Finance. The fact that the terms "advanced" and "preferential" are not clarified gives signatories a certain margin to account for tax breaks. Moreover, it is likely that contracts accepted by MOFERT concern advanced technology and hence are likely to enjoy exemption.

Finally, policy-makers have invited high tech firms to locate in SEZ and Economic and Technological Development Zones (ETDZ) which offer special fiscal arrangements, infrastructure and financial incentives to encourage

---

[64]Goosen, R.J., op.cit, p.15.
[65]Moser, op.cit, p.47.
[66]Add a consolidated tax that ranges 1.5 percent to 69 percent while retail has a 3-7 percent tax. Some circumstances require real estate tax estimated to 1.2 percent on the value of the building. Note that while the latter tax may be waived at the discretion of the local government, the Ministry of Finance gives concessions to low income industries such as farming and forestry (Ibid., p.63).
[67]Blueprints and documentation and fees for services and training may be taxed. However technologies that deal with forestry, fishery, animal husbandry, scientific research, and development of important technical areas. Certain consulting services, technology instruction fees and technical assistance are exempt as are (Goosen, op.cit, p.56).

technology transfer[68]. SEZ and ETDZ benefit from special tax preferences which set taxes at 15 percent for all types of ventures[69]. Exemption from withholding tax on remittance of dividends is also allowed, just as technology transfer enjoys a reduced withholding tax of 10 percent.

Overall, even though market economy rules are yet to be instated, the PRC shows an economic environment that is healthy enough to harbor foreign technology investments. The leadership has given priority to the modernizing drive even if this hurts local expertise. Consequently, foreign investors have profited from this situation to maximize gains. Chinese companies have responded by often playing foreign companies one against the other in order to obtain lower prices. On the down side, there is still the question of entry to the WTO which is left pending[70].

b.The PRC's Legal Framework

A sound legal framework involves the conditions that can favor the flourishing of a particular industry and guarantee certain rights for investors. Logically, laws must be backed up by an upright judiciary that will not change with administrations. Besides the contract laws which have been dealt with above, industry specific laws and IPR are important aspects of a sound legal framework.

i)Environmental Policy in the PRC

Since the focus of this paper is the study of ETT, it is important to see whether the government has instituted provisions to supervise sustainability. The best indicators are the policies and their application following the premise that - as in OECD countries - the more advanced the regulations, the greater the development of technologies.

---

[68] China 2020, World Bank, p.39.

[69]Moser, op.cit, p.67.

[70]The entry of the PRC into the WTO is offset by the American stand over human rights issues - which is said to shield a greater antagonism - and Chinese reluctance to abandon some protectionist policies and uneven competition such as the SEZs - which would have to change rapidly.

Great steps have been taken to protect the environment[71]. Since 1979, the year when China first enacted the **Environmental Protection Law**, regulatory practices have continued to improve. The early 1980's were characterized by a certain negativity towards environment protection. In 1982, the first Environmental Protection Bureau "burdened" on the Ministry of Urban and Rural Construction[72]. Regarding agricultural reforms, they assign each family individual production responsibilities with the 1979 **Household Responsibility System** (HRS)[73]. This yields higher production levels - such as the ones achieved by TVEs - by ensuring monetary incentives and minimizing free-riding, but leads to the devastating conditions that have been depicted previously.

In 1989, the **Environment Protection Law of the PRC** is amended. The Law incorporates the sustainable notion of *harmonious development* (see footnote 70) in article 4, sets national environment standards, and establishes fines or shut downs for companies that do not install or use abating equipment[74]. This leads to the creation of 140 pollution control projects and 799 protected areas across the country, covering 7.2 percent of China's land area. By 1990, provincial level units got their **Environment Protection Target Responsibility System**. Since then, officials are deemed accountable for whether their targets are reached.

---

[71]Environmental policies in the PRC have varied along with the five periods of its history. In the **early years** (1949-1960), pollution control was closely related to policies related to hygiene to avoid health epidemics by building industries upstream and securing potable water conservation. The **isolation years** (1960-1972) were marked by the Sino-Soviet split which saw the repatriation of Soviet technicians. The impact on the environment was considerable since Chinese were left to develop their industry on a trial and error basis ("Global Environmental Issues: Forests", in op.cit, UNDP). The **awakening years** (1972-1978) are marked by the PRC's overture to the world induced by the acquired seat in the UN in 1971. They see the PRC champion the South's stand during the 1972 UNCHE, followed by increased interest on warranting clean water, protecting agro-systems and controlling pesticides. By 1973, the **National Environmental Protection Agency** (NEPA) was created and there took place the first national Conference on the environment (Edmonds, op.cit, p.230). Nevertheless, the fragile concept of *harmonious development* - introduced at this time and defined in terms of "natural rebirth and economic rebirth work together" - has little chance against the widely accepted maxim of "pollute first and clean up later"(Ibid., p.231).

[72]In 1984, NEPA's first gathering of 40 ministries found no consensus. However, by 1986, the question was dealt with more seriously with the installation of Environmental Bureaus in provincial governments. By 1988, NEPA's activities during the **Montreal Protocol** earned it departmental status, more independence and increased powers of coordination. Distribution of funds for research increases and vague central policies that require interpretation reflect a certain degree of decentralization (Edmonds, ibid., p.232).

[73] "Urban and Rural Pollution: Rural Pollution by TVE's", in op.cit, UNDP.

Current legislation covers the management of wastewater, solid waste, and atmospheric pollution, conservation of oceans and water courses, and the management of natural resources (forests, grasslands, soil, fisheries, mineral resources, wildlife, coal, etc.)[75]. At the international level, the PRC signing of the amended version of the **Montreal Protocol** in 1991 is a good example of how policies can affect environmental technology transfer. By signing the protocol the PRC gained access to the equity claims that promoted aid packages that comprised technologies that substituted for *Ozone Depleting Substances* (ODS)[76]. Since the PRC was the number one user of these substances, it received the lion's share of the aid. This would benefit both the Ozone layer and Chinese industry since it could no longer sell ODS based products in the market.

Since 1987, discharge permits compensate the lack of control of overall discharges either on a local environmental capacity basis or set goal basis[77]. Mandatory pollution controls also threaten with closure old plants that use obsolete technology. This however forces the acquisition of EOL control which wastes scarce capital by inducing pollution abatement at excessively high cost. In recent years, more than a dozen environment related laws that provide an exhaustive legal framework have been enacted. These provide a series of regulations and standards and a nation wide enforcement network of local environmental protection bureaus within the sector agencies. They are guided by three principles: *prevention first* (emphasizes planning), *polluter pays* and *strong regulatory framework*[78]. Moreover, pollution levies have been created to force industries to comply with emission standards, raise revenue for investment in clean technologies and finance regulatory activities. They involve fines and other charges based on violations of levy regulations. eighty percent of perceived fees are used in grants and loans for equipment and the balance for local

---

[74] "Urban and Rural Pollution: Rural Pollution by TVE's", in op.cit, UNDP.
[75] Clear Water, Blue Skies, World Bank, p.8.
[76] "Unsheltering Skies: China, India and the Montreal Protocol", Policy Studies Journal, 1996, V.24, #3, 1996.
[77] Clear Water, Blue Skies, World Bank p.59.

administrative fees. Payment of pollution levies is set at 60% for full payment or on time, and larger firms comply better.

No country can claim that it has achieved full industry compliance with pollution control. However, problems of corruption greatly influence the extent of compliance with norms. The fact that environmental regulators do not always abide by the rules, reflects scarcity of resources and the conditions of society. In the PRC regulators fear to impose penalties on indebted firms that are major employers. Moreover, regulation of state-owned plants is not as strict as that of private ones, and local regulators have considerable discretion in judging both compliance and appropriate penalties for non compliance. In other words, "China's regulators play by the rules, but often bend them"[79]. Presently, there are 20 000 environmental officials traveling around the country inspecting factories.

A report from the World Bank finds that underreporting and underassessment are common, but that regulation is systematic and seems to reflect important concerns. The degree of corruption of environmental regulators is not too high if the assessment is related to the emission standards. However, before the approval of the national standards in the 1989 Law, it was up to local administrators to set them. Most often, these same officials held the responsibility of enforcement and monitoring. Reluctance to close productive enterprises that contributed to the local economy was hence expected. Pollution is not a priority, food and shelter are. However, citizens can appeal directly to the polluting firms for compensation. Failing this, they can go to local environmental bureaus. Even if some cases move up the administrative ladder, most cases are solved directly due to the traditional Chinese disdain for legal and administrative matters. Encouraging the public to be vigilant has improved the enforcement record.

This presents not just a problem of corruption but more one of *structural contradictions*. For instance, the division of responsibility between the county, the prefecture and the province does not provide a coordinated effort between incoming

---

[78]Polluter pays principle relates to the imposition of a tax that compensates for the environmental cost of production. This ultimately translates into higher costs for the consumer (Clear Water, Blue Skies, World Bank, p.58).

taxes perceived by the first two and returns from the province[80]. Furthermore, local authorities do not collect high taxes since their priority is economic development since financial gains were used as indicators of promotions. This favored for many years the short-term gain instead of the long-term. It is only by 1996 that local officials where held responsible for environmental quality. That year, China foreclosed 57 000 TVEs. On 1 October 1997, harming the environment became a crime under provisions of the Criminal Law. That same year, burdened with the figures that pollution brought about (as seen 8% of GDP), Beijing put forth a total of 2% of GDP in the protection of the environment in the current five year plan; a 70% increase.

Increasing *clean production technology* represents perhaps the most recognized method of pollution prevention in China. In December 1994, the **National Clean Production Center** was established to promote clean production technology, conduct industrial pollution auditing, provide technical training and carry out international exchanges. Since then China has increasingly been purchasing clean technology. According to Sofres Consulting Asia Pacific, China bought "$1.8 billion worth of equipment and consulting services"[81] in 1996 and $ 6.3 billion were expected for 1997. This results from the gradual induction of legislative measures for environmental quotas. In the current five year plan, NEPA presented a list of 1 200 projects estimated at $18 billion dollars. The main thrust is notably in the water-pollution control technologies. Yixing City, in the Taihu Lake Basin, has become known as China's newly developed center for the manufacture of environmental equipment[82]. Trade reforms have also increase production efficiency in export oriented enterprises and induced rapid absorption of newer technologies which have offset the tendency to specialize in pollution-intensive technologies[83]. This is shown by a decrease in the pollution share of the most polluting industries

---

[79] Dasgupta et al., "Discretionary Pollution Control in China", The Economics of Industrial Pollution Control in Developing Countries, World Bank (RPO 680-20), edecastro@worldbank.org., May 1997.
[80] Institutional Framework for Environmental and Sustainable Development, UNDP, http://www.edu.un/undp//book, 1997.
[81] Saywell, "Infinite Possibilities", China Trade Report, April 1997.
[82] Global Environmental Issues: Lakes, UNDP, op. cit..
[83] Clear Water, Blue Skies, World Bank, p.63.

(chemicals, pulp and paper, and nonmetallic minerals (cement). Finally, cleaner industries have grown faster both in domestic and foreign production.

Public awareness on environmental issues has also been prioritized. This is deemed crucial to bring about voluntary participation and overall acceptance of policies. Mobilization of the masses must walk along side legal measures in order to ensure effective enforcement. This task was conferred on NEPA's **Department of Environmental Education and Dissemination**. Since 1992, this institution has promoted "environmental education as a basic building block in the nation's environmental protection and sustainable development initiative"[84]. Aided by the **State Education Commission**, it establish an environmental education system for both elementary and professional schools.

Overall, China's standards are consistent with international ones, but compliance remains low due to inadequate enforcement. Weak monitoring, insufficient funds, excessive local government intervention to protect enterprises, unavailable monitoring equipment and insufficient public involvement are the main causes of this leniency. Even if the market reforms have made Chinese society more responsive to pricing policies, there is still strong resistance to raising the price of coal and natural resources for environmental purposes.

ii) Intellectual Property Protection in the PRC

This delicate issue relates to the level of IP protection that is present for technology imports. As shown in chapter one, technology holders demand certain guarantees that will protect their work from being copied and thus losing its economic values. A comprehensive IPR framework is therefore needed to appease the concerns of investors in technology.

The PRC has made considerable efforts to incorporate IP into the modernizing drive. Nevertheless, the application of these laws has remained somehow problematic. This results from the difference that exists between Chinese legal traditions and the Western ones. First, there is the need to establish the rule of law. In fact legal norms and procedures must substitute direct investment, and need many decades to establish a firm foothold. Amended in January 1997, the

Lawyers Law aims to promote better national qualifications and a licensing system, continuing legal education, a self-regulating bar, and code of ethics[85]. A large proportion of China's tens of thousands of lawyers have no formal legal training. Second, corruption also represents a problem. In 1996, 65 424 people, including senior party officials, were involved in embezzlement and bribes. This means that discretionary government powers remain high, transparency of government finances is not full, and a honest civil service is yet to be built. Finally, concerning IP, there is the fact that China did not develop a "sustained indigenous counterpart to intellectual property law due to the character of Chinese Political culture"[86]. Attempts to forcefully introduce western concepts of IP law in the 19th Century disregarded the relevance of Chinese tradition - which did not create IP to protect property but rather to maintain government control.

Currently, the PRC has enacted and revised laws on patents, trademarks and copyright, and has done much to enforce them. There has been a substantial growth in lawsuits and prosecutions, and specialized IP courts are in place throughout the country[87]. The government has also created a market in ideas. Before reforms the administrative apparatus transmitted findings from research units free of charge. But technology is presently a commodity which is sold in state sponsored fairs. In 1995, the country held 939 fairs at which 14 686 contracts were signed for up to 5.8 billion Yuan. Acquiring technology from abroad is more economical notably as "capital equipment (turnkey projects or imported capital goods), is sometimes packaged with equipment finance and management (foreign direct investment), or "unbundled" (technical assistance & technology license)"[88].

Currently, IP protection is provided by the 1985 *Patent Law of the PRC*. It initially states that "Patent rights obtained by citizens and juristic persons in

---

[84] Institutional Framework for Environmental (...), UNDP, op.cit..
[85] China 2020, World Bank, p.36.
[86] Alford, W.P., To Steal a Book is an Elegant Offense, Stanford, Stanford University Press, 1995, p.2.
[87] China 2020, world Bank, p.39.
[88] Ibid., p.40.

accordance with the law are protected by the law"[89]. The scope of the law ranges over inventions, utility models and designs. The first two require that they bring about novelty, inventiveness and practical applicability. Designs on the other hand must not be identical or similar to any previous designs. No patent rights are granted for scientific discoveries, rules and methods for metal activities, medical discoveries, foods and flavoring, pharmaceutical and other substances obtained by chemical processes, animals and plants or substances obtained from nuclear transformation[90].

The obtain a patent requires a request form, description of the process and a claim. Applications must be filled separately for inventions, utility models and designs. When two applications are received for one invention, the one that got there first is given priority. A foreign applicant who files a patent in the PRC within twelve months of his/her filing in his/her home country is given priority, if agreements exist between that country and the PRC. Patents for inventions have a fifteen year duration, while utility models and designs have only five years. Annual fees are however expected to keep the patent valid[91]. The entity exploiting a patent must pay a fee and conclude a written license contract that permits exploitation. Licensees cannot share the patent rights except if it is a SOE. Infringes must be prosecuted within two years of the offense. They are liable for compensations for damage. Lastly, computer software is protected under the 1990 Copyright law.

Presently, there is a great desire to incorporate IP protection to attract investment but there is always the issue of maintaining Chinese characteristics that incorporate Confusionanism, communism and capitalism. Nevertheless, there remains the need to separate the legal functions from political ones.

c. The PRC's Political Environment

As opposed to the Soviet Union, the CCP has maintained a domination of the political power which it has no intention of abandoning. Even if some may regard this as undemocratic an often times totalitarian rule, the overall impact of incontestable CCP rule gives the regime incredible stability. Since the reforms, the leadership has

[89]Goossen, op.cit, p.18.
[90]Ibid., p.20.

been able to replace gradually the socialist ideology with a controlled market which may either be ultimately capitalist or establish the material pre-conditions for a new stage of socialism. The CCP has found support in both capitalist and nationalist circkes among those who want progress and cohesion. In this scope, the pragmatic and incremental reforms that are currently in place are a source of stability since they justify the CCP's control over policies. Ultimately, as long as growth and development are favored, there is no reason to question autocratic rule. It is therefore in the CCP's interest to maintain a stable economy and an economic climate that favors foreign investments in order to gain sufficient time to absorb and leap ahead of foreign technological levels. Currently, strong provincial administrations, a skilled and disciplined workforce, and constant direct investment from a wealthy Chinese Diaspora contribute to this stability. One may add the smooth management of the retrogradation of Hong Kong as another sign of stability.

III. Conclusion

Over the past decade the PRC has introduced a comprehensive legal framework to protect the environment as well as economic reforms which have fostered efficient technologies, energy pricing policies to improve resource use and energy conservation policies that aim to reduce pollution and inefficiency. This clearly indicates, if not an acceptance, at least a certain accommodation of the principles of SD. These in turn also find a certain commonalties with Chinese philosophy since Confucianism's anthropocentric approach allows for an understanding of direct causal linkages between human activities and degradation[92], as Taoism indicates the path of respect for nature since destruction produces chaos[93].

As demonstrated, the CCP stand on the issue is that China faces the dual task of developing the economy and protecting the environment[94]. It hence states that the commitment to SD comes from the attempt to control the incredible

---

[91]Goossen, op.cit, p.25.

[92]Yu, Cheung, "On the reactions of Chinese Culture against the Western Challenge", in Learning from China, London, Glaeser Publications, 1987, p.14.

[93]Fairbank et al., East Asia, Harvard University, Boston, 1989, p.49.

momentum of the economy which has led to abuses in the social, economic and environmental realms. In August 1992, shortly after the UNCED, the Chinese government stated once again that the road of SD was a logical choice for China in the 21st Century[95]. However, regarding the hypothesis that stipulated that due to diverging ideologies, the PRC will favor the types of transfers that do not compromise the ideology of the CCP. This chapter found that strong accommodative structures and the pending question of IPR - one of the reasons for excluding the PRC's from the WTO - attest that Chinese authorities are not planing to compromise their stand.

Nevertheless, in March 1996, the Fourth Session of China's Eighth National People's Congress examined and adopted the *Ninth Five Year Plan of the PRC for National Economic and Social Development* and the *Outline of the Long-Term Target for the Year 2010*. Both writings regard SD as an important strategy for China's economic modernization and social development. Ultimately, as this chapter has shown, the PRC has raised the environment as an issue of crucial importance to the survival of the Chinese people as well as their posterity.

---

[94]IOSCPRC, op.cit, p.20.

[95]As convened during this conference, the Chinese government approved and promulgated China's Agenda 21- White Paper on Population, Environment, and development two years later. Based on the country's specific conditions in these three areas, the document put forward the PRC's overall strategy, measures and programs for sustainable development (Ibid., p.3).

CHAPTER 4 : AN OVERVIEW OF THE INVOLVEMENT OF QUEBEC ENVIRONMENTAL FIRMS IN THE PEOPLE'S REPUBLIC OF CHINA

The following chapter compiles the results of interviews with five local environmental firms that have exported their products and services to China. This information is not to be regarded as systematically empirical, but rather as illustrative of what Quebec environment companies face in the PRC. This Chapter also attempts to test the ETT hypotheses, which were presented in Chapter one. Finally, the Chapter briefly portrays the role of municipal officials in the ETT process by displaying the highlights of a meeting with the Mayor of Montreal's Assistant for Pacific Affairs.

Accordingly, the Chapter incorporates both the results from the interviews and the validation of the hypotheses in four sections, that in turn each reflect a major aspect of technology transfers. As such, the first section portrays the issues that relate to the initial stages of negotiations, the second section explores the financial aspects of the process, the third section deals with host conditions and, finally, the fourth section offers an assessment of the overall experience. However, before reflecting on the results it would be proper to introduce the sample. Note that the methodology behind the questionnaire may be found along with the questionnaire itself in Annex I and II.

I. The Sample

The initial objective of the thesis was to define the main obstacles facing Quebec environmental firms when attempting to deal in the PRC. The best way to obtain this information was to contact the environmental firms who attempted to export their products and services to the PRC. Gathering the information by means of an open ended questionnaire, the research aimed both at dealing with their main concerns when working in China, as well as validating the previously presented hypotheses. Seeking out the companies proved quite complicated even if most of them were catalogued in federal data banks, such as the Environmental Industry Virtual Office. Information from the Government of

Quebec was more scanty. While the broad outlines of the industry were available, little was mentioned about exports to China. I also attended the environmental industry's Americana convention held at the Palais de Congrès de Montréal at the end of March 1999. Lastly, I contacted public officials in charge of Pacific Affairs at the provincial and municipal levels. While I obtained little response from the provincial Ministries of International Relations and Industry and Commerce, the City of Montreal provided insightful feedback.

In the end, nineteen companies conformed to the criteria. Each of them was sent a letter presenting the purpose of the research and the need to set a date for a subsequent interview that would preferably take place in their offices rather than by phone (see Annex III for text). Knowing that the issue at hand was delicate and that all interviews would involve senior executives, I expected the response rate to be low. Moreover, since I had no intention of providing an exhaustive empirical study, but rather an illustrative overview, my initial objective was to contact at least three companies. In the end, I was quite surprised when five favorably responded.

The sample offers a very diversified group of companies that vary in both size and specialties. It includes two large companies and three SMEs, four Quebec based firms and one Swiss subsidiary firm, and four different types of ETT agreements. All firms transferred new equipment, that ranged from accessible to highly advanced technologies, except for the last one mentioned below which only sold conventional technologies.

The first firm is Quebec's **SNC-Lavalin**. Involved in an institutional reinforcement project throughout China, it collaborates with national agencies such as: the State Economic and Trade Commission, State Environmental Protection Administration, the State Administration of Petroleum and Chemical Industry and the State Bureau of Light Industry. Financed by CIDA, this project began in the Autumn of 1996 and spans five years with a total cost of CA$10.5 million. The agreement transfers technology in a framework of international cooperation and places SNC as a subcontractor for CIDA. In turn, Swiss based **Asea Boveri Brown** (ABB) has various on-going environmental projects in

China. Among these, the most important ones are a US$150 million hydroelectric plant in Geheyan, province of Hubei, and a US$1.5 billion transmission and distribution (T&D) project (3,000 MW) that links Russia, Mongolia and China. Only the former includes a technology transfer arrangement packaged in a licensing agreement. According to the spokesperson, the choice of this type of transfer was political. Since TT was a prerequisite for Chinese approval of the project, the company had to choose the type of agreement that best accommodated both interests.

The third firm is **Biothermica**. This SME currently transfers *ambient air control emission system technologies* for coal fired thermal plants in Shinyan, Province of Liaoning (North China). With an estimated cost of CA$3 million, the project spans five years and is expected to end in 2001. The nature of the agreement was a participation in the renovation of electric plants for the North-East China Electric Company (NECEC). This type of agreement was chosen to minimize risk and to serve as a demonstration. The turn key project consisted of providing the know-how, and plans since it expected to lead to the establishment of a joint venture in the near future.

The second SME is **Turcotte**. It is currently negotiating a contract for the manufacture of *home environmental control units* (ECU) with two local partners in Shanghai. Estimated at CA$2 million, this four year project began in 1997 with the purpose of producing locally a product that is already sold in China. It is noteworthy to state that the Chinese partners' contribution was limited to land. The contract involves a technology transfer under a joint venture agreement. The choice of this type of agreement, according to Turcotte, gave a certain control and ensured greater involvement of local partners.

Lastly, **Mabarex** - the last SME - did not transfer a technology, but rather sold waste water management equipment in Bai Hai, Province of Jiangxi for a total cost of CA$3.2 million.

II. Results

The following four sections present the results from the interviews by exploring the issues that concern the above mentioned firms. Unavoidably, this will depict the process which led these firms to sign ETT agreements, as well as singular examples of this type of transaction. Annex IV presents a table that compiles all results.

1. Preliminary Contacts and Negotiations

Initially, the contacts in China varied from one company to another. However, as stated by the Mayor's assistant, the role of both the Canadian and Chinese governments seemed crucial in all instances. According to him, when dealing in China, the role of the politician is important, predominant and essential since the Chinese government has the last word. Consequently, when a company has problems, political intervention is often the only way to solve the difficulties. Politicians - such as Maire Bourque - have an open door to the Chinese Government which private firms rarely have. Moreover, knowing that most rival companies are foreign rather than local, it is fair to extrapolate that Quebec firms can maximize gains with political support from higher levels of government[1].

SNC used CIDA in order to get in touch with bureaus at the different levels of the Chinese government. ABB decided to export, after a trip with a delegation from Quebec, most notably for the plant in Geheyan. According to their spokesperson, one cannot enter China without proper contacts. In their case, close bonds were made with the directors at NEPA, the State Power Company, MOFTEC and high contacts close to Jiang Zemin and Zhu Ronji. NEPA gave full support to the T&D project. As for Biothermica, it was the NECEC which proved of greatest help in the whole process. In turn, Turcotte decided to export after an encounter with a Chinese firm and a Canadian company that facilitated the contact. The main contacts remain the firms that work in the same field. Finally,

[1]The main competitors for SNC are the large Canadian and international consulting and engineering firms, for ABB and Biothermica the large European multinationals like Alstom and Siemens, while for Turcotte it is the American and Japanese companies that work in the same area such as Carrier, York and Toshiba. Finally, the main rivals of Mabarex are the firms that

for Mabarex, the sale came from an encounter with a Chinese firm which already had solid contacts in China.

Regarding the information on environmental projects of interest to China, SNC found it in publications from IFI, local trips, contact with the local government and the Canadian Embassy. Chinese authorities also provided information data banks in the form of government documents. In turn, ABB received great support from NEPA. In contrast, Turcotte was not given any material which demonstrated the internal demand for environmental G&S even though the Chinese partners undertook a market study which is yet to be shared. The other firms did not seek information on local demand.

When testing the hypothesis, which presumes that the environmental character of a transfer facilitates the negotiations, SNC, Biothermica and Turcotte responded that it did. ABB was not as convinced of this. It asserted that the Chinese are reluctant to award an economic advantage to foreign investors and this includes using the environmental card as currency. However, it believed that the Chinese, will, in the long run, have no choice. Lastly, Mabarex could not answer this question since all modalities were dominated by the Canadian government. In the same vein, the firms' appraisal of the PRC's commitment to environmental issues suggests high awareness but little initiative[2].

Likewise, the Mayor's assistant also found that even if uncontrolled development is increasingly being questioned by both the leadership and the younger generation, few respect the various laws that have been decreed. Nevertheless, issues that relate to Sustainable Development are central in the political dialogue. For instance, Maire Bourque promotes the premises of SD in

---

seek subventions for work in development projects.

[2]All firms estimated that legislation did not translate into a strong will to protect the environment, with the exception of Biothermica which saw it as average. Public awareness was estimated as strong by Biothermica, Turcotte and Mabarex; medium by ABB, and weak by SNC Lavalin. In turn, the political will was described as strong by SNC, ABB, Biothermica, Turcotte; but weak by Mabarex. This can probably be explained by the quality of the connections that existed between firms and local governments. The firms that had closer ties had a more positive understanding of the political will. However, as experienced in ABB's T&D project, the fact that the CCP favors environmental issues often creates discontentment for major strong local lobbies - such as the coal lobby - which blocs many initiatives. Finally, only SNC, ABB and Turcotte had knowledge of the demands that IFI imposed on the PRC. They all estimated them as strong.

all his trips to China. Even though this concept is not accepted in all provinces, he uses, according to his Assistant, his leadership and his vision to promote it. Hence, politicians have this role to play, notably in Canada where the issue is at the top of the foreign agenda. Since the Mayor's assistant is charged with facilitating the penetration by Quebec firms in China, the premises of SD - one of the City's guiding principles - represent a useful tool to promote local environmental technologies. This can be in the long run very profitable. Therefore, the role of City Hall is to facilitate the dialogue between Montreal firms and Chinese buyers, by taking advantage of the channels that it has opened with Chinese authorities.

2. Financial Aid Programs

Government aid also follows the dynamics mentioned above. Even if financial aid proved very accessible, the most helpful agencies - EC and CIDA - are the ones that have the closest ties to issues of SD. Financial aid for ETT is therefore linked to the different government's commitment to promote sustainable Canadian technologies. On the other hand, Chinese funding was scarce and therefore reflects once again the CCP level of commitment to SD. Out of the five companies, only Biothermica received full funding from their Chinese partner. The remainder received help from Canadian and IFI aid programs.

SNC benefited foremost from funds from IFI and Canadian federal and provincial governments. The former offered well aimed programs of assistance, while the latter two understood the needs and concerns of enterprises, and provided good assistance in China through their excellent contact network. The most cooperative were CIDA, Environment Canada and the Ministere de l'Industrie et Commerce du Quebec. SNC is very satisfied with the results. In turn, ABB's T&D project was financed by funds from IFI and market allocations. Funds were also provided by the Federal Government. In contrast, even though this firm deemed that the funding programs were better than those of banks, it did not find them sufficiently flexible. Ministries at both levels, provincial (Ministère des Resources Naturelles and the MIIC), and federal (MCOMINT,

RESCAN, INTER, CIDA, IC and the P.M's Bureau), proved of great help, notably for political support while contacting Chinese authorities.

Finally, both Turcotte and Mabarex have benefited from federal aid programs. On the one hand, the former is enthusiastic about the promised financing from CIDA., but received no cooperation from any particular Ministry in the negotiations of the contracts. On the other hand, the latter profited from concessional loans at low interest from the Government of Canada and found that the federal government, notably Environment Canada, was most helpful in the negotiations.

With respect to municipal financial aid programs, the City of Montreal offers none, since these remain the prerogative of higher levels of government. However, the City offers references to IFI and governments, thereby providing political support for local firms. Moreover, the City has benefited from privileged relations with the City of Shanghai for the past twenty years. Even though these fall under no specific program, they underline the importance of trade between both markets and, thus, can be brought in to help exporting firms[3]. When asked about the role of regional and municipal governments in transactions that involve technology transfer, the Mayor's Assistant responded that - even though it is presently indirect - it is gaining importance. He further added that this is due to the fact that economic development is increasingly becoming the prerogative of the municipal authorities.

Meanwhile, Federal and Provincial governments still control finances and, therefore, a large part of the process. To illustrate this, he pointed to an exhibit that showcases Canadian technologies that the City of Montreal has recently opened in Shanghai. Worth CA$3 million, this technological window entitled "Jardins de Montréal" is proof of the leadership that the City assumes, even though the costs are equally shared with both federal and provincial governments.

[3]For example, the City has signed recently in Shanghai, a waste management contract and has invited SNC Lavalin to assist. This has created a joint committee which groups officials from both cities to deal with the project. Hence, the City's political clout represents hidden capital that has been developed through ties of confidence. In turn, these have more than monetary value since

3. Host Conditions

a) Inciting Conditions

With respect to host conditions, all companies agreed that the main advantage of doing business in China was the benefits of a huge market for environmental G&S. SNC found that the benefits of being introduced into a good network which has ties in high places resulted from these transactions. ABB highlighted the fact that the market moves faster than other developing countries and that sales are secured, but they are not easy to get. In a similar fashion, Biothermica added that China represents the largest market on the planet for air management equipment and this is reinforced by a nascent environmental consciousness. Interestingly, Turcotte pointed to the advantage of gaining experience in a project that is extremely difficult and the possibility to establish a firm foothold in the Asian market. Lastly, Mabarex saw a big opportunity for profit.

On the other hand, the major obstacles of dealing in China are the unclear legal framework and the way of doing business. For SNC, lax IPR and an incomplete judicial system, which does not define clearly the character of contracts, payments and judicial aid were not the only barriers. The fact that China was isolated from the world in the middle of the century led to the creation of an internal market that has its own standards, technical norms, production and autonomous industrial networks. The result is that many technologies find no application to custom-built[4] Chinese facilities. ABB underlined the high costs of business travel. To this Biothermica adds that the slow rhythm of negotiations, huge bureaucratic hurdles, the approval of the CCP, the fact that everything is decided by consensus requires a great deal of patience. Similarly, Turcotte indicated that the major problems of dealing in China are the lack of transparency by the local partners, the bureaucracy, and the backward services and infrastructure. Finally, Mabarex found that it is impossible to do business without

---

they offer both support and privileges to local competitive firms.

[4]The spokesperson for SNC Lavalin illustrated this by pointing to the fact that whereas Canada has 150 pulp and paper (P&P) plants that work with similar standards, China displays over 12 000 P&P plants that do not always share the same standards.

a strong and experienced Chinese partner and there is always the fear of not being paid.

These findings were corroborated by the Mayor's Assistant. For him, Montreal environmental firms are mainly attracted by the huge market opportunities available in China. However, he also indicated that the major obstacles to doing business in China are the culture and the business tradition. Westerners do not know the culture well, and by this one does not mean the language - which is already an obstacle, but rather the mentality and the customs. Nonetheless, these must be learned on location. Here, Canadians are relatively backward when compared to the Americans, Japanese and the business communities of Taiwan and Hong Kong. Regarding the business tradition, it varies immensely, notably when looking at the determining role played by the Chinese government. On the one hand, big companies are not afraid of going to China. On the other hand, SME are more reluctant, and hence the Municipality has to reassure them.

With respect to more specific conditions, SNC believes that political stability, the government's good credit rating and the environmental policy in China were most attractive; the return on equity was passable, but that the economic environment and the legal framework were uninviting. As for ABB, it believes that the Chinese Government's good credit rating was the best attraction. This was followed by political stability, which was found relatively attractive, and lastly the economic environment, the legal framework, the return on equity and the environmental policy, which were referred to as unattractive. Biothermica ranked the Chinese government's credit rating at the top, followed by the ratio of return on equity and political stability, then came economic environment along with environmental policy, and - at the bottom - the legal framework. In turn, Turcotte held as most attractive the environmental policy followed by the economic environment, while depicting the questions of political stability, legal framework, return on equity and the government's credit as least inviting. Finally, Mabarex stated that political stability encouraged the exchange with China. To a lesser extent came the Chinese economic environment and the

legal conjuncture, while environmental policy and the PRC's credit proved inadequate. Here, the differences may be explained by the disparate nature of the transactions which varied in location, scope and composition; however, all agreed that political stability played a certain role.

b) Accommodative Conditions

Similarly, Chinese accommodative structures were appraised differently from one firm to another, resulting probably from the difference in location. First of all, for **technical components** ABB, Turcotte and Mabarex found them equivalent, Biothermica inferior, and SNC found that education and skills were equivalent but tools and organization were less advanced.

Second, **technological capacity** was differentially rated; while both ABB and Mabarex estimated it of poor quality, Biothermica and Turcotte saw it as equal. In turn, SNC found it inferior in matters of maintenance, equivalent for adaptation and improvement, and better with respect to assimilation of technology.

Third, concerning the **innovative triangle**, SNC believes that it is superior, since Chinese call on more cooperation and have shown the ability to catch up extremely fast. In turn, ABB saw that this was inferior since it did not encourage independence. The socialist nature of the system integrates all aspects of society and therefore the dynamics are quite lethargic. Lastly, Biothermica considered it as equal. The others had no comment on this matter.

Finally, SNC estimated that the **technological infrastructure** was equivalent, and **practical conditions** were equivalent for communications and telecommunications and inferior with respect to legal and financial services as well as databases. ABB deemed the technological infrastructure as highly developed for a developing country, and practical conditions as good for telecommunications, but bad for transportation and financial services. For both Biothermica and Mabarex, the technological infrastructure and the practical conditions were equivalent. Finally, Turcotte found both of them inferior.

The level of Chinese expertise played a role in the choice of transfer but to different degrees. For instance, SNC's transfer was defined by the level of

expertise. In turn, ABB and Biothermica required the Chinese to be able to understand mechanisms behind the procedures since the transfer involved advanced components. For Turcotte and Mabarex the level of expertise did play a small role in the transaction, but was not determinant for the choice of the exchange. These findings confirmed - as it will later be shown - the hypothesis which stated that the transfer would be more participatory if the recipient firms present compatible accommodative structures.

Regarding translation, Turcotte and Mabarex called on the services of a Chinese interpreter, SNC used both Chinese and Canadian interpreters, and ABB and Biothermica Canadian interpreters. In this matter ABB suggested that, Chinese interpreters tend to favor the Chinese perspective.

c) Intellectual Property Rights

Results concerning the hypothesis which stated that insufficient IPR protection would generate agreements that would not include Chinese expertise were inconclusive. Almost all firms did not report any problems, yet seemed well aware of what this entailed. For instance, ABB stated that it has attempted to avoid all ambiguities in the transfers in order to ensure secrecy. The only firm to have reported IPR related problems was SNC Lavalin. Even if these are yet to be resolved, solutions are presently being negotiated. The firm stated that the Chinese have little comprehension of the issues that surround IPR. The fact that IP legislation is nascent leads to agreements that are very different from what is routine in other countries. Consequently, SNC seldom sends state of the art technologies and approves only agreements that maintain its control. The firm's objective is to create a Chinese company that remains under its control and responds to it.

As for the sale of products and technology, the only company to grant the recipient full rights to sell them was Biothermica. It believes that eventually production and sales will be equally shared with the Chinese. In turn, Turcotte's ETT contract only allowed the sale of products within China. The remaining three have not given the right to sell the technology. For SNC the agreement is a partial transfer and for Mabarex a simple direct sale. ABB has set a limit of 20%

on exports and remains in control of local and foreign sales with over 5,000 employees in China and offices in all major cities.

Finally, only four firms responded to the question designed to test the hypothesis that deemed accommodative structures more important than IPR. Mabarex could not answer since it did not make an ETT. Here the results were inconclusive. On the one hand, ABB and Biothermica believed that the ability to accommodate the know-how is more important than IPRs. The former justified this by stating that IPRs did not concern the products and services produced by them as much as telecommunications firms. In turn, the latter stated that IPRs are in an embryonic stage and therefore irrelevant when dealing in China. On the other hand, however, SNC believes that IPRs are more important, since if they are not respected, no deals can be concluded. Moreover, one can always find place for accommodation. Finally, Turcotte states that IPRs are more important, since one has no control over laws, but one can always train people to work.

When asked the same question, the Mayor's assistant stated that business in China includes the implicit but determinant clause that any transaction must involve some sort of technology transfer. Since China has opened up in the early eighties, large numbers of scientists have gone back and brought the ability to adapt technologies. China is to be considered a developing country that has equivalent S&T structures. Conversely, for him the issue of IPRs is totally different. Since there is no legal tradition as we know it, one cannot accuse China without knowing history. China's historical isolation and diverging legal tradition, has in a sense led to this need to copy in order to standardize its business relations. Consequently, both issues are to be considered equally when exporting to China.

4. Assessment of the Overall Experience

When asked whether firms would consider working in China again, all firms responded that they would gladly, but for different reasons. SNC Lavalin and Biothermica argued that Chinese employees are qualified, skillful, hardworking and charge lower wages. In turn, ABB would return but would still withhold any licensing agreement. As for Turcotte, it has no objections to going

back, since their current obligations also involves future ventures. Lastly, Mabarex would return based on the lucrative results of the previous project.

All firms agreed that, when exporting to the PRC, companies must consider local culture and business tradition, the level of IPR, the mechanisms of joint ventures, the need to produce locally and the environmental norms. With respect to the latter, Biothermica pointed out that these are increasingly becoming stringent, indicating a certain normalization. Biothermica also agreed with SNC Lavalin that the good quality of labor is to be considered. As for protectionism, only Turcotte believed that this was to be considered. Finally, financing procedures were only taken into account by Mabarex and SNC Lavalin.

With respect to the elements that would improve the performance of environmental companies from Quebec in China, all firms agreed that they could benefit from more political and financial support from federal and provincial governments. However, Biothermica stated that this was not essential, since business could be organized through other channels. More information on China was regarded as useful by SNC, Turcotte and Mabarex. SNC added, that firms could benefit from more information on the differences that exist between Canadian and Chinese technologies. In turn, contacts with local enterprises that work in complementary sectors were not as important for the large firms as they were for SME. Only Turcotte believed that facilitating the access to project financing was not important. Similarly, Mabarex was the only firm to believe that more information on IFI projects could help Quebec companies. Assistance to plan penetration strategies was deemed important for ABB and Mabarex, but not by the others. Lastly, improvement of IPR protection was regarded as very important by SNC, Turcotte and Mabarex. However, IPRs were considered important by Biothermica, but not as determinant since the firm estimated that it would not sue on the grounds that it would be a lost cause. As for ABB, it stated that firms that work in its field would not benefit enormously from better IPRs.

Finally, when asked what they had learned from technology transfer to China, the most common answer was "to be patient". More specifically, SNC Lavalin has ascertained that the process is very difficult and long. In the case of

ABB, it learned that doing business in China is very complicated and that it is to be avoided if the proper contacts are not made. This is easier for large firms that already have their networks, but not as simple for smaller firms. As for Biothermica, Turcotte and Mabarex, they all learned that business in China represents a long term affair, where time is not a question. This means that one must be ready for long and complex negotiations that require large investments that will take time to flourish.

III. Conclusion

As stated in the introduction, this chapter set out to obtain a general feeling of what is to be expected in China for Quebec environmental firms that wish to export their G&S there. The information gathered here is therefore to be regarded as an illustrative compilation of the process. Future projects should attempt to understand the whole process with greater detail. However, the sketches of these results allow us to detect a certain corroboration of the information gathered from the participating public official. Consequently, even if the information can be considered sparse, it outlines the approximate profile of what a select group has encountered.

One of the major findings with respect to negotiations was that bigger firms tend to secure their contacts through formal government channels, whereas SME tend to use informal relations with their local counterparts. This may result either from the respective weight of the firms themselves (making bigger firms benefit from the scarce projects funded by governments and making SME not bother with counting on them) or from greater political clout. Similarly, big firms had greater access to information than did SME. Another related finding was that the role of the Canadian and/or Chinese politicians remained central in the closing of all deals. In turn, these seemed facilitated when common principles such as the ones present in SD are shared. Even though environmental policies were not well rated, all firms indicated - as did the Mayor's Assistant - that the political will and the public consciousness were growing.

With respect to aid programs, both IFI and government financing seemed accessible since four out of five received some allocations. All of them were

satisfied by both funding and political support granted by the Federal and Provincial governments. Among the various agencies, EC and CIDA were identified as the most helpful ones. Here, one can see that the main purpose of aid programs is not only to promote our local industries and economy, but also to abide by the principles of SD. Conversely, according to one of the respondents the Chinese were not as enthusiastic. They maintain a certain need to avoid compromises by trying to maximize their gains while yielding as little as possible.

On the whole, the PRC was deemed a hospitable country for investment. All firms agreed that the most attractive condition was the giant market opportunities that are currently opening up in China and the possibility to make long term gains by establishing a firm foothold in Asia. Oddly, this variable outweighs the incompatibility that exist between both Canadian and Chinese political regimes and allows a certain "rapprochement". When asked what were the major difficulties to doing business in China, firms pointed out the incomplete IPR regime, the long and expensive negotiating processes, the bureaucratic hurdles and the need for political support.

In turn, even if the grading of inciting conditions varied from one firm to another, all agreed that while the most interesting facet of China was the political stability, the legal framework was deemed inhospitable. On the one hand, the two big firms agreed that both Canadian and Chinese government credit was inciting, while the economic environment and the legal framework were uninviting. On the other hand, the SMEs differed in their choices. Lastly, most firms found that the PRC presented a decent level of expertise which - as shown in the previous section - can be described as equal to, or just below, Quebec's. Among the cited weaknesses were both soft services (legal, banking and accounting) and transportation.

Accordingly, Quebec firms could benefit from improved IPR protection and continued government support and funding. SME in particular could profit from more local contacts with firms that work in complementary sectors. Both the Mayor's Assistant and the responding firms forewarned that one must not overlook the local culture and business tradition. The firms added that the level of

IPRs, the importance of contacts and the long negotiations had to be considered. All seem to indicate that patience is a necessary virtue to work in the PRC.

The questionnaire also served to evaluate four of our hypotheses. Results for the first one - which stipulated that issues of accommodation are more likely to hinder the overall quality of the transfer process than are issues of inappropriate IPRs protection - were inconclusive. Out of the four firms that responded, two believed that IP issues are more important since these are out of the firm"s control and accommodation is not.

In turn, results for the second hypotheses - which stated that transfer ventures would adopt a more participatory type of agreement when the recipient firm provides consonant accommodative structure - were conclusive. According to all firms, Chinese expertise did play a role in both the transfer and agreement. SNC Lavalin's international cooperation agreement was defined by the level of expertise, just as ABB and Biothermica's corresponding licensing and participation agreements were. Both Turcotte and Mabarex - the two firms that did not define expertise as a determinant factor - chose agreements that required less local expertise in a joint venture and a direct sale.

In the case of the third hypothesis that asserts that an inadequate degree of IPR protection will lead to TT agreements that involve little local expertise, results were inconclusive. Regarding IPRs, all firms agreed that this was an issue that could not be overlooked, making this issue a determining factor in the choice of the type of transfer. Therefore, their transfer agreements - including the restrictions set on local and foreign sales - were defined on the basis of what firms wanted to reveal and what they believed could be kept secret. However, one of the firms deemed the situation of IPR so volatile that it did not account for them. Believing that arbitration would be a lost cause, its priorities were to make a profitable deal based on mutual confidence.

Lastly, the fourth hypothesis was confirmed. In fact, almost all firms agreed that the environmental character of their G&S facilitated transfer procedures. The one that disagreed said that authorities would in the near future have to account for this variable.

Finally, the interview with the Mayor's Assistant, proved very insightful when looking at the role of the municipality in ETT procedures. The questions surveyed the perception of the PRC as a potential market for exports but more importantly the City's role in promoting environmental exports. Regarding this last issue, it is clear that the City can facilitate the penetration by Quebec firms into China by offering political support. In order to reinforce trust, the Mayor's assistant drew attention to the need to identify and satisfy the needs of the PRC. What is certain is that the good reputation of a country comes from the ability to transfer technologies. Unlike the Japanese who have often sold outdated equipment, Canada has maintained a good reputation. As such, Montreal benefits from this and is regarded as a scientific city that holds new technologies, credibility and a positive image. What is important is to maintain this trust.

OVERALL CONCLUSION

Issues of development in the 21st Century are to be shaded by universal challenges such as poverty, inequality, pollution, insecurity, illiteracy and developmental unevenness. These absolutes appear rarely in isolation, but rather transcend and intertwine. The task of clarifying and untangling the ensuing complex scenarios requires a holistic approach that provides for generic understanding of the issues. Public policy approaches - such as the one used in this thesis - offer such a basis on to which one can identify, analyze and propose answers to questions of development. In fact, while treating the question of environmental degradation, this thesis has integrated ETT into the broader framework of SD, which in turn interprets the intricate links that bind issues of development. In doing so, it has taken ETT beyond mere simple market transactions and placed it within a larger reality where it becomes a useful tool to counter poverty and inequality, and a means to improve the quality of production mechanisms.

In retrospect, ETTs between Quebec and China have the dual effect of projecting the status of Quebec as a technology leader in the field, and of propagating clean and efficient technologies that will allow the PRC to pursue the modernization drive. From the inception, the main objective has been to see in what way transactions involving environmental technologies between Quebec firms and Chinese firms can be facilitated. The thesis has thus analyzed - in both theory and practice - the mechanisms that govern the process. First, it has revealed the dynamics of ETT by considering its broad and specific characteristics, and delineating the scope of the industry. Second, it has investigated how these exchanges take place in the PRC by looking at the available conditions at hand and by learning from Quebec firms that have already dealt there. Consequently, the relevance of the thesis lies in its practical qualities which test the abstract premises of ETT.

The validation of hypotheses clearly proved an excellent example of this. Results for the first hypothesis, which stated that issues regarding accommodation of technology are more likely to hinder the transfer process than

are issues of IP, were inconclusive. Both issues seem to represent considerable obstacles to ETT. However, as shown in the third chapter, accommodative structures seem to be developing faster than issues of IPR. This denotes a certain predilection of the Chinese to absorb technology on their own terms regardless of international regimes - such as the TRIPs - which are yet to be ratified. The argument then is whether one is interested in profiting from a flourishing environmental market regardless of the costs, or whether the risks of inadequate IPR supersede profits.

In turn, results for the second hypotheses - which stressed that the less developed the accommodative structures, the less technology transfer processes will involve local expertise - indicated that Chinese expertise was, to different degrees, an influencing variable for both choice of transfer agreement and the transfer itself. As shown in the third chapter, the Chinese present accommodative structures that are advanced for a developing country, but - as indicated in the fourth chapter - these have yet to reach western standards. Inciting conditions proved very backward notably in matters of soft services such a legal support, banking and financial services. Once again, knowing that all responding firms see in the PRC a huge market for environmental G&S, one must identify what are firms willing to endure to secure returns. Doing so involves much more intensive research than this thesis initially intended; however, its findings indicate that the PRC is well beyond the non-accommodation threshold and is hospitable for foreign investment. More detailed research would be useful to explore this question further.

Regarding the hypothesis which stated that the less IPRs are protected, the more foreign firms will protect their secrets by using less local expertise or selling a technology rather than licensing it, results were also inconclusive. Even if all firms agreed that IPRs weighed heavily in their decision to trade, the level of protection available in the PRC was looked at in a dubious manner. Once more, Chapter Three detailed the nature of inadequate IPR protection in the PRC. What is to be learned is that the nascent IP legal regime will require many years to be integrated into customs and traditions. Therefore, the conclusion is that firms that

seek to export there are suggested to sign agreements or engage in transactions that do not fully depend on the local IPR legislation which is not yet consolidated.

With respect to the hypothesis that maintained that due to diverging ideologies, the PRC will favor the types of transfers that do not compromise the ideology of the CCP; results from the previous two hypotheses clearly indicate that this country has placed itself in a position where it will rarely be forced to make a compromise. In fact, strong accommodative structures and the pending question of IPR - one of the reasons for excluding the PRC from the WTO - attest that Chinese authorities are not planning to yet concede. One firm implied that the Chinese are ready to gain as much as they can, while granting as little as possible. However, with respect to ETT, the PRC has embraced the principle of SD and hence has the opportunity to gain by facilitating such transactions since this secures investments from the West and respects its own environmental commitments.

Lastly, the hypothesis which indicated that the sustainable character of certain technologies would facilitate their adoption in the recipient country was validated. In fact, findings from the field research indicated that the environmental character of firms did facilitate the entry. Moreover, both theoretical and field results showed that there is a strong will in the PRC to reduce environmental degradation. However, just as in any other country, environmental initiatives come head to head with local interests and lobbies which are often unwilling to compromise their previous gains.

In sum, the large number of specialized SMEs that form Quebec's environmental industry offer technologies and services that are competitive in the international market, but presents no important technological lead nor renown when compared to Japan, Germany, and the US. This is in part due to the fact that Quebec firms have but recently started to open up to international markets, notably with counseling contracts. Nevertheless, the important size of this new industry, its estimated growth and its need for increasingly sophisticated products, offer Quebec firms a niche where comparable know-how at lower cost is a considerable asset. Lastly, one cannot overlook Quebec's participation in

different trading spheres (NAFTA, la Francophonie, the Commonwealth and the ASEAN), its qualified and skilled labor, its renowned R&D centers, and strong governmental support for new technologies.

In turn, the PRC is increasingly concerned with environmental issues. This is evident when looking at legal and economic reforms that have fostered efficient technologies and improved resource use and energy conservation to reduce pollution and inefficiency. This clearly indicates, if not a full acceptance, a certain accommodation to the principles of SD. Meanwhile, the CCP stand on the issue is that China faces the dual task of developing the economy and protecting the environment. Hence, the PRC presently attempts to accommodate the principles of SD into a fast evolving - and often incompatible - economy. Nevertheless, the fact that the environment has been raised as an issue of crucial importance, opens a door of opportunity for Quebec firms that are export ready. However, Quebec firms must be aware that competition will be fierce since rivals will try to exploit this path even if their G&S are only remotely related to the environment.

Overall, this thesis has found that - as in any other market - local firms must learn and comply with the business mentality and culture of local Chinese importers. This process can be as complex as the transfer of technology itself, since one must adopt the business ethic of another country (management, language, laws, culture, and customs). Hence, expansion of an export market is to be regarded as a medium and long term venture that requires substantial human and financial investments. While not explored in this paper, it is likely that the different business culture of Quebec firms may also play a role in the process. In the Chinese case, this implies close attention to the role of political authorities in the process, since their appraisal is in most cases determinant.

ANNEX I: Methodology Behind the Questionnaire

Methodology behind the Questionnaire

The ten page questionnaire is divided into four sections. **Section A** provides a general overview of the ETT projects that the companies have undertaken in China. It inquires into the nature of the project, its duration, the costs, the location, the type of transfer (joint venture, license, sub-contracting, distribution, turn-key project or other), and the type of technology exported (new or used; hi-tech, conventional or low-tech). This section also looks at what motivated the choice of China as a country of export as well as who were the contacts there, what information they had on the evolution of environmental operations in China and the main competitors in the Chinese Market.

In turn, **Section B** concentrates on the funding for the projects. It mainly focuses on the aid programs that are available to Quebec companies from both provincial, federal and international aid programs. Questions probed whether companies request such aid, and if so how successful they were. This section also attempted to see which level of government proved more helpful while realizing these projects.

Section C concentrates on the conditions observed in China. Here companies were asked how they estimated the level of expertise found in the PRC according to technical components (technicians' training and abilities, tools and organization), technological capacity (maintenance, adaptation, improvement and assimilation of technology), innovative triangle (linkage between academic institutions, industry and public R&D centers), technological infrastructure (national institutions that filter foreign technologies and guide local industry), and practical conditions communications, telecommunications, legal and financial services and data bases). They were asked whether this played a role in the choice of the type of technology transfer. Companies were also asked which conditions from, among the following, were the most appealing in the PRC: economic environment, political stability, legal framework, return on equity, government credit, or environmental policy. A question was added on whether

Chinese authorities facilitated the transfer procedures, and whether this was due to the environmental character of their G&S. Lastly, companies were asked if the PRC provided material which demonstrated local demand for environmental G&S as well as where it was presented.

To conclude, **Section D** sums up the companies' experience in the PRC. Initially, it addresses whether problems relating to IPR issues emerged and concomitantly how these were dealt with. Companies were also asked whether they allowed the Chinese recipient to sell the products or technology and if so what restrictions they applied. Another set of questions examined what was considered both the greatest advantages and disadvantages of doing business in China. In more detail, companies were asked how they saw the PRC's commitment to environmental protection, what would improve the performance of Quebec firms in the PRC, and what must be considered when exporting to China (culture, support from a delegation, respect for IPRs, business tradition, environmental norms, protectionism, joint ventures, need to build locally, quality of the workers, financing or other). In order to validate the hypothesis that states that accommodative preconditions supersede respect of IPR, companies were asked which of the too was more important and why. Finally, companies were asked to share whether they would do business with Chinese companies in the future and what they have learned on ETT to China.

Annex II: Questionnaire

QUESTIONNAIRE

Nom de la Compagnie: _____

Produits et/ou Services: _____

_____

Personne Contact: _____

Adresse: _____

Téléphone: _____

Section A: Nature de votre projet de transfert de technologie

1. Quelle est la nature de votre projet en Chine?

   _____

   _____

   _____

   _____

2. Quelle a été la durée d'accomplissement du projet en Chine?

   _____

   _____

3. Quel est le lieu d'implantation de votre projet?

   _____

4. Quels sont les coûts du projet? _____

5. Votre projet comporte t-il un transfert de technologie?

   oui non

6. Quelle est la nature de l'entente pour transférer la technologie?
   a. Joint venture / co-entreprise
   b. Accord de licence
   c. Participation
   d. Entente de fabrication
   e. Entente de distribution
   f. Contrat clé-en-main
   g. Autre: _____
7. Pourquoi avez-vous choisi ce type de transfert de technologie?

   _____

   _____

   _____

8. Votre transfert comportait-il de l'équipement nouveau ou usagé? a. Nouveau b. Usagé

9. Quel type de technologie avez vous exporté?
   a. Technologie avancée
   b. Technologie conventionnelle
   c. Technologie très accessible

10. Comment avez-vous décidé d'exporter en Chine?
    a. Lecture d'études
    b. Réalisation d'études
    e. Association avec des entreprises locales
    f. Rencontre avec une entreprise étrangère/chinoise

c. Rencontre avec l'ambassade chinoise

d. Information des Institutions de Financement Internationales (IFI)

g. Potentiel de marché estimé

h. Autre: _____

_____

_____

11. Quels ont été vos contacts en Chine? _____

12. Avant de traiter en Chine, avez vous trouvé de l'information sur les travaux en matière d'environnement effectués là-bas? Si oui, où?

Oui	Non
a. Publication des IFI	d. Contact avec des firmes canadiennes
b. Voyage sur place	e. Contact avec l'ambassade canadienne
c. Contact avec le Gouvernement de la Chine	f. Autre: _____
	_____

13. Quels sont vos principaux rivaux en Chine?

_____

Section B: Le financement

14. Lors de votre/vos projet(s) en Chine avez vous bénéficié des sources de financement pour projets internationaux (IFI, projets de co-entreprise, banques traditionnelles, ou autre) ou des programmes du Gouvernement Canadien ou Québécois oeuvrant dans le commerce international ou le développement?

_____

_____

15. a) Êtes-vous satisfait? Très satisfait Pas satisfait

b) Pourquoi?

_____

_____

16. Au Canada, quel ministère - provincial et/ou fédéral - s'est montré le plus coopératif lors de la réalisation de votre projet?

_____

_____

Section C: Conditions d'accueil en Chine

17. Comment évaluez-vous le niveau de l'expertise chinoise par rapport à la vôtre en matière de (indiquez si elle est meilleure, équivalente ou moins avancée):

a. Composantes Techniques (éducation et habilité des techniciens; outillage; et organisation) _____

b. Capacité technologique (entretien, maintenance, adaptation, amélioration et assimilation de la technologie) _____

c. Triangle d'innovation (existence de réseaux entre les institutions académiques, l'industrie et les centre de R&D publics) _____

d. Infrastructure technologique (institutions nationales qui filtrent l'entrée de technologie et guident l'industrie locale)

_____

e. Conditions pratiques (communications, télécommunications, services légaux et financiers, et bases de données)

_____

18. Est-ce que le niveau d'expertise a joué un rôle dans le choix du type de transfert de technologie?

_____

_____

19. Selon vous, parmi ces conditions, quelles sont les plus attrayantes en Chine? (Indiquez par ordre croissant de 1 a 6, 1 étant la plus attrayante)

    a. Environnement économique ___
    b. Stabilité politique ___
    c. Cadre légal ___
    d. Assurance de retour sur l'équité ___
    e. Bon crédit des gouvernements ___
    f. Politique environnementale ___

20. Selon vous, est-ce-que les autorités chinoises ont facilité les procédures de pénétration de votre entreprise? Pensez-vous que l'aspect environnemental de vos produits/services aura facilité le processus?

_____

_____

_____

21. La Chine a-t-elle mis à votre disposition du matériel qui présentait la demande locale de biens et services environnementaux? Si oui, quel genre?

Oui Non

a. Banque d'informations
b. Réseau d'affaires
c. Associations
d. Bulletin d'information des IFI
e. Veille technologique
f. Information auprès de l'Ambassade

Section D: Bilan

22. En traitant en Chine, avez-vous eu des problèmes au niveau du respect des Droits de Propriété Intellectuelle (DPI)?

Oui Non

23. Si oui, comment se sont-ils manifestés et comment ont-ils influencé le choix de la nature de l'entente?

_____

_____

_____

24. Comment avez-vous résolu le problème? Était-ce à votre satisfaction?

_____

_____

_____

25. Selon vous, quels ont été les avantages de faire des affaires en Chine?

_____

_____

_____

26. Avez-vous permis à l'entité récipiendaire chinoise de vendre les produits ou la technologie elle même tant en Chine qu'à l'extérieur?

Oui Non

27. Si non, quelles restrictions avez-vous prévu?

_____

_____

28. Selon vous, quelles sont les difficultés majeures pour faire des affaires en Chine?

_____

_____

_____

29. Qui est responsable de la production et de la vente locale et étrangère?

_____

30. Comment trouvez-vous l'engagement de la Chine en matière environnementale?

a. Réglementation

Forte Faible

_____

_____

b. Sensibilisation Publique

Forte Faible

_____

_____

c. Volonté politique

Forte Faible

_____

_____

d. Exigences des bailleurs de fonds

Forte Faible

_____

_____

31. A votre avis, qu'est-ce-qui améliorerait la performance des firmes québécoises en Chine dans votre secteur d'activité?

a. Appui des gouvernements québécois et canadien

Très important Pas important

b. Plus d'information sur la Chine

Très important Pas important

c. Connaissance d'entreprises locales qui oeuvrent dans des secteurs complémentaires au vôtre

Très important Pas important

d. Faciliter l'accès au financement des projets

Très important Pas important

e. Plus d'information sur les projets financés par les IFI

Très important Pas important

f. Aide pour formuler une stratégie de pénétration

Très importante Pas important

g. Meilleure protection des DPI

Très importante Pas important

h. Autre: _____

_____

Très important Pas important

32. Comment avez-vous traité la question de la communication verbale?

a. Interprète chinois

b. Interprète canadien

c. Autre:_____

33. a) Selon vous, qu'est ce qui est plus important: l'habilité des firmes chinoises d'accommoder votre savoir faire ou le respect des DPI? _____

b) Pourquoi?

_____

_____

_____

34. Selon vous, que doit-on prendre en considération lorsque l'on exporte en Chine?

a. Culture du pays
   Très importante
   Pas importante

b. Contraintes d'appels d'offre
   Très importantes
   Pas importantes

c. Support d'une délégation ministérielle
   Très important
   Pas important

d. Respect de la propriété intellectuelle
   Très important
   Pas important

e. Façon de faire les affaires
   Très importante
   Pas importante

f. Normes environnementales
   Très importantes
   Pas importantes

g. Protectionnisme
   Très important
   Pas important

h. Joint Ventures
   Très importants
   Pas importants

i. Besoin de fabriquer sur place
   Très important
   Pas important

j. Qualité de la main d'oeuvre
   Très importante
   Pas importante

k. Financement
   Très important
   Pas important

l. Autre: _____
   Très important
   Pas important

35. Feriez vous affaire avec des entreprises chinoises dans l'avenir? Pourquoi?

_____

_____

_____

36. Qu'avez-vous appris sur le transfert de technologie en Chine?

_____

_____

_____

Annex III: Letter

Brossard, 18 Mai 1999

Nom
Compagnie
Adresse

Cher Monsieur/Madame,

Je suis un étudiant à la maîtrise de Science Politique à l'Université McGill. Je rédige présentement un mémoire de maîtrise qui portera sur les transferts de technologie environnementale du Québec en Chine. Bien que de nature académique, le but ultime de ce travail est de faire connaître les conditions qui facilitent les projets de transfert de technologie des firmes canadiennes et québécoises en Chine. Celle-ci est évidement désireuse de recevoir des moyens de production durables tandis que les firmes québécoises souhaitent bien sûr s'implanter sur ce marché prometteur.

Par les présentes, auriez-vous l'amabilité de me recevoir - durant le courant des prochaines semaines - pour répondre à quelques questions portant sur vos expériences de projet en Chine. D'une durée ne dépassant pas vingt minutes, les questions portent d'une part sur les aspects généraux de votre projet, et de l'autre sur les conditions d'accueil que vous avez rencontré là-bas.

Dans l'espoir de vous lire sous peu à ce propos, je me permettrai entre-temps de communiquer avec votre bureau par voie téléphonique. Toute information recueillie est assujettie aux régles de stricte confidentialité et vous sera soumise.

Je vous remercie à l'avance en vous priant d'agréer mes sentiments les plus distingués.

Annex IV: Results

RESULTS

SECTION A

	SNC Lavalin	ABB	Biothermica	Turcotte	Mabarex
Project(s)	Institutional reinforcement	A hydro-electric plant (P1)and a transmission and distribution project (P2)	Transfer of ambient air control emission technologies for coal fired thermal plants	Local fabrication of household environmental control units (ECUs).	Sale of waste water management equipment
Duration	5 years	n.a.	5years	4 years	1 year
Location	Beijing and Anhui	P1: Geheyan in Hubei Province P2: Northern China, linking Mongolia and Russia	Shinyan, Province of Anhui	Shanghai	Baihai, Province of Jiangxi
Costs	$10.5 million	P1: $150 million P2: $1.5 billion	$3 million	$2 million	$3.2 million
Type Of TT	International Cooperation Treaty	Licensing agreement	Participation agreement	Joint Venture	Direct sale
Reason for exporting to China	CIDA hired SNC for this project	P1: following a visit with a Quebec Delegation P2: Local Contacs	Estimated gains from the market	Decided after meeting a Chinese enterprise	Decided after meeting a Chinese enterprise
Main Contacts in China	CIDA and the different levels of the Chinese Government	State Power Commission, MOFTEC, NEPA and officials in the Politburo	North East China Electric Company	Local companies that work in the same field	Local buyer became the best contact
Main Rivals	Large Canadian and interntional engineering firms	Large Multina-tionals such as Alstom and Siemens	Large multina-tional Corpora-tions from Sweden and Germany	Carrier, York and Toshiba	Firms that seek subventions for work in development projects

	new	used
Was the equipment new or used?	All firms	none

	Hi-tech	Conventional	Low-tech
What type of technology was transfered?	SNC, ABB, Turcotte, and Biothermica	SNC and Mabarex	SNC

SECTION B

	IFI	Federal Goverment	Provincial Government	None
What aid programs did the firms benefit from?	**SNC & ABB**	**SNC, ABB, Turcotte & Mabarex**	**SNC & ABB**	**Biothermica**

	Satisfied	Unsatisfied
Degree of satisfaction	**All**	**none**

Most helpful Ministries and/or Agencies	**Environment Canada & CIDA**

SECTION C

Evaluation of Chinese Expertise	Technical components	Technological capacity	Innovation triangle	Technological infrastructure	Practical Conditions
Superior			**SNC**	**SNC & ABB**	
Equivalent	**SNC, ABB, Turcotte & Mabarex**	**SNC, Biothermica and Turcotte**	**Biothermica**	**Biothermica & Mabarex**	**SNC, ABB, Biothermica and Mabarex**
Inferior	**Biothermica**	**ABB & Mabarex**	**ABB**	**Turcotte**	**Turcotte**

	Very determinant	Relatively determinant	Not determinant
How determinant was the level of expertise in the choice of the transfer agreement?	**SNC**	**ABB & Biothermica**	**Turcotte & Mabarex**

Inviting conditions	Most attractive	Moderately attractive	Unattractive
Economic environment		**Biothermica , Turcotte & Mabarex**	**SNC & ABB**
Political stability	**SNC, Biothermica & Mabarex**	**ABB**	**Turcotte**
Legal framework		**Mabarex**	**SNC, ABB, Biothermica & Turcotte**
Return on equity	**Biothermica**	**SNC**	**ABB & Turcotte**
Environmental Policy	**SNC, Turcotte**	**Biothermica**	**ABB & Mabarex**
PRC's credit rating	**SNC, ABB, Biothermica**		**Turcotte & Mabarex**

	YES	No	Not applicable
Did the environmental character of the technologies facilitate the procedures?	**SNC, Biothermica & Turcotte**	**ABB**	**Mabarex**

SECTION D

How many firms had IPR problems?	**Only one, SNC Lavalin**
How were they resolved?	**They are presently in negociations**

	Full rights	Restricted rights	No rights
Did firms grant the right to sell the products and technologies?	**Biothermica**	**Turcotte (sales allowed only in China)**	**SNC, ABB & Mabarex**

Major advantage of doing business in China	**Huge market for environmental G&S**
Major obstacles of doing business in China	**Unclear legal framework and different way of doing business**

China's environmental Commitment	Legislation	Public awareness	Political will	Demands from IFIs
High		**Biothermica, Turcotte & Mabarex**	**SNC, ABB, Biothermica & Turcotte**	**SNC, ABB & Turcotte**
Medium	**Biothermica**	**ABB**		
Low	**SNC, ABB, Turcotte & mabarex**	**SNC**	**Mabarex**	

Which of the following conditions would improve the performance of Quebec firms in China?	Important	Not important
Increased government support	**SNC, ABB, Biothermica, Turcotte & Mabarex**	
More information on China	**SNC & Turcotte**	**ABB, Biothermica & Mabarex**
Contact with local enterprises	**Biothermica, Turcotte & Mabarex**	**SNC & ABB**
Increased financing	**SNC, ABB & Mabarex**	**Biothermica & Turcotte**
Information on environmental projects sponsored by IFIs	**Mabarex**	**SNC, ABB, Biothermica & Turcotte**
Help to plan a penetration strategy	**ABB & Mabarex**	**SNC, Biothermica, Turcotte & Mabarex**
Improved IPR protection	**SNC, Biothermica & Turcotte**	**ABB**

	Chinese Interpreter	Canadian Interpreter
How was communication ensured?	**SNC, ABB & Biothermica**	**SNC, Turcotte & Mabarex**

What is more important....	...Accomodative structures or...	... IPR protection?
	ABB & Biothermica	**SNC & Turcotte**

What should firms consider when exporting to China?	Very important	Significant	Not important
	• **Local culture** • **Level of IPR** • **Joint venture mechanisms** • **Need to produce locally**	• **Quality of labor** • **Financing procedures** • **Bid constraints (contraintes d'appel d'offre)**	• **protectionism**

Given the opportunity, would firms accept to undertake other project in China?	**All firms answered positively.**
What did firms learn from their experience in China?	**Patience was the most common answer**

Bibliography

ALFA LAVAL, Alfa Laval Homepage, www.automation.alfalaval.se/30r.htm.

ALFORD, W.P., To Steal a Book is an Elegant Offense, Stanford, Stanford University Press, 1995.

ASIAN DEVELOPMENT BANK, Technology Transfer and development, Asian Developement Bank Publication, 1995.

BALZHISER, R.E., "Innovations in Energy Technology" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C, National Academy Press, 1995.

BASF, BASF Home Page, www.basf.com/asia/indones/adress/ltd.htm

BEG, Daud, "Privatization in Developing Countries", in Energy Technology Cooperation for Sustainable Economic Development, Guertin, D.L., Gray, J.E., & Bailly, H.E., New York, University Press of America, 1993.

BROOKS, H., "What We Know and Do not Know about Technology Transfer: Linking Knowledge to Action" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

BUGLIARELLO, G., "The Global Generation, Transmission, and Difusion of Knowledge: How Can The Developing Countries Benefit?" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

CHAUDHARI, P., "Materials and Critical Technologies" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

COLWELL, Rita, "Technological Trends and Applications in Biotechnology" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

DAMES CORPORATION, Dames Homepage, www.dames.com/dmg_home/.

DASGUPTA et al., "Discretionary Pollution Control in China", The Economics of Industrial Pollution Control in Developing Countries, World Bank (RPO 680-20), edecastro@worldbank.org., May 1997.

DUMAIS, Marie Christine, Le potentiel d'intervention internationale pour les entreprises quebecoises en environnement, Québec, Centre de recherche industrielle du Quebec (CRIQ), 1994.

DUPONT, Dupont Homepage, www.dupont.com/corp/gbl-company/history.html

EDMONDS, R.L., Patterns of China's Lost Harmony, New York, Routledge, 1994.

EIBENSCHUTZ, J.; GRAY, J.E.; HYDE, R.P & PORTER, W. M., "Energy Technology Transfer and Trade" in Energy Technology Cooperation for Sustainable Economic Development, Guertin, D.L., Gray, J.E., & Bailly, H.E., New York, University Press of America, 1993.

FAIRBANK J. et al., East Asia, Harvard University, Boston, 1989

FOSTER-WHEELER, Foster Wheeler Homepage, www.fwenc.com

FT FINANCIAL PUBLISHINGS, Banking in China, www.live.co.uk/china.htm

GOOSEN, R.J., Technology Transfer in the People's Republic of China: Law and Practice, Boston, Martinus Nijhoff Pub., 1987

HANINK, D. M., Principles and Applications of Economic Geography, New York, John Wiley & Sons Inc., 1997.

HART ENVIRONMENTAL Inc., HEI Homepage, www.artenv.com/.

HARWOOD, Richard R., "Broadened Agricultural Developement: Pathways toward Greening the Revolution" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

HOEKMAN, B.M. & KOSTECKI, M., The Political Economy of the World Trading System, Oxford, Oxford University Press, 1995.

INFORMATION OFFICE OF THE STATE COUNCIL OF THE PEOPLE'S REPUBLIC OF CHINA (IOSCPRC), White Paper-Environmental Protection in China, Beijing, 1996.

JINGPING Ding, "Using imported technology to transform existing enterprises in China", in Chinese Technology Transfer in the 1990's, Feinstein & Howe, Cheltenham, Edward Elgar Publications, 1997.

JIANGPING Xu, "China's International Technology Transfer: the Current Situation, Problems and Future Prospects", in Chinese Technology Transfer in the 1990's, Feinstein & Howe, Cheltenham, Edward Elgar Publications, 1997.

McCOLLAM, W. & DENNY, F.I., "Processes for Transnational technology Transfer and technology Cooperation in the Electric Power Industry" in Energy Technology Cooperation for Sustainable Economic Development, Guertin, D.L., Gray, J.E., & Bailly, H.E., New York, University Press of America, 1993.

McKAY- CAREY, M.J., "Patenting and Intellectual Property Rights for Biotechnological Inventions", in ENVIRONMENTAL LAW CENTER, Law in the New Age of Biotechnology, Edmonton, Alberta Law Foundation, 1992.

MOSER, M.J., Business Strategies for the PRC, Hong Kong, China Intelligence Reports, 1986

PADBURY, P.,"UNCED and the Globlization of Civil Society", in E. Fawcett United Nations Reforms, Toronto, Science for Peace Publication, 1995.

PERRIN, Jacques, Les transferts de technologie, Paris, La Découverte, 1983.

PIZER W.A., The Kyoto Protocol to the UN Framework Convention on Climate Change - Finished and Unfinished Business, http://www.cicero.uio.no/eindex.html, 1998.

POTTER, P.B. & OKSENBERG, M., " A Patchwork of IPR Protection", China Business Review, www.nbr.org/regional-studies/ipr/cbrarticle .html

QU, Geping, Population and Environment in China, London, Paul Chapman Publications, 1994.

RISCHARD, J.F., "Forces Reshaping the World Economy" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C , National Academy Press, 1995.

RUNNALLS, David, "Environment and Development", in United Nations Reforms, E. Fawcett, Toronto, Science for Peace Publication, 1995.

SAINT-ANDREW, P.P., "Cooperation as a Vehicle for Technology Transfer" in Energy Technology Cooperation for Sustainable Economic Development, Guertin, D.L., Gray, J.E., & Bailly, H.E., New York, University Press of America, 1993.

SAYWELL, "Infinite Possibilities", China Trade Report, April 1997

SCHARF, T., The German Greens, Oxford, Berg Publishers, 1994.

SIEMENS, Siemens Homepage, www.siemens.com/

STEINMULLER, Steinmuller Homepage, www.steinmuller.co.za/

SUEZ-LYONNAISE, Suez-Lyonnaise des Eaux HP, www.suez-lyonnaise-eaux.fr/french/metier/index.htm.

TAMBUNAN, A., China's Banking System, pacificrim.bx.com/asianbank/chinabank.htm

von MOLTKE, K. , "Environment and Trade: An Uneasy Realationship" in International Trade and Sustainable Development, Ottawa, Centre for Trade Policy and Law, 1995.

WORKING GROUP, "The Policy Paper" in Energy Technology Cooperation for Sustainable Economic Development, Guertin, D.L., Gray, J.E., & Bailly, H.E., New York, University Press of America, 1993.

WORLD BANK & NATIONAL RESEARCH COUNCIL, "The Globalization of Knowledge and technology" in Marshaling Technology for Development, World Bank & National Research Council (U.S), Washington D.C, National Academy Press, 1995.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. Our Common Future, Oxford, 1987.

XIAOJUAN Jiang, "Chinese Government Policy Towards Science and Technology and its Influence on the Technical Development of Industrial Enterprises", in Chinese Technology Transfer in the 1990's, Feinstein & Howe, Cheltenham, Edward Elgar Publications, 1997.

YU, Cheung, "On the reactions of Chinese Culture against the Western Challenge", Learning from China, London, Glaeser, 1987.

Les biotechnologies dans la region de Montreal, Quebec, Conseil de la Science et de la Technologie, 1994.

Sustainable Development Homepage, Department of Foreign Affairs and International Trade, http://www.dfait-maeci.gc.ca/sustain/menu-e.asp.

Le rôle d'Environnement Canada dans l'élaboration de nouvelles approches à la coopération technologique dans les marchés naissants, Ottawa, Environnement Canada, 1995.

Canadian Environmental Industry Strategy, Environment Canada, http://www.wc.gc.ca/press/ceis_b_e.htm, 1997.

La Actualidad de Alemania, German Government, Societats-Verlag, 1992.

"Environmental Industry Virtual Office Opens in Alberta", Industry Canada, http://info.ic.gc.ca/cmb/ (...) welcomeic.nsf/Pages/searchfr.htm, 1997.

"Technology Partnerships Canada", Industry Canada http:/strategis.ic.gc.ca/sc_mangb /tp/engdoc/ homepage.html.

Canada-China: Environmental Solutions, Industry Canada 1997.

"Canadian Office for Technology Exchange in the Environment" (COTE), Industry Canada http:/strategis.ic.gc.ca/SSG/ea01593e.html

Point de mire sur l'industrie de l'environnement, Québec, Ministère de l'Industrie, du Commerce, de la Science et de la Technologie, Gouvernment du Québec, 1995.

L'industrie de l'environnment dans les pays de l'OCDE: situation, perspective et politiques gouvernmentales, Paris Organisation de Cooperation et de Développement Economiques (OCDE), 1992.

The Global Environmental Goods and Services Industry, OCDE, Paris, 1996.

Environment Protection in China/ White Paper, People's Republic of China, Beijing, 1996.

The International Trade Business Plan: Environmental Equipment and Services 1995/1996, Ottawa, Supply and Services Canada, 1995.

Earth Summit-Agenda 21: The United Nations Program of Action from Rio de Janeiro 1992, United Nations Publications, 1992.

Current Environmental Problems and Initiatives, United Nations Development Program (UNDP) - China http://www.edu.un/undp//book, 1997.

Institutional Framework for Environment and Sustainable Development, United Nations Development Program (China) http://www.edu.un/undp//book, 1997

China 2020, World Bank, Washington D.C, 1997.

Clear Water, Blue Skies, World Bank, Washington D.C, 1997.

"Environment", Country Brief: China, World Bank, ftp.//monarch.worldbank.org/pub/decweb, 1997.