Development Policy
of Environmental Protection Industry in Macao and
Prioritized Fields of Cooperation with the Mainland

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Abstract

On the basis of the analysis of the status quo and the prospect of environmental protection development in Macao, the Mainland and the whole world, the research proposes the following suggestions for the development of policies for an Environmental Protection Industry (EPI) in Macao.

- To supplement and improve the existing environmental protection laws and regulations in Macao, especially, to strengthen environmental monitoring and implement relevant environmental economic policies
- To formulate sustainable development strategies and initiatives, push for the concept of sustainable development in Macao and elsewhere and establish sustainable cities
- To develop environmental education programs, cultivate environmental consciousness, and work on the next four topics: environmental basic education, environmental professional education and research, environmental training programs and environmental social education and publicity
- To improve and develop an EPI industry, and take the following measures:
  - Organize the corresponding organizations, companies or governmental institutions in the Mainland and arrange visits, through the local environmental protection institutions, to the environmental protection infrastructure and companies in Macao;
  - Establish an information platform of environmental protection in Macao by utilizing the internet;
  - Confirm an environmental protection structure and green infrastructure concept; and develop ecological tourism with Macao characteristics
Some further suggestions are proposed for the prioritized fields of cooperation in EPI between Macao and the Mainland.

- To push environmental cooperation and development under the general cooperative structure of “Closer Economic Partnership Arrangement between Macao and the Mainland” (CEPA for short)
- To get involved in the environmental protection plans of Guangdong, Hong Kong and Macao so as to create, overall, a strategic, visionary and scientific plan, and to solve the environmental problems through regional cooperation and development
- To popularize the experiences of operating public facilities in Macao in the Mainland from a marketing perspective
- To strive to become the agents of information and technological exchange between the Mainland and the Portuguese-speaking countries
- To cooperate with the Mainland and develop, jointly, a model environmental protection economy
1. The Status Quo and Prospects of EPI Development in Macao

1.1 The Economic, Social and Industrial Characteristics of Macao SAR

1.1.1 The Economic Status Quo

The economy in Macao resembles that of a mini island economy, whose development is unavoidably constricted by many aspects like market, resources and structure etc. Though the economic scale in Macao is not large, it plays a very important role in the regional economy and is an important window and bridge to connect the Mainland and the international markets, by virtue of its extroverted economy.  

Macao is an international free trade seaport. The 2001 policy report by the WTO pointed out that the economy of Macao SAR developed smoothly since it had been established, and Macao is still one of the most open areas in the world with the freest trading and investment policies. 

The industrial structure in Macao is quite unique, with tourism travel and gaming industries as the major economic pillars. In 2001, the local total production value was 49.81 billion Patacas. The gross production value is mainly in the tertiary industry, among which the gaming industry accounted for about 50% (including public administration, social service and private service). Then came finance and security, real estate, lease and commercial service; wholesale and retail, maintenance and repairs, hotels, and together with the manufacturing industry (the secondary industry) were provided by middle or small scale companies. In 2001, the local production value for each person was 114,726 Patacas.

As to foreign trade, the value of imports in 2002 was 20,323 million Patacas primarily coming from the Mainland, Hong Kong, EU, Japan, Taiwan, and America in descending order. The imported products mainly were raw materials, half-made products, consumption goods, manufactured goods, fuel and lubricants. The value of

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1 Macao Yearbook 2002, Macao SAR
2 Ditto
3 The Statistics and Census Service of Macao (the forth volume of 2002) c (DSEC for short)
4 2002 Macao Data The Statistics and Census Service
exported goods was 18,925 million Patacas and the main destinations were America, the European Union, the Mainland, Hong Kong and Taiwan, and the major exports were ready-made clothes, other textiles, shoes, machinery equipment, and parts.  

The number of newly-established companies in 2002 was 1,187, among which the wholesale and retail industry accounted for 40.7%, construction 8.1%, and manufacturing 4.6%. The number of failed companies was 99, among which were wholesale and retail industry 40.4% and construction 12.1%. The unemployment rate of the last three months in 2002 was 6.2%, the insufficient employment rate was 3.5%, and the employment pool was 198,000.  

1.1.2 Population Characteristics

According to the population statistical information from The Statistics and Census Service, the resident population was 442,000 by the December 31st, 2002, and the resident population was 435,235 based on the census of late August 2001, among which 48% were male and 52% female. Compared with the Census of 1991, the population of 2002 has an increase of 22.4%. Most of the residents lived in the Macao Peninsula, accounting for 89.29%, 9.6% of the residents lived in Taipa, 0.67% in Coloane, and 0.44% on the sea. More than 95% of the residents were Chinese.

The number of the travelers coming into Macao confirms Macao’s status as a tourist destination. Visitors to Macao exceeded 10 million in 2001 for the first time, and the number grew to 11,530,800 in 2002.

1.1.3 Education Background

A talented, skilled work force is an important asset for Macao. The education policy of Macao SAR government is to provide education for everyone and expand educational opportunities to meet current and future employment needs.

Macao offers ten years of free education. In the 2000/2001 academic year, there were 113 schools in pre-school, elementary, secondary and special education, among

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which 96 were privately-owned, and 81 were within the public school system. There were 99,576 students, 3,983 teachers, and the language of instruction was Chinese\(^7\). There were 14 schools providing special education and 122 schools providing adult education.\(^8\)

At the tertiary level, there are four public higher education institutes: University of Macao, Macao Polytechnic Institute, Institute for Tourism Studies and Escola Superior Das FSM. There are also 8 private higher education institutes: Asia International Open University (Macao), Macao Inter-university Institute, Macao European Studies Institute, Kiang Wu Nursing College of Macao, United Nations University International Institute for Software Technology, Macao University of Science and Technology, Macao Institute of Management, Macao Millennium College.\(^9\)

Based on the census of 2001, the distribution of residents over three-years old was as outlined in Table 1 below.\(^10\)

\(7\) Macao Yearbook 2002, Macao SAR  
\(8\) 2000/2001 Education Investigation, The Statistics and Census Service of Macao  
\(9\) Macao Yearbook 2002, Macao SAR  
Table 1 - the distribution of residents of and over three-years old according to education background

<table>
<thead>
<tr>
<th>Education Background (population of &amp; over 3-years old)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never in elementary school/pre-school education</td>
<td>41,831</td>
</tr>
<tr>
<td>Not yet finished elementary school</td>
<td>80,285</td>
</tr>
<tr>
<td>Finished elementary school</td>
<td>109,561</td>
</tr>
<tr>
<td>Finished lower secondary school</td>
<td>94,491</td>
</tr>
<tr>
<td>Finished upper secondary school</td>
<td>66,250</td>
</tr>
<tr>
<td>Higher education without college degree</td>
<td>7,481</td>
</tr>
<tr>
<td>Higher education with college degree</td>
<td>23,944</td>
</tr>
<tr>
<td>Special education</td>
<td>360</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>424,203</strong></td>
</tr>
</tbody>
</table>

The registered tertiary students of 2001/2002 academic year numbered 22,571, mainly majoring in economics and business management (74.88%), social and cultural science (7.41%), information technology and engineering fields (4.69%). See Table 2.  

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11 Macao High Education Information 2000/2001 the number of teaching staff and students, Higher Education Assistant Office
Table 2 - Distribution of registered students in higher education in 2001/2002 academic year

<table>
<thead>
<tr>
<th>Based on the degree and diploma</th>
<th>Registered student numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral degree</td>
<td>69</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>13,514</td>
</tr>
<tr>
<td>Post degree diploma</td>
<td>2,036</td>
</tr>
<tr>
<td>Undergraduate degree</td>
<td>4,316</td>
</tr>
<tr>
<td>High junior college degree</td>
<td>2,521</td>
</tr>
<tr>
<td>Diploma course</td>
<td>115</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22,571</strong></td>
</tr>
</tbody>
</table>

1.2 The significance of developing EPI in Macao SAR

With the increasing attention on environmental protection, sustainable development has become an important factor in the future development of Macao. Macao will develop an EPI by actively relying on its convenient connections with other regions and countries.

**Economic significance:**

1. To introduce the latest foreign environmental protection techniques into the Mainland by virtue of Macao’s unique position to model, develop platforms, and use its geographical location as a window on the Mainland.

2. To introduce environmental protection products and techniques of the Mainland to other countries, especially to Southeast Asia and Portuguese-speaking countries.

3. To benefit and enhance local production values of Macao.

4. To create more jobs for local people in the process of developing the industry.

5. To highlight Macao’s green image in international trade, to promote foreign investment and finance, to decrease trade risks and to promote the development of entertainment, exhibition and real estate industries.
Environmental protection significance:

1. To increase advanced environmental protection products and techniques.
2. To promote the development of an EPI and technological research.
3. To use and reuse natural resources effectively.
4. To assist in promoting the formulation of environmental protection regulations and laws.
5. To improve the environment of Macao through various industrial techniques.

Social significance:

1. To promote awareness of EP strategies.
2. To increase EP consciousness.
3. To encourage EP and consumption/conservation behaviors.
4. To highlight the quality and work of specialized experts.
5. To improve the living standard of the residents.

1.3 The Administrative Concept of EPI in Macao SAR

Mr. Ho Hou Wah, Chief Executive of the Macao SAR, pointed out in the administrative policy report of the 2002 fiscal year that, “With the development of the society, the economic structure will change in various degrees. In the recent years, Macao’s economy has undergone a great change, and tourism has developed rapidly. Soon, competition will be introduced into the gaming industry of Macao, tourism together with other concerned industries; will be the first to benefit from it. On the other hand, the ready-made clothes quota system will change dramatically in 2005, which will lead to a shift in the manufacturing industry of Macao. After observing the variety of changes and considering the advantages and conditions, we can easily see that Macao is forming a commercial structure, with gaming and tourism as leading industries, service as an integral support sector, and other industries developing harmoniously…”

The report promised “to make comprehensive consideration and harmonious arrangements of the infrastructure, education, training, technology, environmental protection etc.” and “at the same time, we are increasing support of emerging
industries such as the *EPI*, value added industries, and increasing the number of new economic growth industries...” “…The local government will function as a trading service platform along with the new conditions of China’s entry into the WTO…”  

The Macao government reaffirmed in the administrative policy report of the 2003 fiscal year that “…The basic idea to promote the industrial structure is to understand its focal points, and to consider multi-industries. Therefore, to find out new economic growth industries is the main thrust in the administrative policy initiatives for next year. Based on the development potential and local conditions, the government will cultivate and support emerging industries like exhibitions/conferences, offshore service, logistics, Chinese herbal medicine, environmental protection etc. The government will make technology work for the good of Macao through the efforts of the technology committee and creative center, and the help of the technology development fund. The government also hopes that the support of the emerging industries will stimulate the growth and vitality of the society and provide more opportunities for our citizens…” 

“… To make full use of the geographic and historical advantages and the close relation with Portuguese-speaking countries, the government will promote Macao as a contact platform and vital bridge for the EPI of China and other countries, especially for medium or small enterprises, so as to drive economic prosperity and sustainable development…”

1.4 The Description of the Status Quo of the EPI

In 2001, Macao SAR invested 301,144,388 Patacas in planning and environmental aspects, accounting for 3.2% of the total expense of public administration. 

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12 The administrative policy report of 2002 fiscal year of Macao SAR, PRC, 2001  
13 The administrative policy report of 2003 fiscal year of Macao SAR, PRC, 2002  
Diagram-1  The investment classification on planning and environment of Macao SAR

<table>
<thead>
<tr>
<th>STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Internal factors)</td>
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</tbody>
</table>

1. The policy support from the government, the directions the administration have suggested to establish a platform for EPI.

2. Taking China, especially the Guangdong market as the support. (It is estimated that there is a market of 700 billion Yuan in China in the next 5-10 years, among which the environmental protection investment in Guangdong will reach 10 billion Yuan, mainly in the treatment of ‘the three wastes’.)

3. Macao is a free trade seaport with a good relationship with the Mainland, EU and other Portuguese-speaking countries, and also is a member of the WTO.

4. Macao’s advantages in culture and language.
5. Compared with adjacent areas, Macao has advanced incineration and waste water treatment facilities.
6. Macao has experience of management by market forces.

<table>
<thead>
<tr>
<th>WEAKNESS</th>
<th>(Internal factors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The local market is too small to support the existence of a local EPI.</td>
<td></td>
</tr>
<tr>
<td>2. The limited land available constricts the development of some EP industries.</td>
<td></td>
</tr>
<tr>
<td>3. The lack of a specialized institute of EP and related industries.</td>
<td></td>
</tr>
<tr>
<td>4. The lack of professional experts in EP and environmental technology research and development.</td>
<td></td>
</tr>
<tr>
<td>5. The lack of comprehensive EP laws and regulations.</td>
<td></td>
</tr>
<tr>
<td>6. The lack of information and investment in the EPI.</td>
<td></td>
</tr>
<tr>
<td>7. Weak public awareness of the importance of EP initiatives.</td>
<td></td>
</tr>
<tr>
<td>8. The lack of local technologies.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPPORTUNITY</th>
<th>(External factors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The possibility to cooperate with the Mainland and to acquire support from the huge Mainland market.</td>
<td></td>
</tr>
<tr>
<td>2. The treatment of “the three wastes” is a common local concern</td>
<td></td>
</tr>
<tr>
<td>3. Macao takes the position that the tourism and gaming sectors will drive the overall economic development. Macao is in a period of economic transition internally and economic cooperation externally.</td>
<td></td>
</tr>
<tr>
<td>4. The establishment of the border processing/manufacturing district (CEPA).</td>
<td></td>
</tr>
<tr>
<td>5. ISO14000 certification has become more and more important.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THREAT</th>
<th>(External factors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Competition from adjoining areas.</td>
<td></td>
</tr>
<tr>
<td>2. Competition for skilled personnel, capital and advanced technology.</td>
<td></td>
</tr>
</tbody>
</table>
Table- 4 Strategic analysis mode concerning strength, weakness, opportunity and threat

(SWOT Matrix)

<table>
<thead>
<tr>
<th>Strategic analysis of Strengths and Opportunities (SO)</th>
<th>Strategic analysis of Weaknesses and Opportunities(WO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To make use of strengths and to seize opportunities.</td>
<td>To make use of opportunities and to overcome weaknesses.</td>
</tr>
<tr>
<td>1. To establish an extensive, cooperative relationship with the Mainland with support from the government.</td>
<td>1. To cooperate extensively with the Mainland and enlarge local EPI market, so as to provide more scope for the existence and growth of the industry.</td>
</tr>
<tr>
<td>2. To cooperate with the Mainland through regular experiences in market mechanisms.</td>
<td>2. To eliminate border limitations on industrial growth and expand markets through a wider network.</td>
</tr>
<tr>
<td>3. To establish a border processing district based on governmental support.</td>
<td>3. To increase the limited resources of Macao by establishing competitive and cooperative relationships.</td>
</tr>
<tr>
<td>4. To promote environmental management and ISO 14000 certification relying on the support of the government.</td>
<td>4. To introduce environmental protection awareness into the tourism and gaming industries.</td>
</tr>
<tr>
<td>5. To become a model site for the local treatment of garbage incineration and sewage treatment, taking advantage of a free trade seaport.</td>
<td>5. To attract investments into EPI through tax incentives and other policies.</td>
</tr>
</tbody>
</table>
Strategic analysis of Strengths and Threats (ST)

To use strengths and to relieve threats.
1. To achieve win-win situations by transforming the relationship with adjacent areas from competitive to cooperative.
2. To cherish and cultivate local talents and to attract talented personnel from outside with the support of government.

Strategic analysis of Weaknesses and Threats (WT)

To minimize weaknesses and threats.
1. By establishing an EP institute or awarding a supervisory function to an existing institute with government support.
2. By regularizing comprehensive EP methods in the development of EPI.
4. By supporting the development of local technology.

1.5 Main industries and products

It is a fact that key data of the EPI have not been sorted out systematically, so the study is only a basic analysis of the industries, according to available information.

1.5.1 The infrastructure and facilities of environmental protection

With knowledge of the emerging need for environmental protection in the world, Macao has invested several billion Patacas on many large-scale infrastructure projects in diversified fields to ease the pressure from a growing population and a vibrant economy. The following projects are governed primarily by market forces that adopt advanced technologies, to achieve high levels of cost control and effective utilization of human resources. These industries will be the models and benchmarks for developing future EPI platforms.

1.5.1.1 The incinerator center and garbage collection in Macao

Due to limited space, garbage treatment has always been a great challenge in Macao since the beginning of 20th century. For example, the garbage dump problem
in Sha Lei Tau in 1925 brought diseases like cholera. In 1983, garbage was sent to a temporary dump site in Taipa for storage. In the 1980s, the government began to study a systematic approach to improve the methods of garbage collection, transportation and treatment to solve the environmental problems caused by garbage. The chosen method was incineration, primarily, and sanitary landfill as a supplementary treatment.

In 1992, the collection of garbage was contracted to a private Hong Kong-US company, Macao Sanitation Specialized Co., Ltd (CSR). The costs were paid by government and the service quality was monitored by The Official Provisional Municipal Council of Macao.

Also in 1992, a modern garbage incinerator was built with a maximal daily treatment capacity of about 900 tons with due consideration for the environment. It was estimated that this center could meet the needs of a growing population for the next 20 years. It would not only relieve the pressure for more landfill sites but also treat all garbage by incineration. There are three production lines in the complex, all with the latest technology. The core of the incineration process has Martin GmbH technology that uses thermal energy from the three incinerators to produce steam and then drive a 12-mgw turbine to generate power by the steam. By transforming waste to energy, the power generated can not only support the daily use of incinerators, but also extend the public power network. With respect to air pollution control, to treat combusting gas effectively, the system is equipped with a solution exhaust purifier as an attachment, which uses lime as its essential component to neutralize the gas, thus removing the sour ingredient in the form of calcium salt. Then the purifier pours the lime solution through a sprayer, forming an atomized solution. This will make the calcium salt easier to mix with the gas stream and form precipitation in dust, that will be separated by the electrostatic dust remover. The dust remover uses 50-kws of high voltage, and the gas near the electrode produces an electrical corona effect as well as a negative electronic corona, and thus ionizes the calcium salt gas molecules, generated by the reaction between the dust and the lime, while burning waste. Then a large number of anions and cations are generated; that will immediately be neutralized by
the electrode, and the anions and free electrons then move towards the dust-gathering electrode and form a curtain of anions. Once the dust laden gas passes through this kind of dielectric medium, collisions between the particles within the dielectric medium or caused by the heat movement of ions, the particles will be electrically charged, instantaneously. Driven by the Coulombic force, these charged particles then would be caught separately on the dust-gathering electrode, causing the particles to be electrically neutralized and sink. The micro motes collected by the dust remover will first be stored in the basement and later transported to collection piles and landfills. The combustion operation and gas-exhausting conditions are all comprehensively monitored by computer systems. The sewage containing organic matters is first gathered from the waste storage pit. The sewage can be completely reused after filtering and being poured into the incinerators. Before being discharged into public drainage networks, the sewage must be neutralized first and be chemically treated by filters. The mud generated during the process will be sent back to the waste storage pit to be burnt. To reduce noise pollution, the incineration plant is also equipped with noise-restricting instruments, to maintain the noise outside the plant at not higher than 65 decibels (A) during the day and 50 decibels (A) at night.

The total investment in the incinerator plant equipment could reach as high as 550 million Patacas. The detailed plan was developed and managed by Consultores de Engenharia Sanitaria Lda/Goepefert, Reiner and Partners, and CESL Asia, the Far-East Branch of the Somaque Group of Portugal. The infrastructure contract of the Incinerator Plant was managed by Soares da Costa Corporation, a Portuguese-US joint enterprise. The bid for supplying precise electrical machinery equipment was won by Japan’s Mitsubishi. After the center was completed, the government awarded operational business contracts to Macao Tratamento de Resíduos, Lda, a Franco-Portuguese group, CGS of France and Macao’s AGS Sanitary Engineering Organization & Management Ltd., to be responsible for the company’s management. The Construction & Development Office of the government oversees its operation.
1.5.1.2 Macao’s Drinking Water

Before 1960, Macao’s drinking water source was completely self-sufficient, mainly from well water, river water and water from the mountains. Due to the sharp growth of Macao’s population during 1960s and 1970s, the original local natural water resources could not keep up with demand, and it was necessary to import water from other areas. In 1935, the government signed a 60-year-term specialized contract\textsuperscript{16} with Macao Tap Water Ltd., to ensure the supply of drinking water. This company was reorganized in 1985, and its major shareholder was the Sino-French Water Development Company Ltd., a joint venture between Hong Kong’s New World group and the French Suez-Lyons Group. The obsolete waterworks of Macao was upgraded into an entirely automatic water treatment center of a world class standard. The success of Macao’s water supply laid the groundwork for Sino-French Water Service to blaze new trails in China’s water supply service sector\textsuperscript{17}.

To guarantee Macao’s drinking water supply, the construction of the Modaomen water supply project started at the beginning of 1986 to ensure the supply, transportation and treatment of drinking water. At present almost all the unprocessed water supply comes from the Modaomen water course, within the Pearl River drainage area.

The unprocessed water is transported to pumping stations in the Mainland, first by gravity, then transported to the Ilha Verde water plant on the Macao peninsula to be processed, and after that is sent to the public water network by pumping stations. The rest is stored in the ZAPE reservoir to meet the demand during the dry periods in winter and spring. In addition, the Islands’ Seac Pai Van, Jiuao reservoir and the Hac Sa reservoir also store rain water.

In 2001, Macao’s total unprocessed water supply amounted to 56,700,000 cubic meters. Most water consumption was for household use (50.1%), followed by commercial use (30.9%), while industrial use accounted for a relatively low proportion (6.2%). In 2001, household average water consumption was 151 L/capita/\textsuperscript{16} A Series of books on Macao’s environmental protection- Drinking water of Macao, Environmental Committee, 2001\textsuperscript{17} http://www.sinofrench.com/intro/contentb5.htm
day, indicating a growing trend. The highest consumption was in the Macao peninsula. But as the population increased in Taipa in recent years, water consumption increased quickly.

Every day, the Macao SAR government Civic Chemical Examination Bureau extracts water samples at different outlets of water plants and the water supply network, and then carries out the microorganism and the physic-chemical analysis, to monitor the quality of drinking water and ensure that it meets the standard. The quality of the drinking water in Macao is in line with the European Union’s Drinking Water Sanitary Quality standard. Through the pipe network renewal, maintenance and the leak detection by Macao Water Supply Co. Ltd. the water-loss rate of Macao’s water supply network is comparatively low at about 12%.

Ultra Filter is one of most advanced drinking water processing technologies in today’s world. It boasts many advantages: the equipment is compact, the use of chemical treatment such as flocculate is not required, the quality of water processing is high and stable, and it is also highly automated, mobile and the construction cycle is short. Since 1989, the Macao Water Supply Co. Ltd. has done extensive research and tests on the Ultra Filter system’s structure, the material selected, the best operating conditions for the different qualities of unprocessed water and so on. With reference to the experience of French Lyon Water Service Group, the construction of au Ultra Filter demonstration plant was completed in 1991 with a daily output of 3,000 cubic meters of drinking water. In 1995, a new generation of the Ultra Filter system produced by Japan with a daily output of 3,500 cubic meters, was introduced by Lyon Water Service Group’s subsidiary company AQUASOURCE. A sales agency contract was signed with AQUASOURCE and the subsidiary company of Sino-France Water Services, Dongguan New Era Micro Filters Equipment Ltd, with an aim to develop the Chinese market together.

With respect to micro filter water processing technology, the Macao Water Supply Co. Ltd. has made significant breakthroughs in the study of the thin film micro filtered water processing since 1991. Guided by the film theory, based on modern micro filter technology, a summary of the latest drinking water processing technology
has been completed. It has many merits, including strong compatibility with the quality of unprocessed water, where the highest turbidity that can be processed is 3500NTU, the quality of the processed water is good and stable, low equipment costs, it’s relatively easy to manufacture complete sets of equipment, the installment area required is only 1/5 of previous ones, high mobility and short construction cycle and so on. In 1994, the company carried out technical cooperation with Dongguan Taiping Tap Water Company, and established a fully automated micro filter demonstration plant with a daily output of 4,000 cubic meters of drinking water. In 1994, Sino-France Water Service and Taiping Tap Water Company jointly set up Dongguan New Era Micro Filter Equipment Ltd., specialized in manufacturing complete sets of micro filter equipment.  

Macao’s Ilha Verda Ultra Filters demonstration plant and micro filters demonstration plant utilize experimental computer automatic monitoring with the application of thin film filtration water processing technology.  

In fact, Sino-France Water Service Ltd. is one of the biggest water service groups in the world; its main business is to invest, construct and manage water plants in China. At present, the group has 15 cooperative enterprises in China, and also provides technical and business management services for the domestic water services with over 130 million US dollars of actual investment and a daily water supply capacity of 3.23 million cubic meters. 

1.5.1.3 Macao’s Sewage Treatment  

As for sewage treatment, Macao once directly dispersed unprocessed sewage into the Pearl River, during the 1980s, causing the pollution of coastal waters. In order to improve Macao’s quality of life and solve the environmental problems caused by sewage, Macao began to formulate a series of large-scale environmental protection capital construction projects. Since the mid 1980s, the entire city’s ring-like sewer and the drainage system has been upgraded, and three airproof second-grade sewage 

\[18\] Macao Tap Water Company Ltd.  
\[19\] Ditto
treatment plants have been built at different stages at a total cost of approximately 520 million Patacas in the Macao peninsula, Taipa and Coloane, with a total handling capacity for a population of one million.

**Macao Sewage Treatment Plant**

The First Sewage Treatment Plant, located on the north part of the Macao peninsula, went into operation in 1995. With a handling capacity of 144,000 cubic meters/day it can meet needs of up to 500,000 people. When tenders were issued for the plant's construction, the government stated “no environmental pollution” as one contract condition, to ensure that this plant would not have a negative impact on the environment, while processing the sewage. The dirty water sent to the sewage plant is first poured into an adjoining cylinder of the pipeline to screen out the solid wastes longer than 6 mm in diameter. The sewage flows through the grit chamber equipped with dispersing devices, so the solid wastes, fat and sediment are removed. In the two-level processing system, the sludge passes through the biological treatment process to separate the active sludge in the aeration tank. The sludge then goes through the precipitation treatment again, in the new precipitating tank, which applies the advanced sloping plate precipitation principle to separate the active sludge contained within. After compacting the sludge and extracting the moisture, it is incinerated. Meanwhile, to handle the gas and unusual smell let off during the processes, and to neutralize the ashes left after burning, the plant is also equipped with an incinerator to burn the sludge produced by the three sewage treatment facilities.

The construction of the plant cost approximately 320 million patacas and the work was managed by a financial group formed by Teixeira Duarte Engenharia e Construções S.A., Sociedade de Construções Soares da Costa S.A. and Water Engineering Hong Kong Ltd..

In addition, the Macao SAR government has installed a 10,000 cubic meter storage tank at the Macao Sewage Treatment Plant in 2002 to solve the problem of overload in peak times in the rainy season,

**Taipa and Coloane Sewage Treatment Plants**

The Second Sewage Treatment Plant, built in 1996 at a cost of 110 million
Patacas, and located in the Taipa Pac On industrial district, has a processing capacity of 70,000 cubic meters/day. The Third Sewage Treatment Plant near the Seac Pai Van junkyard of Coloane, went into operation in 1999 and can handle 20,000 cubic meters/day. This plant still has second and third phases, which, if completed, will increase the total processing capacity to 60,000 cubic meters/day to meet the demands of the future developments in the Cotai Strip, formed by reclamation between the islands of Taipa and Coloane. The two plants use the single pond system (Unitank) developed by the Seghers Engineering Water N.U. to conduct secondary treatment of the sewage in airtight conditions, using a biological process on the ozone to guarantee zero pollution. The disposal procedures include the pretreatment (the elimination of solid waste and fat), the active sludge system, the sludge dewatering system and the biological ozone processing system. Compared with the traditional active sludge system, the single pond system uses an automatic cyclical operation on the sewage. This kind of agglomeration and regenerative process decreases the threat of the formation of bacteria. At the same time, because two processes are used, it is no longer necessary to let the active sludge backflow to the aeration tank from the precipitating tank.

The construction and the first three years of operation were awarded to Seghers Engineering Water N.U./CESL Asia, a joint Belgian/Portuguese group.

**Macao International Airport Sewage Treatment Plant**

In 2002, to perfect environmental protection capital construction and apply for UN “Global Five Hundred”, Macao SAR government contributed 42 million Patacas for additional primary and secondary sewage treatment plants near the Macao international airport. The plants’ design and operation will be managed by the Macao Water Power Engineering Ltd, and the construction period is expected to take 75 weeks.

The establishment of a sewage plant near the airport mainly focused on industrial level sewage that goes through dual treatments of floatation-pond and submerging-type aerobic biofilter before being delivered to Macao Sewage plant for further treatment. It is estimated that the sewage processing capacity is 20,000 cubic
meters/month when completed.

1.5.1.4 Power production in Macao

Power production in Macao started almost one century ago. At present, the monopoly, including generating power, input and output, distribution, allocation and purchase is held by the Macao Electricity Company, Ltd.

No alternative energy sources such as wind or solar are used in Macao. Therefore, the combustion of fuel is the only way to meet energy requirements. This has been the main source for pollution discharge. In the last ten years, the demand for power has increased significantly and will continue to grow with the expansion of the gaming industry in Macao.

According to EMEP/CORINAIR Atmospheric Emission Inventory Guidebook of European Economic Committee of UN, IPCC Guidelines for National Greenhouse Gas Inventories of Weather Change Specialized Committee between Governments, US EPA “Compilation of Air Pollutant Emission Factors, AP-42” and the technology of PARCOM/ATMOS Emission Factor Handbook, it is estimated that in the air emissions, the main pollutants from power production are oxysulfide, oxynitrogen, suspended particles and carbon dioxide. Then Macao Electricity Company Ltd. is the main source responsible for the air pollution and greenhouse gases in Macao.  

Currently, the power used in Macao is mainly provided by the Coloane Plants A and B while the power plant in Macao Peninsula only is for back-up.

Due to the use of low-speed diesel generating technology, the discharged waste gas can often be seen from the emission stacks of Plant A. To reduce the pollution, Macao Power Co., Ltd has signed a “Selective Catalytic and Reverting System” Plan with Burmeister & Wain Scandinavian Contractor A/S of Denmark to decrease the oxynitrogen, so as to research and test the effectiveness of various solutions and to propose an overall solution to decrease the impact on eco-environment from power use in Macao. The local government has approved the plan from Macao Electricity Co., Ltd and planned to invest 220 million Patacas in two years to reduce the amount.

of waste gas discharge.

In 1998 the government decided to build a new power plant near Plant A to meet the increasing demand for electricity. In the construction, the impact on the eco-environment was given careful consideration besides the operational cost, reliability and profitability. An advanced combined cycle gas turbine was selected. The new power plant was constructed in January 2000, with three combined recycling gas turbines, each with two gas turbines, two thermal recovery steam boilers, and one steam turbine. The plant was to be completed in 2003 and yield 38% of total power requirements, up to 488 mw. The investment amount for the whole plan was 1.2 billion Patacas.

The transformation of thermal energy from fuel into electricity is commonly used in power plants. Loss of energy is unavoidable in any method of energy transformation, but with the combined recycling technology that reuses the hot steam generated from steam turbines and minimizes the energy loss, thus helping to protect the environment.

At the same time, to decrease the impact on the environment, an incinerator with the maximal treatment capacity of 12 cubic meters was built, with advanced environmental protection technology, to handle the waste oil from power production. Also the waste gas from burning waste oil is under continuous supervision around the clock.

The Macao Electricity Co., Ltd was established in 1972 and 90% of the shares are held by two big shareholders. One of them is of Sino-France investments, represented mainly by the Suez-Lyons group and New World Infrastructure Company Limited. The other shareholder is a Portuguese group composed mainly of the EDP, while the Macao SAR government accounts for 8.16% of its shares.

1.5.2 Environmental protection products

The Macao market is not a major market for EP products. This is related to EP awareness, as well as source and price of these products. No information system is yet available on such issues. Local market currently supplies imported products such
as low energy-consuming household appliances, aerosol sprays that do not harm the ozone layer, writing materials, energy-saving equipment, hydro-vent, electrostatic filters, organically produced food, environmentally friendly paper, recycled paper, electric bicycles, three-phase catalytic converters, lead-free gasoline, low-sulfur diesel for cars with sulfur less than 0.05% in weight, sound-absorbing materials, equipment and software for environmental monitoring etc.

There is also little information available on production of EP products. It is estimated that only few companies whose business scope is in the production of corrugated paper, bio-degradable garbage bags, solar-energy pumps etc.

1.6 Environmental service industry

1.6.1 Environmental protection conferences and exhibitions

In recent years, the number of different types of seminars, academic conferences, exhibitions, and regional or international meetings is on the increase with the development of the economy and tourism in Macao and the attention on environmental protection. Previously, the Macao government co-sponsored two Guangdong-Macao EPI exhibitions with the Guangdong government. In 2000, MIF hosted by IPIM took environmental protection as its leading topic. The “2001 International Seminar and Exhibition on Sustainable Development and EPI” hosted by the Environmental Committee of Macao, with the State Environmental Protection Administration of China as a specially invited supporting institute and the China Environmental Protection Association as a specially invited hosting institution, was the first international meeting hosted by Macao concerning EPI, and also was a landmark for the development of EPI. The seminar on “Green Opportunity—the Trend of Global Environmental Protection and Green Trade”; “Macao Construction Exhibition in 2003”; “Fifth Seminar on Urban Sustainable Development of Guangdong-Macao-HongKong”; the 3rd EUREKA Plan with Exhibition and Seminar of Asian International Technology” hosted in the name of Macao SAR with the topic
“To build green industry and to seek sustainable development” were further signs of the SAR's strong interest in the EPI.

1.6.2 Environmental publicity and education service

Environmental publicity and education can be seen as a service market in EPI, because it includes different fields such as advertising and design, stage performances, marketing, and printing etc. According to data from The Statistics and Census Service of Macao, the SAR government had held 841 activities with 332 different groups under the theme of environmental protection and education in 2001, with 262,000 participants, and different types of environmental protection journals were published.

1.6.3 Environmental management and consultation service

The concept of an environmental management system was to benefit an organization’s efforts at self-improvement during the change process. Due to close relationship between trade and environment, it is clear that recognition from agency like ISO14000 environmental management system certification will help to improve a firm’s competitiveness in international export trade, and ease the barriers when export, especially to the European and American markets.

Actually, the number of firms having acquired ISO14000 certification keeps on increasing, from only 1 enterprise in 1999 to 8 organizations in 2002; including one industrial manufacturer, one garment manufacturer, one telecommunication maintenance service, two construction companies, and two sewage-treatment services. At the beginning of 2003, there were three firms applying for the certification. The related certification work is mainly supported by the Macao Productivity and Technology Transfer Center.

Environmental consultation services include environmental management,

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21 EUREKA is an European industrial development network which was founded in 1985. It is a structure composed by 31 European and EU industrial and research institutes. At present, there are nearly 3000 enterprises and research institutes engaging in EUREKA. The latest statistics show that the total investment on projects is 26 billion Euros, being 10.2 billion over 697 projects in the pipeline and 15.8 billion over completed projects.

22 Macao environmental status report of 2002, Macao environmental committee, 2003
environmental impact assessment, environmental monitoring advisory and consultative service (like ambient noise advisory and consultative service, car exhaust gas research consultation service etc), research and consultation service on environmental and ecological problems etc. As the market and the pool of experts in Macao are limited, this kind of service is usually provided by external groups or academic institutes (mainly from Hong Kong or the Mainland).

1.6.4 Talent training and environmental research

In talent training, there are no specialized courses in high schools or primary schools. Education on environmental science often mixes with subjects like general knowledge, geography, physics, biology and chemistry.

For higher education, there is civil and environmental engineering degree provided by the faculty of science technology of University of Macao. 137 bachelors and 47 masters were entitled ever since. There are also some relevant courses in the Macao Polytechnic Institute.

In professional training, government departments, academic institutes and groups have set up different courses like environmental management, summer training courses for teachers, training courses for environmental volunteers, noise monitoring, environmental law, “training in design and regulation of water-supply and drainage in cities”, “senior training on remote sensing technology”, “senior training on GIS” etc.

In environmental research, the investigators are mainly from academic institutes, professional groups and individual scholars like the University of Macao, the Macao development strategy research center, and different government departments such as the environmental committee, the Meteorological and Geophysical Bureau, Port Authority, Civic and Municipal Affairs Bureau and Health Bureau of Macao. They carry out environmental research and monitoring, sometimes against different environmental problems, mainly in areas of sources of air pollution, exhaust emissions from motor vehicles, pollution from all types of transportation, noise, hydrology, sediment pollution, quality of drinking water and coastal water, persistent
organic pollutants (POPs)\textsuperscript{23}, environmental management and city development strategy, environmental mathematic models, environmental legislation, etc.

1.6.5 Environmental monitoring

Environmental monitoring can be divided into four categories:

The first is monitoring by different government departments on air quality, drinking water quality, coastal water quality, car exhaust, automotive fuels, emissions from incinerators, excessive noise, etc, which account for the majority of environmental monitoring.

The second is monitoring by public services or contracted companies in their operation process such as monitoring of water quality by Macao Water Supply Company Limited, monitoring of the discharged gas by Macao Electricity Company Limited, the monitoring of the effluent discharged by sewage disposal factory.

The third is monitoring of the research by academic institutes.

The fourth is a monitoring service provided for private companies, such as monitoring of the effect of soundproofing products or equipment.

1.7 Waste Recycling & Reuse

1.7.1 Waste Recycling & Reuse

Due to the rapid growth of Macao's economy, the amount of garbage has been increasing. This trend continues at a rate higher than that of the local GNP. In 2001, the solid wastes collected by Macao Residue System Company, Ltd. amounted to 232,732 tons or 1.45 kg of wastes generated per capita every day, thus increasing the need for incinerators and land-fill sites. In 2002, the analysis of the fragments of incinerated solid wastes indicated that the wastes processed by the incinerator center contain considerable materials that can be recycled or reused like plastics, paper and cardboards, glass, cloth and metal.

At present Macao's waste paper, waste plastics and waste aluminum cans are generally collected by family industries and by garbage-collectors in addition to the

\textsuperscript{23} Persistent Organic Pollutants
collection via classification dustbins. Recycling processes are very simple too and the recycling market is not well developed.

Meanwhile, also due to the limited size of Macao’s market, though a lot of investors are interested in it, the high investment costs have discouraged new projects from starting or surviving. A computer printer cartridge-recycling factory in Macao was forced to relocate because of the insufficient number of cartridges gathered in Macao.

On the other hand, due to the lack of effective processing facilities, the wastes already collected usually have to be further processed in the Mainland. But their import and export are restricted by local regulations and so the development of the recycling industry has been limited.

1.7.2 Second-hand Market

The second-hand market is small and not well-developed, and mainly deals with disposed car parts, antiques from old houses, old books and used clothes donated to charity groups.

1.7.3 Maintenance Market

The maintenance market mainly deals with motor vehicles, small household appliances and authorized maintenance by manufacturers or their agents. The market is not vigorous.

1.8 Natural Eco-system

The land resources of Macao are very limited. How to balance the eco-system and residents’ quality of life while sustaining rapid economic growth is a question that must be faced in this period of rapid urbanization.

Macao pointed out under division of Transport and Public Works in its 2003 policy, “…Coloane will remain as a green city zone featuring vacation, sightseeing and ecological conservation…” and “…with the assistance of the Mainland experts, the government will draft a overall eco-protection plan, to gradually realize the
formation of a Coloane eco-zone…” 24

1.8.1 Green Zone

The increase of Macao peninsula’s green areas mainly come from the newly created resting areas, children’s playgrounds, safety islands and roadside greenbelts, while the increase of Taipa’s and Coloane’s green areas come from roadway median strips and traffic circles. These new greenbelts not only beautify the city, but also cover the land and prevent soil erosion.

In 2001, the trees on the Macao peninsula increased by about 4% over 2000, reaching 5,634.

In the heavily-planted areas of Coloane and Taipa, the newly-planted tree species are mainly imported and the majority of them are Taiwan acacia and big-leaf acacia. According to the statistics of 2001, the forested areas contain over 20 tree species, with altogether 412,000 trees25. The government plans to add some tree species with qualities of fire resistance, long life and fine form to enhance the areas’ anti-fire and beautification value.

1.8.2 Ecology Problems and Eco-invasion

The invasion of Mikania micrantha

In the past few years, “plants killer” Mikania micrantha has also been found in the suburbs of Macao. Mikania micrantha is a kind of branched, slender-stemmed perennial vine, native to Central and South America. It grows rapidly in places with high temperatures and humidity, and has strong regenerative ability. It often clings to and grows with other tree varieties, and kills them gradually by cutting out the light and preventing proper photosynthesis. It’s now rampant in South-East Asia and the Pearl River Delta. Due to its nature of being an alien invasive species, its natural enemies that can restrain its creeping have not been found. At present, it can only been removed by hand.

24 The Administrative Principles of Transportation Affairs of 2003, 2003
The experts at home and abroad are now carrying out relative studies with an aim to introduce Mikania micrantha’s natural enemies that won’t hurt indigenous species using eco-balance principles to achieve a balanced development of the whole eco-system. The neighboring areas of Macao, such as Hong Kong, Zhuhai and Shenzhen, are also confronted with the damage caused by Mikania micrantha. It is suggested that long-term exchange and cooperation be maintained with these areas to enhance investigations of the existing species resources and their ecological structure.

**Common Water Hyacinth**

The botanical name of the common water hyacinth is Eichhornia crassipes (Mart.) Solms, its synonyms also include Eichhornia speciosa Kunth, Heteranthera formosa, *Piaropus crassipes* and so on. It’s native to South America. Since common water hyacinths reproduce quickly and have a high nutritional value, especially in protein, they were introduced to China in many places. In the past, the farmers in Guangdong used their roots and leaves to feed pigs, chicken, ducks, geese and other domestic fowl. In recent years, with the popularization of manufactured feeds and reduction in the number of local private pig-raisers, the common water hyacinth has lost its original economic value, and degenerated into weeds that obstruct river courses.

The common water hyacinth is running rampant especially in waters of eutrophication. They drift along with the current and the wind to Macao’s inner harbor and outer harbor sea, especially to the inner harbor sea-route, the inner harbor wharf, and the Ilha Verde and Fai Chi Kei Shelter Ponds. The SAR government and the Government of Guangdong Province have set up a special task force under the environmental protection cooperative with specific responsibility, to seek and explore for solutions.

**Coastal Erosion**

In September and October 2000, the quantity of sand drained from the Hac Sa and the Cheoc Van beaches was high when compared with that of the previous few years. The loss of sand causes parts of the retaining walls and trees to collapse, and

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26 “Common Water Hyacinth does harm to the water of Macao” by Huang Jiushun, *Lotus Flower Magazine* Environmental Committee
27 Macao’s environmental status report of 2002, Environmental Committee, 2003
some trails are buried, thus impacting on the beach environment.

Although the beach is regarded as a dynamic equilibrium system, namely the sand drains or accumulates along the coast in a kind of natural and periodic phenomenon, in Macao, the sand outflow occurs generally in winter, but the accumulated inflow recorded in 2000 was insufficient to make up for the loss\textsuperscript{28}.

This kind of coastal decline may be caused by many factors such as wind, waves, storms, currents and so on. In addition, human activities such as land development, dredging, mining and breakwaters along the coast also may have negative influences on the beaches.

In 2001, the Port Authority asked the Macao Civil Engineering Laboratory to conduct research related to sea sand loss, while the Macao University is also conducting related research. At present Macao is carrying on a coastal erosion monitoring project, for the purpose of regularly gathering qualitative and site data of sea sand loss, discovering the reasons for the erosion and recommending proper control measures.\textsuperscript{29}

**Ecology Maintenance, Conservation and Eco-conservation Zone**

In the early 1980s, for the purpose of science studies, ecology, landscape and education, the Macao government established a protected zone of 198,060 square meters in Coloane (at current site of Seac Pai Van park) by promulgating the law 33/81/M and 30/84/M, with an aim to provide suitable resources for relative departments to protect Macao’s rare plant species, to develop new planting methods and to enrich the plant species variety. Now, this protected zone is an important site for the protection of the native mountain forest species of Macao.\textsuperscript{30}

Before the 1980s, the hilly areas of Taipa and Coloane were covered by verdant horsetail piney. But since the early 1980s, the piney was severely damaged by blight, 

\textsuperscript{28} 2002 Macao’s environmental status report of 2001, Environmental Committee, 2002

\textsuperscript{29} Macao’s environmental status report of 2002, Environmental Committee, 2003

\textsuperscript{30} Macao’s environmental status report of 2001, Environmental Committee, 2002
causing big patches to wither. Then the Macao Agriculture and Forestry Department accepted the Guangdong Province Agriculture & Forestry Department’s suggestion, and started to clear the horsetail piney from 1982 for planting of a mixed forest belt, and replanted trees. In 1999, the Provisional Municipal Council of Island invited again the Guangdong Province Agriculture & Forestry Department to carry out an integrated ecological and the environmental benefit appraisal of the 360 hectares of replanted forest in Taipa and Coloane. The result demonstrated that the overall growth conditions of the forest were good and played important roles with respect to dust-absorbing qualities, water source protection, soil and nutrient protection, absorption of carbon dioxide and the release of oxygen. Besides becoming a precious component of Macao’s ecological environment, it also provides vital opportunities for the residents to contact with nature.

With respect to coastal ecology, since Macao lies on the south-west side of the Pearl River Delta estuary, the area accumulates silt, rich in organic matter. At the same time, the salt and fresh water mix together along the coast. Blocked by natural and man-made obstacles, certain parts of the coast are less influenced by storms and waves. All these factors contribute to form an ecological environment suitable for the growth of a mangrove forest. Along the coast opposite to the seashore road, (the Taipa road, on the west side of the Coloane road), the mangrove forest once surpassed 50 hectares by 1970s, creating a precious shallow sea and tidal ecosystem. This mangrove forest withered gradually, as a result of land reclamation projects after 1992. To sustain the growth of a local mangrove forest, the Provisional Municipal Council of Islands started in 1998 to transplant part of the mangrove forest to the coast opposite to the Macao Jockey Club.

To effectively protect the mangrove forest resources and the biodiversity of Macao, in 2001, the Macao SAR government strategically decided to establish Macao’s first ecology conservation zone in the Coloane reclamation area, a space of about 55 hectares. The zone includes approximately 40 hectares of mangrove forest located on the west bank of the reclamation area for birds to seek food and a 15

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31 Macao’s environmental status report of 2001, Environmental Committee, 2002
hectares area close to this area for the birds to perch. Near the scope of the protected
zone, some Grade II national protected animals, including Black Face Aigret and
White Belly Sea Hawks have been discovered. At present this area is still under
construction. In the long term, this area’s effective development, maintenance and
management will play important roles in the growth of eco-tourism and ecological
education.

1.9 Others—Information Software

1.9.1 The Development of an Environmental Information System

Macao’s Environmental Geographical Information System serves as a
management tool to combine environmental data with the geographical characteristics
of the various districts, with an aim to set up an environmental database, which can
systematically gather, process and analyze the current environmental data of the SAR.
This can facilitate further studies of environmental conditions through mathematical
models using data already in the system.

The Environmental Committee, the Cartography and Cadastre Bureau jointly
developed this system in 1999. The collected data includes Macao’s air quality index,
air pollutants, meteorological data, tap water data, sewage processing load, wastes and
ambient noise monitoring data.

Many academic institutions, such as the University of Macao, and public utilities
such as Macao Water Supply Co. Ltd., and public administrative institutions such as
the Cadastre bureau and Land, Public Works and Transport Bureau, the Cultural
Affairs Bureau and the Civic and Municipal Affairs Bureau, are all developing a
geographic information system for different purposes. But, the respective geographic
information systems of different department have not established links. There is still
some reluctance to share information.

1.9.2 The Development of Environmental Software

In concert with the Meteorological and Geophysical Bureau of Macao in its
project to publicize the AQI, in 1998, University of Macao started the “Urban air
pollution management mixed system: AI and traditional simulation” research project with the name INTELAIR under the authorization of the Eureka International Project. The 500,000 Euro project has 7 partners from the Mainland China, Portugal, Britain, and Macao. The simulation model has passed beyond the experimental stage and is applicable to the forecast of air quality. In addition, the University of Macao has also developed the computer software named “Urban Scenic Lake Water Quality Simulation Forecast System” in partnership with Tsinghua University.

1.9.3 The Application of Environmental Software

Information about roads, traffic, the water supply network, city air and noise pollution evaluation and the socio-economic statistics are often used in city management and planning. Because these data have the distinctive spatial distribution feature, the geographic information system provides an effective tool to apply and process these data. In recent years, the related functional departments of the Macao SAR Government and the universities concerned have conducted their research respectively in geography, information technology development and applications, with some degree of success.

1.10 The Status quo of Macao’s Environmental Investment

According to the data from the Trade & Investment Promotion Bureau, there were altogether 8 business related projects concerning EPI in the last few years, and the total of planned investment amounts to about 100 million Patacas. There were 20 other proposed projects seeking investment funds.

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32 Macao’s Automatic Air Quality Forecast System (excerpts), Huang Qiming \ Tan Xizhong \ the 20th & 21st issue of Lotus Flower Magazine, Environmental Committee
### Table 5 - Investment Proposals Relative to EPI

<table>
<thead>
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### Table 6 - Investment Inquiries Relative to Environmental Protection Projects

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Sales of Environmental Protection Products    1
Environmental Protection Joint Ventures    1
Environmental Management Consultation Service    1
Totals    2 9 7 2

1.11 The Prospect of Macao to Develop an EPI

1.11.1 Environmental protection projects, architectural designs, plan, assessment and consultation service

The Macao SAR government is in the development phase of restructuring part of its economy to attract overseas investors. With the opportunities such as the expansion of the gaming industry and the East Asian Games to be held in 2005, using many new, large-scale facilities, basic construction projects involving extensive foreign investment funds are expected to boom in Macao. In line with the government’s idea of promoting sustainable development, the SAR government also must take into consideration environmental concerns while developing the economy, to safeguard and enhance, gradually, the quality of life for the citizens. While Macao’s own environmental protection market is small, it has the huge China market at its backdoor. In the future, along with the growth of tourism and entertainment industries, there will be increasing demands for environmentally friendly designs and constructions, environmental impact assessments, environmental consultation services, environmentally sensitive landscape architecture, and other specialized technical services, that will grow into an industry of considerable development potential in the long term. 33

33 The Opportunities and challenges in developing green industries for Hong Kong, the Pearl River Delta and Beyond, as illustrated by other international environmental management programs, James R. Mahoney, 2000
1.11.2 Urban Pollution Control Demonstration & Service Platform

Although a small place, Macao has invested a lot in its EP infra-structure. Macao boasts comparatively advanced incinerators and a large number of secondary treatment plants, with advanced technology and management systems developed overseas. Skilled managers with marketing experience can both reduce demands on government manpower and enhance cost benefits.

Some public utilities, such as water and electric power have also been improving production technology, management practices, and environmental pollution control technology, to meet the demands of Macao’s future development and enhance their competitiveness in the China market.

In the short term, the main industries mentioned above can serve as demonstration platforms of controlling pollution. By inviting managerial counterparts from Mainland enterprises to visit Macao is the first step to promote Macao as an exemplar of the EPI.

1.11.3 Ecological Environment Service

Over the years, Macao has demonstrated its conservation strategies in various ways: the preservation of Coloane’s natural assets, the development of an ecological conservation zone, the reforestation areas of Coloane, attention to the ecological invasion challenges, the inner-city gardens and the reforested design. In the future the emphasis put on these areas will promote the development of many services including ecological environment conservation service, ecological environment consultation and advisory services, research on ecological invasion, regional maintenance and management services, eco-tourism and ecological education.

1.11.4 The Business of Pollution Prevention Technology and its Instrumentation & Equipment

At present, Macao does not produce the instruments and equipment to prevent or control pollution. The majority of this equipment and technology is imported, such as waste incineration, sewage treatment, discharged waste gas treatment, automobile
exhaust control technology, and noise pollution prevention and control. Some of these technologies and equipments are also necessary in different areas to improve environment. Problems of how the middle and small enterprises handle the three types of wastes, how restaurants handle smoke from ventilations, how hotels implement energy saving and distillation system, and maintain lower cost for these technologies are all vital if Macao is to achieve its desired goal as a major tourism destination.

1.11.5 Business of Environmental Projects

Different sectors have environmental projects of different scope, such as the Praia Grande lake water quality treatment, incinerator installations and exhaust monitoring and research on sand loss at Hac Sa Beach. These all require different specialized knowledge, technology and experience and, with Macao’s growing attention to environmental protection, there are good prospects for creating an EPI in Macao.

1.11.6 Environment Management and Operation Service

There is a global movement for sustainable development, and modern states and organizations want to obtain environmental authentication like ISO14001 as social responsibility and to promote a ‘world class’ image and be competitive in the international market. EP is considered important particularly by some international enterprises. Industries such as construction, hotels, public services and garment manufacturing will have greater need for environmental consultation and environmental management verification, creating ample opportunities for the development of an EPI.

On the other hand, some professional environment businesses such as large scale incinerators and sewage treatment plants seemed to be saturated.

1.11.7 Specialized Training Service

To protect the environment and develop an EPI, human expertise is indispensable
and a skilled labor force is the key to success, because control, monitoring, research, and management, marketing activities all require specialized talents. Thus specialized training in such areas is extremely important.

1.11.8 Environmental Data Management Service

Current age is under dominance of advanced technology: exchange, process and analysis of environmental data and information system; using mathematical modeling to analyze, assess, predict and imitate environmental conditions; to broadcast and estimate catastrophes and danger, all depend on environmental data and relevant management such as making use of GPS to get exact locations. As environmental data system is still at a starting stage in Macao, there will be an increasing need of mathematical modeling and GPS system for data analysis and assessment.

1.11.9 Environmental Legal Consultation Service

At this point, Macao’s environmental legal framework is incomplete, and there is a need for technical research into various EP categories and legal regulations governing them, to create an advisory service.

1.11.10 Green Products and their Sales and Service

Macao’s green products production and sales market are not well-developed. There is the potential to grow a green consumption and green labeling advocacy lobby, through exhibitions and public education.

2. Status Quo and Prospects of the Mainland’s EPI

2.1 Status Quo of the Mainland’s EPI

2.1.1 Definition and Connotation of the Mainland’s EPI

The definition of China’s EPI is basically consistent with that of the OECD and the U.S. (See 3), i.e. EPI is defined as the industry that provides technical and product service support to environmental pollution prevention and treatment, ecological
conservation and reuse, effective resource use, fulfillment of people’s environmental needs, and social and economic sustainable development. It not only provides products to control environmental pollution and discharge reduction and treatment, garbage disposal etc., but also clean technologies and products, energy-saving technologies, ecological designs and other services related to improving the environment. It is mainly composed of five areas: production of environmental protection products, production of cleaner products, services of environmental protection, recycling of wastes, and protection of natural ecology.

Environmental protection products refer to the equipment and materials to prevent environmental pollution and to protect the eco-environment, and instruments especially designed for environmental monitoring.

Cleaner products refer to products which are environmentally friendly in their entire life cycle, and which are also non-hazardous or low-hazardous when used.

Environmental protection services refer to service and trade activities related to the environment, such as environmental technology, environmental consultation, management of contaminated facilities, recovery and disposal of waste and used resources, environmental trade and finance, environmental related functions etc.

Resource utilization refers to reuse of industrial waste materials, which include solid wastes, waste water, and waste gas.

Natural ecological conservation includes the construction of nature reserves and ecological model areas, and recovery and maintenance of damaged sites.

2.1.2 Development History

China’s EP related industry has witnessed a nearly 30 year period of development. The economy has shifted from resource consumption to resource saving and recycling, and the significance of an environmental protection related industry and support of a sustainable development strategy. It has moved from “physical technological basis for preventing environmental pollution and ecological destruction” to “meeting the public’s environmental needs and creating economic value”. The development of China’s environment related industry has undergone three stages:
1 Beginning stage (“EPI”, from the mid 1960s to early 1980s)

China’s EPI can be traced back to the mid and late 1960s. In the beginning, it was embodied as “the three wastes” treatment (waste water, waste gas, and waste residue) in trades like machinery, metallurgy, building materials, chemical engineering and etc, the main measure of which is to introduce foreign environmental protection facilities and technologies.

In the 1970s, as the country began to pay attention to environmental protection, industries gradually formed departments like scientific research, design, manufacture etc., by working on industrial pollution treatment, comprehensive utilization of the “three wastes” etc, and this constituted the basis of an EPI. However, the EPI at this time still remained at an initial stage and progress was slow.

In early 1980s, the central government clearly pointed out that “environmental protection is a basic state policy of China”. This provided the momentum to move to the preliminary development stage.
**Time evolution:** Beginning stage  Development stage  Rapid development stage

**Chart 2 - Process of EPI Development in China**

### 2 Development stage (“EPI”, from mid and late 1980s to mid 1990s)

With economic development, environmental issues became increasingly prominent. To solve these problems, the Chinese government has formulated a series of environmental protection guiding principles, policies, laws and regulations, standards and strengthened its environmental law enforcement efforts. The proportion of environmental protection investment in the economy has been increasing year after year, thus providing the foundation for the development of China’s environmental
protection policies. Ever since the 90s, with the increasing efforts in environmental treatment and ecological conservation by the government, the environmental protection policies, serving as the important legal and technological guarantees to China’s environmental protection lobby, there began a process of continuously balancing the needs of economic development with environmental protection. The focus of EP policy shifted from simply providing new environmental protection equipment to developing a multi-faceted approach affecting environmentally friendly manufacturing processes, environmental services, and environmentally friendly construction techniques.

3 Rapid development stage (“environment related industry”, from the late 90s till now)

From the late 90s till now, under the guidelines of a sustainable development strategy, environmental protection began to be seen as an “environment related industry.” During this period, the use of recycling, cleaner products (green products, environmental friendly products, products with low levels of pollution etc), environmental services, ecological construction projects and recovery that aim at improving the economy and people’s quality of life, have made quite fast progress as the benefits can be clearly seen.

During the 2003 NPC and CCPCC meetings, in reply to a question about foreign investment in China’s EPI, the State Environmental Protection Administrator stated that, “There’s great market potential in China’s EPI and foreign investors are welcomed. At present, the value of our EPI is about 170 billion Yuan, and it is growing at a rate of 15% each year. It is estimated that, from 2001 to 2005, our needs in environmental protection is to reach 700 billion Yuan. We welcome foreign enterprises in fields such as sewage and garbage disposal plants, power station de-sulphurization facilities, automobile emission treatment, and environmental consultation service industry etc. These areas provide vast market potential and there are no barriers for foreign investors to enter.”
2.1.3 Status Quo of EPI

Generally speaking, the current EPI in the Mainland does not meet development demands, regardless of its scale, structure, product quality, technology, service standard etc. Nevertheless, the Mainland possesses tremendous development potential. During the period of the “Ninth Five-Year Plan” (1996-2000), there were 18,000 corporate units in the Mainland managing environmental protection projects exclusively or cooperatively, with over 3 million employees. It is estimated that the Mainland EPI will maintain an annual growth rate of about 10-15%, and its output value will exceed RMB 200 billion by 2005. In comparison to 1997, number of corporate units running environmental protection related industries nearly doubled, with a 87% increase in workers, a 268% growth in total annual income, a 187% increase in total annual net profit, and a 73% and 53% increase in income per capita and net profit per capita, respectively.

The production value of environmental protection facilities in the Mainland is increasing by an average of 23% a year. Hopefully, it will increase from the 17.3 billion Yuan per year in 1997 to an anticipated 47.2 billion Yuan by 2010, with a growth rate much higher than the 7-8% growth of the GDP. Among all the sectors, the overall profit of EPI can be as much as 12% on average. Consequently, some of the financial investors, industrial corporations as well as military corporations in the Mainland have turned to EPI, making it one of the hottest industries of today. Aside from the Tibetan autonomous region, there are environmental protection industries in all provinces (cities) across the country, among which coastal and riverside provincial (municipal) industrial districts have the most rapid growth in EPI.

2.2 Related Legal System in Mainland China and General Overview of the Environmental Protection Objectives during the “Tenth Five-Year Plan”

2.2.1 Related Legal Systems

2.2.1.1 Formation of a Legal System for Environmental Protection in Mainland China

The current legal system for environmental protection in the Mainland is based on
the environmental protection regulations in the Constitution. It is a system which is formulated and issued by the concerned national environmental protection authorities, law enforcement agencies, administrative agencies and other related agencies in accordance to their functions and powers, and is composed of pollution prevention and treatment, environmental standards and other related lawful norms.

Since the 70s, a comprehensive industrial system has been established in the Mainland. But, a lack of effective safeguards against polluters plus a steadily expanding economy have resulted in a worsening situation of environmental pollution and ecological destruction. In 1973, China for the first time held a national conference on environmental protection, during which environmental protection guiding principles were developed and an environmental protection bureau was established. Among them, the “Regulations on Protecting and Improving the Environment (trial draft)”, the first comprehensive law on environmental protection in China, was endorsed by the State Council.

The administrative authorities in charge of environmental protection under the State Council and other concerning agencies have set up rules and standards in the environmental protection sector. Over 600 local laws and regulations have also been established in provinces, autonomous regions, special municipalities, municipalities and large cities and approved by the State Council. Local rules on environmental protection and regulations related to local environmental standards have also been worked out by local governments, with advice from experts. At present, there are already more than 360 environmental standards in the Mainland. The environmental protection laws are being gradually developed into a complete legal system.

2.2.1.2 Basic Content of the Legal System on Environmental Protection in Mainland China

China values environmental legal constructs. Currently, an environmental legal system has been produced, which has the “Constitution of the People’s Republic of China” as its basis and “Environmental Protection Law of the People’s Republic of China” as its main body.

1 The Constitution
“The Constitution of the People’s Republic of China” is a basic law of the Mainland. It enacts environmental protection laws and other special regulations, and serves as the legal basis and guiding principle for environmental protection law in China. The constitution provides that, “The country shall protect and improve the environment and the eco-systems, prevent and treat pollution and other dangers to the environment.” “The country shall guarantee the rational utilization of natural resources, safeguard precious animals and plants. All organizations and people are prohibited from seizing or destroying natural resources, by any means.”

2 The Basic Law on Environmental Protection

The “Law of the People’s Republic of China on Environmental Protection” is a comprehensive basic law on environmental protection, and a legal basis for setting up special protective measures. It is categorized as: objective and mission of environmental protection, targets under production, basic principles, rules and regulations, environmental supervision and management authorities, and other principal norms like legal responsibilities of environmental protection. This law establishes firmly the basic guidelines on economic build-up, social development and a coordinated development of environmental protection, stipulating the rights and responsibilities of environmental protection for governments at all levels and for all units and individuals.

3 Special Laws on Environmental Protection


At the same time, over 30 administrative regulations on environmental protection
have been introduced which include “Regulation on the Collection and Utilization of Pollution Discharge Fees”, “Regulation on the Prevention and Control of Noise Pollution”, “Regulation on Nature Reserves”, “Regulation on Safeguards against Radioactive Isotopes and Radioactivity”, “Regulation on the Safe Management of Hazardous Chemicals”, “Temporary Regulation on the Prevention and Control of Water Pollution in Huai River Areas”, “Regulation on Environmental Protection in Offshore Oil Exploration and Development Areas”, “Regulation on Dumping Wastes into Ocean Waters”, “Regulation on the Protection of Land and Wild Animals”, “Temporary Regulation on the Management of Famous Scenic Areas”, “Regulation on the Protection of Farmland”, “Regulation on Municipal Tree Planting” etc.. In addition to such promulgated laws, certain identified agencies have issued a great many administrative and technical rules aimed at reinforcing environmental protection practices.

4 Environmental Protection Standards

Environmental protection standards are defined as regulations formulated for the purpose of environment protection, pollution prevention and treatment, human health protection, resource protection and implementing environmental supervision and management.

Environmental protection standard is an important component of Chinese environmental law system. They include standards on environmental quality, pollution discharge, environmental principles, samples and methods, among which environmental quality standards and pollution discharge standards are classified as national and local standards, respectively. Chinese law stipulates that environmental quality standards and pollution discharge standards are mandatory and those who break them shall bear relevant legal responsibilities.

At the moment, standards such as environmental quality of the surface water, waste discharge from waste water disposal plants in cities and towns, effluent reuse, air pollution discharge from boilers, indoor air quality, domestic waste incineration pollution control, diesel and petrol powered motorcar exhaust etc., have been initiated or amended at both national and local levels.
5 Related Departmental Regulations of EP Laws

Among the departmental laws, civil, criminal, and commercial laws on environmental protection are subsumed. For instance, among the regulations concerning violation of national environmental protection and pollution prevention, there are regulations governing those who bring harm to others by polluting the environment. Also, there are consistent rules in “Regulations on Implementing the Law of Joint Ventures between China and Foreign Countries” ensuring that applications for establishing joint ventures that might cause pollution to the environment would be denied.

6 International Conventions on Environmental Protection acceded to by China


It should be pointed out that there is room for further improvement in China’s environmental legal system. For instance, in certain areas, there are still sections of legal ambiguity, or laws not obeyed or strictly enforced etc. To ensure enforceability, some laws require amending. Therefore, it is vital to reinforce the environmental legal system.

2.2.1.3 Basic Characteristics

Except for the general legal characteristics, the environmental protection laws in the Mainland have the following characteristics:

Scientific Relevance: environmental protection is based upon scientific ecological
patterns, principles; regulations and management systems based upon commonly accepted research achievements and technical regulations.

Comprehensiveness: environmental protection law touches upon substantive areas and is inclusive. It has basic laws as well as specific laws; it has equity laws as well as procedural laws; and it relates to administrative laws, economic laws, labor laws, civil laws, criminal laws and other regulations.

Regional Relevance: Mainland China is unique with its many cultural differences and economic disparity between and among provinces. For this reason, China’s environmental protection laws have regional characteristic. All provinces and cities are allowed to formulate related local regulations and standards in accordance with their local needs. For example, in order to implement national environmental protection laws, local peoples’ congresses and local governments have issued more than 600 regulations on environmental protection in light of specific local situations.

2.2.2 Summary of the Objectives of Environmental Protection during the “Tenth Five-Year Plan”

2.2.2.1 Objective of Environmental Protection during the “Tenth Five-Year Plan”

1 General Objective

By 2005, environmental pollution shall be reduced; damage to the eco-systems shall be contained; the environmental quality in cities and towns, especially in large and medium-sized cities and key areas, shall be improved; environmental protection laws, policies and management systems conforming to market economic systems shall be strengthened.

2 Specific Objectives

By 2005, sulphur dioxide, dust (smoke dust and industrial dust), COD, ammonia nitrogen, industrial solid wastes and other main pollutants discharge will be reduced by 10% compared to that of 2000; heavy metals, cyanogens, compounds, oil and pollutants in industrial waste water shall be brought under effective control; dangerous wastes shall be safely disposed.

The sulphur dioxide discharge in acid rain control zones and sulphur dioxide
control zones shall decrease by 20%, compared to that of 2000. Both rainfall acidity and acid rain frequency shall be reduced.

The planned objectives of water pollution prevention in key river basins and sea areas shall be realized; and water main quality standards will be raised.

Worsening of under water pollution shall be reversed; quality of water sources for centralized drinking water shall reach international standards; air, surface water, noise level quality in large and medium-sized cities shall be demonstrably improved, resulting model cities for national environmental protection.

The supervision of nuclear safety and radioactivity shall be greatly enhanced; radioactive levels of the discharge wastes of nuclear power plants and nuclear facilities shall conform to the international standard.

Unlawful destruction of the ecological environment shall be contained; key eco-systems shall be protected; the construction and management of the reserves and ecological pilot areas shall be improved.

Environmental protection in rural areas shall be strengthened; water quality of sources for public drinking water shall reach international standards; pollution from livestock and poultry cultivation shall be controlled; agricultural pollution shall be reduced; establishing models of ecological agricultural counties and creating cities and towns with beautiful environment.

2.2.2.2 Main Planning Index Related to EPI

1 Control quotas of total discharge of main pollutants
   - 18 million tons for sulphur dioxide discharge;
   - 20 million tons for dust (smoke dust and industrial dust) discharge;
   - 13 million tons for COD;
   - 1.65 million tons for ammonia nitrogen discharge;
   - 29 million tons for industrial solid waste discharge; and dangerous wastes shall be safely stored or disposed.

2 Quotas on industrial pollution prevention
   - 14.5 million tons for sulphur dioxide discharge;
- 8.5 million tons for smoke dust discharge;
- 9 million tons for dust discharge;
- 6.5 million tons for COD;
- 0.7 million tons for ammonia nitrogen discharge;
- Recycling utilization of industrial water reaches 60%;
- Comprehensive utilization of solid waste reaches 50%.

3 Quotas on urban environmental protection

- The air quality of 50% of the prefecture-level cities reaches state level 2;
- Surface water environmental quality of the 60% of the prefecture-level cities reaches standard level in accordance with their function areas;
- Noise on streets and highways of 50% of prefecture-level cities reaches state standard;
- A 45% rate of centralized disposal in urban daily polluted water;
- A 92% rate of gas usage for city dwellers;
- 0.15 million tons per day of garbage environmentally treated in newly established cities;
- A 35% coverage of green plants in developed urban areas.

4 Quotas on ecological conservation

- Nature reserves shall cover over 13% of the land area; maritime natural protection areas shall reach to 40 thousand square kilometers.
- A stable maintenance of natural forests, mature forests and old growth forested areas, and an increase in the stable growth of good quality forests
- A 60% reduction in new water erosion areas, spread of deserts and degraded grasslands;
- 25% recovery and treatment of former mining areas

5 Quota on rural environmental protection

- A standard level for environmental quality of centralized drinking water resources;
- A 95% burning-forbidden rate in balloonflower areas and an 80% comprehensive utilization rate of nation-wide balloonflower;
- quota rate of 60% for polluted water discharge in scaled livestock and poultry breeding places and a 70% resource reuse rate of excrements;
- Farmland irrigation water usage basically reaches the quality standard of farmland irrigation an overall enhancement of the quality and safety of agricultural products.

6 Quota for environmental protection in key areas

See Table 7 for the reduction plan for main pollutants discharge in key areas during the period of the “Tenth Five-Year Plan”.

Chart 7  Reduction Plan for Main Pollutants Discharge in Key Areas during the Period of “Tenth Five-Year Plan”

(Unit: ten thousand tons)

<table>
<thead>
<tr>
<th>Name of River Valley</th>
<th>COD</th>
<th>Total phosphorus</th>
<th>Ammonia Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 2000</td>
<td>Year 2005</td>
<td>Year 2000</td>
</tr>
<tr>
<td>Huai River</td>
<td>105.9</td>
<td>64.3</td>
<td>—</td>
</tr>
<tr>
<td>Hai River</td>
<td>158.4</td>
<td>106.5</td>
<td>—</td>
</tr>
<tr>
<td>Liao River</td>
<td>58.33</td>
<td>32.58</td>
<td>—</td>
</tr>
<tr>
<td>Tai Lake</td>
<td>49.15</td>
<td>37.81</td>
<td>1.44</td>
</tr>
<tr>
<td>Chao Lake</td>
<td>6.38</td>
<td>5.91</td>
<td>0.15</td>
</tr>
<tr>
<td>Dian Lake</td>
<td>4.39</td>
<td>3.52</td>
<td>0.13</td>
</tr>
<tr>
<td>Divert water from the south to</td>
<td>97.2</td>
<td>54.7</td>
<td>—</td>
</tr>
</tbody>
</table>
2.3 Analysis of Market Structure of EPI

2.3.1 Location Distribution

In 2000, the distribution areas of EPI in the Mainland were mainly centralized in seaside and riverside areas with developed economies. Among them, the total EPI annual income of both Zhejiang and Jiangsu provinces are over 20 billion RMB; the total amount of annual income of EPI is between 10-20 billion RMB in Shandong Guangdong, Liaoning and Hunan; total EPI annual income is about 5-10 billion RMB in Henan, Fujian, Shanghai, Hebei provinces (special municipalities) etc.

Since the twentieth centuries, the 90s, even though the EPI has speeded up its expansion towards the west, the EPI on the whole is still pretty vulnerable in the western 12 provinces (districts, cities). There were 2940 employed units in western areas in the year 2000, representing 16% of the total units employed nation-wide, and only 7% of the total employees around the country with its 220,000 employees. However, the units engaged in natural ecological conservation are mainly located in Liaoning, Hunan, Shandong, Henan and Heilongjiang provinces. Please refer to Table 8 for general information of EPI in other provinces, autonomous regions, and special municipalities.
Table 8 General Information of EPI in Provinces, Autonomous Regions, and Special Municipalities in 2000

<table>
<thead>
<tr>
<th>Area</th>
<th>Total amount of Units (Number)</th>
<th>Number of Employees (Person)</th>
<th>Total amount of annual income (100 million RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nation-wide</td>
<td>18, 144</td>
<td>3, 176, 178</td>
<td>1, 689.9</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>1, 967</td>
<td>159, 964</td>
<td>245.0</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>1, 711</td>
<td>163, 879</td>
<td>209.9</td>
</tr>
<tr>
<td>Shandong</td>
<td>1, 071</td>
<td>162, 392</td>
<td>187.1</td>
</tr>
<tr>
<td>Guangdong</td>
<td>1, 564</td>
<td>108, 690</td>
<td>143.5</td>
</tr>
<tr>
<td>Liaoning</td>
<td>872</td>
<td>156, 946</td>
<td>133.7</td>
</tr>
<tr>
<td>Hunan</td>
<td>1, 114</td>
<td>77, 083</td>
<td>100.4</td>
</tr>
<tr>
<td>Henan</td>
<td>831</td>
<td>820, 159</td>
<td>94.4</td>
</tr>
<tr>
<td>Fujian</td>
<td>965</td>
<td>48, 273</td>
<td>66.2</td>
</tr>
<tr>
<td>Shanghai</td>
<td>745</td>
<td>40, 466</td>
<td>62.7</td>
</tr>
<tr>
<td>Hebei</td>
<td>994</td>
<td>83, 740</td>
<td>59.7</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>464</td>
<td>798, 845</td>
<td>48.1</td>
</tr>
<tr>
<td>Shanxi</td>
<td>559</td>
<td>53, 382</td>
<td>43.9</td>
</tr>
<tr>
<td>Beijing</td>
<td>375</td>
<td>31, 157</td>
<td>39.8</td>
</tr>
<tr>
<td>Hubei</td>
<td>381</td>
<td>39, 293</td>
<td>32.7</td>
</tr>
<tr>
<td>Shanxi</td>
<td>643</td>
<td>104, 586</td>
<td>28.7</td>
</tr>
<tr>
<td>Jilin</td>
<td>393</td>
<td>42, 182</td>
<td>24.6</td>
</tr>
<tr>
<td>Guangxi</td>
<td>399</td>
<td>25, 580</td>
<td>24.1</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>321</td>
<td>29, 269</td>
<td>22.4</td>
</tr>
<tr>
<td>Tianjin</td>
<td>313</td>
<td>22, 926</td>
<td>20.7</td>
</tr>
<tr>
<td>Anhui</td>
<td>387</td>
<td>58, 425</td>
<td>20.3</td>
</tr>
<tr>
<td>Sichuan</td>
<td>420</td>
<td>32, 915</td>
<td>17.8</td>
</tr>
<tr>
<td>Yunnan</td>
<td>538</td>
<td>35, 933</td>
<td>16.2</td>
</tr>
<tr>
<td>Guizhou</td>
<td>223</td>
<td>17, 013</td>
<td>12.4</td>
</tr>
<tr>
<td>-------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Gansu</td>
<td>249</td>
<td>17,420</td>
<td>11.1</td>
</tr>
<tr>
<td>Chongqing</td>
<td>141</td>
<td>10,397</td>
<td>7.9</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>243</td>
<td>18,750</td>
<td>4.4</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>65</td>
<td>3,187</td>
<td>3.8</td>
</tr>
<tr>
<td>Hainan</td>
<td>93</td>
<td>5,468</td>
<td>3.1</td>
</tr>
<tr>
<td>Xinghai</td>
<td>28</td>
<td>1,019</td>
<td>2.7</td>
</tr>
<tr>
<td>Qingxia</td>
<td>74</td>
<td>6,811</td>
<td>2.7</td>
</tr>
<tr>
<td>Tibet</td>
<td>1</td>
<td>28</td>
<td>—</td>
</tr>
</tbody>
</table>

Source: *State Environmental Protection Administration of the People’s Republic of China, 2001*

2.3.2 Scale and Structure Characteristics of the Environmental Protection Market

2.3.2.1 Scale of Environmental Protection

According to the statistics, the market scale of the environmental protection in Mainland China amounted to US$ 2,930 million and 3,750 million in 1995 and 1997 respectively, as shown in Diagram-3 (following charts).

Classification Diagram of Environmental Protection Facilities in the Mainland China

(Unit: US$ Million)
Classification Chart of Environmental Service in the Mainland China  
(Unit: US$ Million)

Diagram 3

According to a nation-wide survey of environmental protection related industries, the total annual EPI income in 2000 was 168.99 billion RMB, with an average annual net profit of 16.67 billion RMB, total tax revenues of 21.68 billion Yuan, average income per capita of $53,200, and net profit of $5,200 per capita. The total EPI income was 1.9% of GDP for the same year, which is about 1.6 times the total investment in national environmental pollution treatments for the corresponding period of time. There were altogether 18,144 employed units in the EPI in the Mainland, among which 2487 enterprises and public institutions passed the certification of ISO9000 standard system.

Most of the environmental protection enterprises are small sized units, identified mainly by their fixed assets, i.e., there were 15,536 small scale economic units whose fixed assets were under 15 million Yuan, making up 85.6% of the total units; there were 1,418 medium size units whose fixed assets were between 15-50 million Yuan, constituting about 7.8% of the total units; there were 1,190 large sized economic units whose fixed assets were beyond 50 million Yuan, making up about 6.6% of the total
There were 3.176 million employed personnel in EPI across the country, among whom there are 2.023 million being employed by enterprises, making up 64% of total work force; there were 1.153 million staff in public institutions, constituting 36% of the total number of employees; there were 171,100 mid-level technical personnel, taking up 5.4% of the total number of employees. Please refer to Table 9 for the overall level of the scale of the EPI, nation-wide.

**Table 9: Scale of the Nation-Wide EPI**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>18,144</td>
<td>100</td>
</tr>
<tr>
<td>Professional unit numbers</td>
<td>12,806</td>
<td>71</td>
</tr>
<tr>
<td>Concurrent unit numbers</td>
<td>5,338</td>
<td>29</td>
</tr>
<tr>
<td>Original price of fixed asset for production and management (100 million Yuan)</td>
<td>84,84.7</td>
<td>—</td>
</tr>
<tr>
<td>Small-sized unit numbers</td>
<td>15,536</td>
<td>85.6</td>
</tr>
<tr>
<td>Medium-sized unit numbers</td>
<td>1,418</td>
<td>7.8</td>
</tr>
<tr>
<td>Large-sized unit numbers</td>
<td>1,190</td>
<td>6.6</td>
</tr>
<tr>
<td>Annual income (100 million Yuan)</td>
<td>1,689.9</td>
<td>—</td>
</tr>
<tr>
<td>Per capita (Yuan)</td>
<td>53,200</td>
<td>—</td>
</tr>
<tr>
<td>Annual profit (100 million Yuan)</td>
<td>166.7</td>
<td>—</td>
</tr>
<tr>
<td>Per capita (Yuan)</td>
<td>5,200</td>
<td>—</td>
</tr>
</tbody>
</table>

*Source: State Environmental Protection Agency of the People's Republic of China, 2001*
In the materials related to environmental protection issued by the State Environmental Protection Administration of the People’s Republic of China in December 2001, the survey covered a whole range of five fields of professional and concurrent environmental protection service, environmental protection facility production, waste recycling and reutilization, manufacturing of cleaner products, and natural ecological conservation in 31 provinces, autonomous regions and municipalities directly under the Central Government, except for Hong Kong and Macao Special Administrative Regions and the province of Taiwan. The above-mentioned five areas constitute, respectively, 51.7%, 19.8%, 13.5%, 7.8% and 7.2% of the total environmental protection units across the country, as shown in Table 10. The total amount of annual income of these five environmental protection areas is listed successively as environmental protection service, natural ecological conservation, manufacturing cleaner products, wastes recycling and reutilization and environmental protection facilities, taking up respectively 38.1%, 16.9%, 16.6%, 14.4% and 14% of the total amount of annual income of the national EPI.

**Table 10 - Statistics for the Five Main Areas of EPI in Mainland China, 2000**

<table>
<thead>
<tr>
<th>Item</th>
<th>Environmental Protection Services</th>
<th>Environmental Protection Equipment and Products</th>
<th>Waste Recycling &amp; Reutilization</th>
<th>Natural Ecological Conservation</th>
<th>Cleaner Products Manufacturing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Enterprise Units</td>
<td>9,890.0</td>
<td>3,786.0</td>
<td>2,590.0</td>
<td>1,482.0</td>
<td>1,370.0</td>
<td>19,118.0</td>
</tr>
<tr>
<td>Workers (10,000)</td>
<td>58.1</td>
<td>27.2</td>
<td>26.6</td>
<td>165.6</td>
<td>19.8</td>
<td>297.3</td>
</tr>
<tr>
<td>Total annual income (RMB 100 million)</td>
<td>—</td>
<td>27.8</td>
<td>41.7</td>
<td>—</td>
<td>36.1</td>
<td>105.6</td>
</tr>
<tr>
<td>Additional assets of</td>
<td>643.4</td>
<td>236.9</td>
<td>243.1</td>
<td>285.4</td>
<td>281.1</td>
<td>1,689.9</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>environmental protection within the year (100 million RMB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total annual profit (RMB100 million)</td>
<td>49.8</td>
<td>32.0</td>
<td>23.6</td>
<td>27.0</td>
<td>34.3</td>
<td>166.7</td>
</tr>
<tr>
<td>Earnings in export contracts (US$100 million)</td>
<td>7.1</td>
<td>1.0</td>
<td>0.5</td>
<td>0.8</td>
<td>4.7</td>
<td>14.1</td>
</tr>
<tr>
<td>Total industrial output of environmental related products (RMB100 million)</td>
<td>—</td>
<td>281.5</td>
<td>286.2</td>
<td>—</td>
<td>387.0</td>
<td>954.7</td>
</tr>
<tr>
<td>Industrial sales of environmental related products (RMB 100 million)</td>
<td>—</td>
<td>245.5</td>
<td>256.4</td>
<td>—</td>
<td>321.1</td>
<td>823.0</td>
</tr>
</tbody>
</table>

Note: Among the 18,144 enterprise units that have been included, about 5% are concurrently engaged in multi-faceted activities. This is the reason why the number of the enterprise units is 19,118 in this table.

Source: State Environmental Protection Administration, 2001

According to the total amount of annual income and annual profit as shown in table 10, although the item of environmental protection service has the highest total amount of annual income among the five main areas of EPI in the Mainland, its total profit is rather low in comparison with the other four main areas, when examining income and profit. By contrast, both the environmental facility products and the manufacture of cleaner products have relatively high profit potential, and merit being closely followed, as shown in Diagram 4.
Diagram 4 Statistics of Annual Income and Annual Profit of the Five Main Areas of EPI in Mainland China, 2000

*Source: State Environmental Protection Administration of the People’s Republic of China, 2001*

### 2.3.2.2 Structural Characteristics of the Environmental Protection Market

The environmental protection products manufacturing industry and environmental service industry are traditional businesses in the EPI. As shown by the surveys conducted in 1993, 1997 and 2000, there was an evident reduction in the numbers of employed units and employees in the manufacturing sector of environmental protection products, but an obvious increase in the total amount of its annual income; there was an evident increase in units and workers in the environmental service sector, with a big increase in annual income, with a trend towards centralization in the manufacturing sector of environmental protection products. The environmental service industry saw strong development. In addition, there has been rapid development in natural ecological conservation. Please refer to Table 11 for the development in the various fields of EPI in the Mainland, in 1993, 1997 and 2000 respectively.
## Table 11 Structural Characteristics of the EPI in Mainland China

<table>
<thead>
<tr>
<th>Areas</th>
<th>Annually</th>
<th>Employed Units (number)</th>
<th>Number of Employees (10 thousand persons)</th>
<th>Original Price of the Fixed Asset (100 million Yuan)</th>
<th>Total Amount of Annual Income (100 million Yuan)</th>
<th>Total Amount of Annual Profit (100 million Yuan)</th>
<th>Total Amount of Export Contracts (100 million US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>1993</td>
<td>8651</td>
<td>188.2</td>
<td>501.3</td>
<td>311.5</td>
<td>40.9</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>9090</td>
<td>169.9</td>
<td>839.2</td>
<td>459.2</td>
<td>58.1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>18144</td>
<td>317.6</td>
<td>8484.7</td>
<td>1689.9</td>
<td>166.7</td>
<td>14.1</td>
</tr>
<tr>
<td><strong>Environmental Protection Products</strong></td>
<td>1993</td>
<td>3158</td>
<td>51.7</td>
<td>101.0</td>
<td>104.0</td>
<td>13.4</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>4524</td>
<td>89.8</td>
<td>325.2</td>
<td>182.1</td>
<td>23.9</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>3786</td>
<td>27.2</td>
<td>201.9</td>
<td>236.98</td>
<td>32.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Cleaner products</strong></td>
<td>1993</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>110</td>
<td>2.7</td>
<td>11.8</td>
<td>21.6</td>
<td>2.4</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1370</td>
<td>19.8</td>
<td>332.4</td>
<td>281.1</td>
<td>34.3</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Environmental Service</strong></td>
<td>1993</td>
<td>3401</td>
<td>83.4</td>
<td>173.7</td>
<td>11.1</td>
<td>8.3</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>2364</td>
<td>24.7</td>
<td>123.7</td>
<td>57.8</td>
<td>8.3</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>9890</td>
<td>58.1</td>
<td>—</td>
<td>643.4</td>
<td>49.8</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Resource Recycling Utilization</strong></td>
<td>1993</td>
<td>2806</td>
<td>92.5</td>
<td>257.8</td>
<td>169.3</td>
<td>14.8</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>3491</td>
<td>63.3</td>
<td>369.4</td>
<td>181.4</td>
<td>19.4</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2950</td>
<td>26.6</td>
<td>—</td>
<td>243.1</td>
<td>23.6</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Natural Ecological conservation</strong></td>
<td>1993</td>
<td>425</td>
<td>13.4</td>
<td>1.2</td>
<td>27.1</td>
<td>4.4</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>322</td>
<td>8.4</td>
<td>9.1</td>
<td>16.3</td>
<td>4.1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1482</td>
<td>165.6</td>
<td>—</td>
<td>285.4</td>
<td>27.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*Source: State Environmental Protection Administration*
2.3.3 Summary of Technology and Markets in Five Main Areas

2.3.3.1 Environmental Service

The environmental service in China mainly refers to environment-related service trade activities, including environmental technical service, environmental consultation service, operation and management of pollution prevention facilities, waste resources recovery and disposal, environmental trade and financial service, environmental functional service etc. It has the biggest share of the EPI, the annual income of which constitutes 38% of national EPI, among which, the environmental technical service, environmental consultation service and waste resource recovery and disposal, have 90% of employed units of environmental service and 93% of the total workers. The waste resources recovery and disposal is the main source of the annual income of the environmental protection service, accounting for 80% of total annual income, with an annual profit of 3.66 billion RMB. See Table 12 for the income and annual profit of individual projects such as environmental technical service, environmental consultation service, polluted facilities operation and management, waste resources recovery and disposal, environmental trade and financial service, environmental functional service etc.

Table 12 Statistics of the Environmental Protection Related Structural Data in Mainland China, 2000 (Unit: 100 million RMB)

<table>
<thead>
<tr>
<th>Name of the Project</th>
<th>Employed Units</th>
<th>Number of Employees (10 thousand persons)</th>
<th>Annual Income</th>
<th>Annual Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Technical Service</td>
<td>5,155</td>
<td>13.1</td>
<td>97.3</td>
<td>9.7</td>
</tr>
<tr>
<td>Environmental Consultation</td>
<td>1,413</td>
<td>1.8</td>
<td>4.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Service</td>
<td>2000</td>
<td>2001</td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Polluted Facilities Operation and Management</td>
<td>521</td>
<td>3.2</td>
<td>5.8</td>
<td>-0.04</td>
</tr>
<tr>
<td>Waste Resources Recovery and Disposal</td>
<td>3,960</td>
<td>40.7</td>
<td>514.0</td>
<td>36.6</td>
</tr>
<tr>
<td>Professional Operation and Marketing of the EP Products in the Mainland’s Trade</td>
<td>644</td>
<td>1.0</td>
<td>21.4</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11,693</strong></td>
<td><strong>59.8</strong></td>
<td><strong>643.4</strong></td>
<td><strong>49.76</strong></td>
</tr>
</tbody>
</table>

Source: State Environmental Protection Administration of the People's Republic of China, 2001

1 Technical Service

The environmental technical service is composed of environmental technology and product development, environmental projects design and construction, environmental monitoring and analysis.

The annual income of environmental technology and product development was 1.26 billion Yuan in 2000. There were 378 employed units involved, 95 of which had an annual income of over 20 million Yuan (accounting for 89% of the total). The same year also witnessed 9,418 technologies being developed, 183 of which accomplished technical transfers. However, traditional scientific research institutes and universities and colleges were still the main force of environmental technical product development. The technical development system of the enterprises is yet to be formed. In future, if the above situation remains unchanged, the development and marketing of environmental technology and product development in the Mainland will be held back.

- environmental project design and constructions

In 2000, the total income of the design and construction of environmental projects
was 8.23 billion Yuan. Among the 1,453 employed units, 268 (amounting to 81% of total units) were units whose annual operation income exceeded 5 million Yuan; there were 493 units who received the qualification certificates for designing environmental pollution prevention and treatment, among which, 110 of Class A and 316 Class B on waste water; 109 of Class A and 182 Class B on waste gas; 66 Class A and 124 Class B on solid wastes; 14 Class A and 136 Class B on noise; and 3 Class B on ecology.

At present, China has a comprehensive capability in various pollution treatment projects, such as urban sewage disposal, industrial sewage disposal, effluent reutilization, dust removal and desulphurization, transportation pollution control, noise, vibration control etc. Nevertheless, China is still in the initial stage of developing its engineering technologies for toxic waste treatment and urban waste disposal.

### Environmental Monitoring and Analysis

The annual income of environmental monitoring and analysis sector in 2000 was 8.23 billion Yuan. Among the 1,822 employed units, 348 (amounting to 75% of total units) were units with an annual income of over 500 thousand Yuan. Those engaged in environmental monitoring and analyses are mainly scientific research and monitoring institutions on environmental protection in various environmental protection agencies and sectors. In recent years, a group of environmental engineering companies, universities and colleges have also entered the field of environmental monitoring and analysis service.

### 2 Environmental Consultations

The environmental consultation service consists of environmental impact assessment, environmental engineering strategies, environmental supervision, environmental management systems, product labeling and certification, organic food certification, environmental technology evaluation, evaluation of a product’s biological cycle, clean manufacturing auditing and staff training, and environmental information services.

Among the listed above, environmental impact assessment achieved an annual income of 3300 million Yuan in 2000, involving 724 employed units and 174 (76% of
total units) out of which are units with incomes of over 500 thousand Yuan. The employed units mainly come from environmental scientific research institutes of environmental protection agencies, various sectors, and universities and colleges. In recent years, private environmental consultation companies have entered the field. After more than 20 years of development and construction, the environmental influence evaluation has been improved day by day in its policy and legal regulations, team quality and technical regulations, and has played an important role in the environmental influence evaluation of China’s development, management, and construction projects.

Besides, other services including environmental management systems, product labeling and certification, information services, technology evaluation, auditing, engineering strategies and supervision earned 980 million Yuan in 2000, involving over 300 units.

Currently, the environmental consultation service is still in its preliminary development period. The major market for environmental consultation service is yet to be developed and the system needs to be strengthened.

3 Operation of environmental pollution treatment facilities

This sector achieved 0.58 billion Yuan of annual income in 2000, involving 521 units and 32,000 employees; 124 units have certificates for pollution treatment facility operations, running 681 operational management projects.

2.3.3.2 Environmental Protection Products

The environmental protection products refer to facilities for preventing environmental pollution and protecting eco-systems, manufacturing medicines and materials, and special monitoring facilities. An environmental product manufacturing system has been developed with many varieties, and its technology and products basically meet the needs of pollution treatment. Environmental protection products are mainly categorized as water pollution treatment facilities, air pollution treatment facilities, waste disposal and treatment facilities, noise and vibration control facilities, radioactivity pollution prevention, electromagnetic wave treatment facilities,
environmental monitoring equipment and facilities, environmentally based medicine and materials, accounting for 523 categories and 10,409 products.

According to the statistics of the State Environmental Protection Administration, environmental protection facilities took up 14% (about 23.65 billion RMB) of the total annual income of national EPI in 2000, as shown in Table 13. Besides, a survey on actual sales, income and profit of Chinese environmental protection products in 2000 showed that water pollution and air pollution prevention and treatment facilities are the most important, with actual sales of 9.45 billion and 9.11 billion, constituting 38.5% and 37.2% respectively of the total sales income of the product manufacturing industry. Together, they achieved a profit of 2.39 billion RMB (5% of the total sales profit of environmental protection facilities), as shown in Chart 5. High sales were closely related to the environmental protection policies promoted by the Central Government and higher annual profit for these products at the present stage. Taking into account environmental protection policies promoted in the Mainland, it is estimated that in the future, water pollution and air pollution prevention and treatment facilities will still be the main products required by the market.

Table 13 - Distribution of Environmental Protection Product Sales in Mainland China in 2000

(Unit: 100 million RMB)

<table>
<thead>
<tr>
<th>Item</th>
<th>Actual Sales Output</th>
<th>Sales Input</th>
<th>Sales Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution treatment facilities (176 categories)</td>
<td>94.5</td>
<td>87.4</td>
<td>12.6</td>
</tr>
<tr>
<td>Air pollution treatment facilities (102 categories)</td>
<td>91.1</td>
<td>92.5</td>
<td>11.3</td>
</tr>
<tr>
<td>Special medicine and materials for pollution treatment (45 categories)</td>
<td>24.1</td>
<td>22.9</td>
<td>3.0</td>
</tr>
<tr>
<td>Solid waste disposal and treatment facilities</td>
<td>14.2</td>
<td>13.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>
(33 categories)

| Environmental monitoring equipment (124 categories) | 13.0 | 12.9 | 2.4 |
| Noise and vibration control facilities (41 categories) | 8.1  | 7.6  | 1.0 |
| **Total** | **245.0** | **236.5** | **31.9** |

*Source: State Environmental Protection Administration, 2001*

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**Chart 5 - Sales Distribution of Various Environmental Protection Products in Mainland China**

### 1 Water Pollution Treatment Facilities

In 2000, water pollution treatment facilities achieved a sales total of 94.5 billion Yuan, involving 202 enterprises with annual sales over 10 million Yuan. The main products of water pollution treatment facilities are traditional separating equipment, chemical and oxidizing-process, biomembrane treatment, wind turbines, air exposure
machines (equipment), pumps, mixers, automatic controls and system facilities. Such products can meet the various challenges of handling industrial waste water, urban polluted water and industrial water treatment. In general, although manufacturing enterprises are mainly focused on individual facilities, this sector has improved rapidly and there has been progress as well in developing product varieties and technical capabilities. The main problems are: that the primary industry has many overlapping products; the high cost of manufacturing complete facilities for urban polluted water treatment and special industrial waste waster treatment; a shortage of computer control systems, membrane techniques, etc.

2 Air Pollution Treatment Facilities

In 2000, air pollution treatment facilities achieved sales of 9.11 billion Yuan, involving 181 enterprises whose annual sales were over 10 million Yuan. Its main products are dust removing facilities and simple desulphurization facilities, automobile discharge cleaning facilities, clean gas facilities etc. These account for 67.4% of the total sales of air pollution treatment facilities.

Dust removing facilities include multi-tubed precipitators, electrostatic precipitators, and fibre precipitators. They include small and medium sized wet desulphurization precipitators whose technical capability and product quality have basically met the market demands.

At present, the electronic dust removing technology in the Mainland has reached the current world standards. Pocket dust remover is, after the electronic dust removers, another kind of dust-removing technique in China, which is complete in its variety and high in its technical standard. Industrial facilities for removing dust from boiler smoke and desulphurization are mainly based on simple technologies. Nevertheless, there are still no Chinese-made power plant desulphurization facilities, due to a lack of technical expertise.

The current market for treating smoke and dust from small and medium size facilities is small and capability exceeds demand. The focus should be on improving current methods.

There were 45 enterprises for developing automobile emission purifiers in 2000,
with a sales of 0.54 billion Yuan. Some had passed the EU and American EPA standards.

According to technological classification, the Chinese-developed-and-produced purifiers for hazardous gas mainly include filtration techniques and facilities, condensation techniques and facilities, burning techniques and facilities, absorption techniques and facilities, and biological cleaning techniques and facilities. Among them, the biological purification technology is still in the experimental stage, due to the fact that there have been a large variety of poisonous and dangerous gases, which are complicated in compositions and difficult to treat. Also the employed units in this area are usually small in scale and inadequate in scientific expertise, resulting in a lack of reliable techniques for toxic gas treatment.

3 Solid Waste Disposal and Treatment Facilities

In 2000, the solid waste disposal and treatment facilities achieved sales of 1.42 billion Yuan, involving 89 manufacturing enterprises with annual sales of over 20 million Yuan. Since urban rubbish and industrial waste control is still a weak link in China’s environmental pollution controls, facilities for the disposal, treatment and comprehensive utilization of solid wastes are still in the initial stages. The 2000 survey showed that, the main products of solid wastes disposal and treatment facilities are rubbish recovery and transporting equipment, small and medium sized incineration facilities, pollution-free treatment facilities of industrial wastes, etc. Among them, design and manufacture of city garbage trucks is approaching levels of scale, while other items are still in preliminary stages. These include leakage-prevention materials for land-fill sites, machinery for garbage landfills, mechanized rubbish sorting equipment, composting facilities, large-sized incinerators etc.

4 Noise and Vibration Control Facilities

In 2000, the noise and vibration control facilities achieved sales of 0.81 billion Yuan, involving 65 manufacturing enterprises with annual sales of over 2 million Yuan. The market share of the noise and vibration control facilities was about 4 billion Yuan, among which noise engineering treatment took up about 30%, noise and
vibration control materials took up 40%, complete facilities for noise and vibration control constituted 30%. In 2002, the total investment in the emerging sector of sound protection shields near roads and rail lines exceeded 1 billion Yuan.

Noise and vibration control facilities can be divided into passive noise and vibration control facilities, active noise and vibration control equipment, and low-noise facilities. At present, China’s noise and vibration control mainly relies on the first approach, including noise absorption, noise elimination, and sound insulation, shock absorption equipment etc. These currently meet China’s needs and there is no big gap between their technical quality and that of the developed countries. China is a leading proponent of aspects of micropore noise absorption and noise elimination structures. However, in areas of manufacturing technical level, quality consistency, quality stability and product design, China still lags behind the developed countries. With regard to the passive noise and vibration control facilities, mature products have not entered the market in China, posing a large gap between China and foreign countries. There has been some progress in the development of ‘quiet’ products like air-blowers, cooling towers and electrical machines. However, when compared to foreign products, there is still big gap in the quality and technical refinement.

5 Environmental Monitoring Instruments and Facilities

In 2000, the environmental monitoring instruments and facilities achieved sales of 1.3 billion Yuan, involving 59 manufacturing enterprises with annual sales of over 2 million Yuan. These instruments and facilities have long been under developed in China. Their main products were water and air environmental monitoring instruments. There were other instruments to measure noise and vibration, radioactivity and electromagnetic wave, and soil conditions.

Monitoring instruments and facilities are divided into three categories of sampling and pre-sample treatment facilities, laboratory analysis instruments and facilities, and on-line monitoring instruments. They are divided into monitoring instruments and those for tracking origins of pollution. In general, the Chinese-made artificial sampling, laboratory analysis instruments and facilities can basically meet the needs of environmental monitoring. However, the varieties of the products and
reliability of the instruments still depend on imports, due to the country’s inability to conform to the international standards in monitoring environmental conditions.

6 Medicines and Materials

In 2000, materials for the purpose of pollution treatment had sales of 2.41 billion Yuan. The products are divided into four main categories: water treatment, air pollution prevention and treatment, solid waste disposal and treatment, and noise and vibration control, including coagulant, condensation drops, erosion moderation, dirt-blocking drops, insecticide, organism protective cloth, desulphurization drops, clean fill materials, ionic exchange resin, water filtration materials, air filtration materials, antiseptic materials, anti leakage, lining materials, sound insulation, and shock absorption materials.

There is pretty complete supply of most of the pollution treatment materials, to meet domestic needs. But there are still some gaps between China and developed countries in the quality stability, and performance consistency of the products. Though there is no big quality gap with foreign products in some professional enterprises.

2.3.3.3 Wastes Recycling Utilization

Waste recycling reutilization refers to the reutilization of solid wastes, waste water, and air.

The scale of waste recycling utilization in the Mainland has been expanding continuously. In 2000, industrial waste overall usage amounted to 0.355 billion tons during the project of industrial “three wastes” comprehensive utilization, among which the usage of coal waste reached 66 million tons and fly ash usage reached 70 million tons.

According to a survey on the EPI in 2000, based on waste and old materials recovery and waste recycling utilization, there were 3,960 employed units on waste and old materials recovery, ensuring jobs for 407 thousand employees, and annual revenue of 51.4 billion Yuan. There were 2,950 employed enterprises on waste recycling and utilization, with 266 thousand employees and sales of 25.64 billion Yuan, and the actual sales output of 81.2% of the total income from waste recycling.
See Table-14 for the statistics for annual income and annual profit of the waste recycling and reutilization in 2000.

Table 14- Statistics for annual income and annual profit of the waste recycling and reutilization, 2000 (Unit: 100 million RMB)

<table>
<thead>
<tr>
<th>Item</th>
<th>Actual sales output</th>
<th>Sales income</th>
<th>Sales profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid waste recycling reutilization</td>
<td>208.3</td>
<td>197.6</td>
<td>18.2</td>
</tr>
<tr>
<td>Waste water recycling and reutilization</td>
<td>29.6</td>
<td>27.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Waste air recycling and reutilization</td>
<td>18.5</td>
<td>17.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>256.4</td>
<td>243.1</td>
<td>23.6</td>
</tr>
</tbody>
</table>

Source: State Environmental Protection Administration, 2001

Waste recycling regulations in the Mainland need to be strengthened, as resource reutilization policies are difficult to implement, investments in the construction of recycling centers are insufficient, equipment is obsolete, and ecologically friendly technology is still in the embryonic stage. Much work needs to be done to improve and strengthen this sector of EPI.

2.3.3.4 Natural Ecological conservation

Natural ecological conservation includes three aspects, namely, the development of nature reserves, ecologically model areas, and ecological recovery and treatment.

In 2000, there were 1,482 enterprise units engaged in natural ecological conservation across the country, constituting 7.2% of the total enterprise units in EPI, providing jobs for 1.656 million employees who account for 55.7% of the total workforce in the EPI. The total annual income of the above-mentioned enterprises reached 28.54 billion Yuan, or 17% of the total income of the national ecological
conservation industry; the total annual profit of these units reached 2.7 billion Yuan, or 16% of the total profit of the EPI.

The construction of nature reserves cost 0.56 billion Yuan and yielded an annual profit of 0.14 billion Yuan; the construction of ecological pilot areas cost 25.88 billion RMB and returned 2.04 billion Yuan; ecological recovery and treatment cost 2.1 billion Yuan and returned 0.52 billion Yuan. The annual income from mine recovery and ecological construction work was 800 million Yuan, annual income from trees and grass planting was 0.55 billion Yuan, annual income from water and soil maintenance was 0.71 billion Yuan, and the annual income of the prevention and treatment of desertification was 200 million Yuan.

Natural ecological conservation relies mainly on the construction of ecological pilot areas that makes up 90.6% of the total. With regard to the projects required by “Tenth Five-Year Plan” of China’s environmental protection, the State Environmental Protection Administration of the People’s Republic of China will establish 120 national-level key ecological pilot areas as shown in Table 15, and the construction of the ecological pilot areas remains important in future development of natural ecology.

**Table 15 - Investment Needs for the Key Environmental Protection Projects**

**during the “Tenth Five-Year Plan” Period**

(Unit: 100 million Yuan RMB)

<table>
<thead>
<tr>
<th>Treatment Items</th>
<th>National Objectives</th>
<th>Anticipated Investment Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological conservation</td>
<td>To establish 15 ecologically functional protected areas, 120 key ecological pilot areas, 100 ecological agricultural forests, 40 pilot projects for rural pollution control and 50 nature reserves, and to enhance the management capability of 155 nature preserves.</td>
<td>500</td>
</tr>
<tr>
<td>Basic</td>
<td>Environmental supervision using survey data on</td>
<td>100</td>
</tr>
</tbody>
</table>
The Central Government has attached great importance to natural ecological conservation, which has been included in key plans. However, results to date are discouraging and leadership has not been especially effective. Rapid improvements are needed in agricultural ecological conservation, conservation of water resources, protection of nature reserves, ecological recovery of desertification and protection of the many varieties of botanical species.

2.3.3.5 Clean or Green products

Clean or Green products are defined as environmentally friendly products throughout their whole biological cycle. They are also known as environmentally-sound products or low public hazard products, low discharge products, biodegradable and reusable products, healthy products for protecting humans, energy-saving and water-saving products, organic foods etc. Among them are:

Low harm products include: low poison oil and latex paint, low poison adhesives, asbestos substitutes, mercury-free batteries, cadmium-free batteries and lead-free batteries.

Low discharge products include: low nitrogen oxygen compounds discharge burning incendiary facilities, phosphorus-free detergents, CFC substitutes, halone substitutes and zero-emission motor vehicles.

Degradable, retrievable, and reusable products include: biologically degradable packing materials, lubricants, disposable catering tools, and light (decomposable)
biological degradable membranes.

Low noise products include: quiet fans and cooling units, roller machines and woodworking machines.

Organic foods include: vegetables, fruit, milk products, livestock and poultry products, honey, aquatic products, and condiments.

In 2000, there were 1,370 employed units in this sector, with a sales volume of 32.1 billion Yuan, or 9% of the total retail sales of the same period in China; and 10% of these products met the certification standards for Clean/Green product labels. According to the statistical data from the State Environmental Protection Administration, sales of the Clean products depend mainly on low discharge, low poisonous and low pollution products, representing 58% of the total sales of the Clean/Green products, as shown in Table 16

<table>
<thead>
<tr>
<th>Item</th>
<th>Actual Sales Volume</th>
<th>Sales Income</th>
<th>Sales Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low poison and low pollution products (6 categories)</td>
<td>67.8</td>
<td>60.9</td>
<td>7.4</td>
</tr>
<tr>
<td>Low discharge products (8 categories)</td>
<td>118.2</td>
<td>96.3</td>
<td>11.8</td>
</tr>
<tr>
<td>Biologically degradable products (6 categories)</td>
<td>24.5</td>
<td>22.7</td>
<td>2</td>
</tr>
<tr>
<td>Low noise products (7 categories)</td>
<td>29.1</td>
<td>29.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Organic foods (10 categories)</td>
<td>18.8</td>
<td>22.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Others</td>
<td>62.7</td>
<td>49.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Total</td>
<td>321.1</td>
<td>281.1</td>
<td>34.3</td>
</tr>
</tbody>
</table>

Source: State Environmental Protection Administration of the People's Republic of China, 2001
The EPI in the Mainland has witnessed a rapid growth and continuous expansion. With the strengthened efforts by the Central Government in the environmental prevention and treatment and ecological conservation, the EPI has entered a period of rapid development. Aided by market forces, the scale of this industry has expanded rapidly and the industrial structure has become more rational. Though distribution is still focused in the eastern coast and major river valley areas, the industry is rapidly expanding in the west, with clear growth of its profits. Moreover, the overall supply can basically meet the demands of the development of China’s environmental protection lobby.

2.3.4 Classified Analysis of Listed Companies of EPI in Mainland China

2.3.4.1 General Situation

Not until 1997 when the first environmental protection company was listed did other listed companies that were mainly engaged in environmental protection fully come into being. Now, more and more listed companies have begun to endorse the EPI. In 2000, in the “sector attribution” after component share index adjusted to sample share in Shenzhen, there, for the first time, came the “EPI”. The environmental protection business has become an important source of profits among the companies involved in this field. Also, it has been a primary direction and objective for lots of listed companies, when they consider the industrial structure adjustment, strategic transfer, and diversified management.

At present, listed companies join the EPI mainly through the following means:

(1) Through companies which are mainly engaged in environmental protection business, namely Longjing Environmental Protection Co., Qinghua Purple Light Co., Kaidi Electric Power Co.

(2) By means of holding environmental protection related companies by raising funds, providing funds and buying shares; some of the companies involved are Precision Share Co., Yu Development Co., and Suibao Pyroelectricity Co..

(3) By developing environmental protection projects through fund raising; some listed companies that have taken this route are Yongan Forestry, Gas Share, Suweifu,
and Wanhui High & New.

(4) By seeking to implement a sustainable development strategy and environmental protection planning for their business; some listed companies involved are National Chemical Industry, North Shandong Chemical Industry, Capital Steel Share, Meili Paper Industry, and Fujian Three Agricultures.

According to related materials and the analysis of the annual reports of the listed companies, the overall quality of the listed companies engaged in EPI is rather high as shown from the 1999/2000 financial year:

1) good overall performance: there was no loss in normal nor listed EPI companies; rather, listed companies made an average profit of 0.34 Yuan per share, which was 1.7 times the average level of the listed companies in Shenzhen and Shanghai.

2) high growth: the net profit of the EPI and listed companies involved in the EPI achieved an average growth rate of 20.77%, while the average growth of the net profit of the listed companies in both Shenzhen and Shanghai was only 17.28% in the same year.

3) high value: the average net asset of the EPI and listed companies involved in the EPI was 2.571 Yuan per share, 3.54% higher than the average level of that of both Shenzhen and Shanghai.

4) high ability for profit-making: the average net asset profit of the listed companies involved in the EPI was 12.44%, while that of the listed companies in Shenzhen and Shanghai was 8.32%.

With good performance, high value, high growth, strong ability for profit-making of the EPI, the environmental protection related share has become gradually popular among the investors, especially medium and long-term investors and strategic investors, making obvious profits for them. Whether high-tech EPI or traditional industry transformed from environmental protection technology, the development potential of the EPI has not yet been fully realized in today’s share market, thus providing a rich prospect for its future development.
2.3.4.2 Industry Classification

The industry distribution of the listed companies engaged in environmental protection is rather extensive, involving businesses like metallurgy, chemical industry, papermaking, machinery manufacturing, energy and electric power, and car manufacturing. The following 10 main businesses related to the EPI are examined:

1 Machinery facilities for environmental protection and project installation

According to relevant surveys and statistics, water pollution prevention manufacturing facilities constitute 42.1% of the total output of the environmental protection products; air pollution prevention and treatment facilities take up 40.3%; solid waste disposal and treatment facilities 4.9%; noise and vibration control facilities 6.4%; monitoring equipment 2.2%; others 4.1%. As can be seen from the “List of Current EPI Facilities Encouraged by the State” that the water pollution treatment facilities, air pollution treatment facilities, solid waste disposal facilities, noise control facilities, environmental protection testing facilities, energy-saving and regenerative energy utilization facilities, facilities for resource overall usage and clean manufacturing facilities are consistent with the market demands of the EPI in the days to come and have good development prospects.

2 Polluted Water and Industrial Waste Disposal

There is a clear change in the structure of the environmental protection products, as the percentage of water pollution prevention and treatment facilities has surpassed the air pollution prevention and treatment facilities, reflecting the current situation of China’s environmental pollution and the direction of China’s environmental protection policies. It is obvious that the current situation of China’s water pollution is rather critical, the gravity of which is higher than the air pollution. Since 1990, the government has enhanced its efforts on water pollution prevention and treatment. The prevention and treatment of three rivers and three lakes in the program of “33211” fully demonstrated the government’s determination with respect to water pollution treatment. In 2000, the treatment of China’s urban polluted water disposal reached 20-30%, the industrial waste water disposal was 84%, and the regenerative rate of urban polluted water reached an average 10% of the total disposal. All these have
provided opportunities for the listed companies engaged in polluted water treatment.

3 Power Generation from Rubbish and Other New Energies and Rubbish Disposal

With regard to the environmental pollution caused by the electricity and power sector, power generation by using new energies is the best solution to pollution apart from vigorously developing clean gas technology and installing desulphurization, denitrogen and high effective dust removing facilities. Among them, the utilization of waste heat and power generation from rubbish are the primary targets of China’s new energy policy. Right now, Kaidi Electric Industry is one listed company engaged in power generation from rubbish, while others like Power in Southern Shenzhen, and Suibao are gradually entering this field. Thus it can be seen that, electric power listed companies are actively developing the marginal market of electric power by taking advantage of investment funds and technologies.

4 New Types of Environmental Construction Materials and Green Materials

The 21st century is a century of “green coverage”. Many contractors and consumers have taken notice of the impact that construction materials have on the health of human body and on the environment. People now are paying more attention to the natural and pollution-free features of the construction materials, thus resulting in a rapid growth of this market. At the same time, with a view to enhancing the industry of housing modernization and quality of the houses, the Ministry of Construction, State Economic and Trade Commission, State Bureau of Quality and Technical Supervision and other agencies pointedly issued a statement, demanding the elimination of a group of backward construction materials, and actively promoting the use of new and improved environmental protection oriented construction materials that conform to the state standard. In recent years, new commercial and residential buildings have popularized the use of resource-saving and better products, replacing the construction materials that do not accord with the standards of resource-saving and environmental protection. Other factors that have helped to provide a solid foundation for future development of these listed companies include a fresh look at the general situation of listed companies mainly engaged in green production and
environmental protection construction materials in Shenzhen and Shanghai, substantial growth of the market, and the active support of the state industrial policies.

5 Vehicle emission and noise disposal devices, clean gas and environmentally friendly, efficient trucks, cars and motorbikes

The listed companies engaged in automobile environmental protection are divided into following three categories: providing clean gas, producing car tailing gas and noise disposal devices, and producing environmental friendly trucks, cars, and motorbikes.

1) to improve gas quality. Clean gas development is the priority of car discharge pollution treatment in China, where existing exhaust problems have posed serious challenges in new types of environmental protection technologies. The first step in exhaust pollution prevention and treatment is to improve the quality of the fuel products which mainly rely on imports. Among the listed companies, Wuhan Petroleum has successfully developed high clean lead-free gas, indicating a grand market prospect.

2) With the worsening air pollution day by day, the problem of car tailing gas discharge is becoming more prominent. At present, this kind of product mainly depends on imports, and involves only a few domestic companies. Among the listed companies, Suweifu holds a monopoly in this field. The state’s determination in car pollution treatment aiming at changing the situation of worsening air environment has created vast market demands for the listed companies of this type.

3) Environmental protection and energy-saving car and motorbike products have become the competitive focus between various manufacturers.

6 Environmental protection treatment in the smelting process of the metallurgical industry

Concern for the environment has become a priority for listed companies in the metallurgy industry. Apart from making technical changes to their equipment to reach the requirements of environmental protection, these companies have stepped up their investment efforts in environmental protection facilities, by carrying out
comprehensive treatment on the environment within and surrounding the plants. Some listed companies that have shown outstanding results include Capital Steel Share, Shao Steel, and Songshan.

7 Environmental protection treatment and clean gas in green chemical industry and the production process of chemical industry

Green chemical industry refers to the activity of thoroughly reducing and eliminating the environmental pollution by the chemical industry, by taking advantage of chemical theories. It includes using highly selective chemical reflection to reduce wastes and to bring about “zero pollution”. At present, the environmental strategy of China’s chemical industry is chiefly, to comply with world development trends, improve the quality of oil products, reduce the amount of harmful materials, greatly reduce the discharge of “three wastes” by means of technical refinements, scientific research and development, and increasing investment in pollution prevention, improve the percentage of “three wastes” disposal and achieve “zero discharge”, produce more “green” products; improve overall recovery and utilization, with the three main wastes as the focus, and develop pollution-free technologies.

8 Comprehensive development of green agricultural chemical fertilizers

Developing highly effective environmentally harmless agricultural chemicals has been the main theme of future agricultural chemicals development. One characteristic of such chemicals is to restrict the damage from harmful materials to acceptable limits. Since China joined the WTO, it has been increasing its investments in agriculture, and moving it towards a market driven economy. This development has opened up markets for green and environmentally protective agricultural chemicals. Traditional agricultural chemicals with organic phosphorus, high residues and toxicity will be squeezed out of the market. Moreover, those green chemical fertilizers that won’t harm the soil will have vast markets.

9 Ecological agriculture and planting of forests

Compared to traditional agriculture and “Petroleum Agriculture”, ecological agriculture has good ecological profits, economic profits and environmental profits. Many of the listed companies engaged in ecological agriculture are using in
water-saving irrigation methods that mainly focus on sprinklers and drip irrigation. This has resulted in the wise use of water resources. The listed companies engaged in desert land development, soil rejuvenation, transformation of low and medium production farms, forests, woods, and flower plantations, have also committed to improving the agricultural environment. Seed production and natural agricultural sideline products are the main elements of China’s ecological agriculture. As early as 1984, the State had included “actively promote ecological agriculture and prevent the pollution and destruction of agricultural environment” in “Decisions of the State Council on the Environmental Protection Works”. Later on, the State made ecological agriculture one of the important measures of sustainable development in China, in “Suggestions on Formulating the ‘Ninth Five’ Plans of National Economic and Social Development and on the 2010 Vision Target”, “Report on Developing the Ecological Agriculture”, “China Agenda 21”.

10 Environmental technologies, consultations, assessments and monitoring

The Environmental Protection Service Industry is a late entry in China’s EPI. There is a big gap between China’s environmental protection service industry and that of developed countries. Nevertheless, foreign investors and companies are anxious to enter the Chinese markets, having clearly noticed the poor state of China’s environmental protection service industry. In order to face the challenges posed by foreign involvement in China’s environmental protection enterprises, listed companies in particular, must speed up their development efforts by providing the market with multiple services like pollution treatment technologies, environmental protection engineering design, technical consultation, environmental monitoring and assessment.

2.4 Future development prospects for the Mainland’s EPI

2.4.1 Problems and prospects Analysis of the development of the EPI

The future development prospects of the EPI in the Mainland will be examined through three aspects of demand, supply and market management. Generally speaking, all three have problems, but still, demand has been the main bottleneck in developing the Mainland’s EPI. Though there is great potential demand, actual demand is still low.
It is imperative to turn potential demand into real demand. Under the circumstances of the limited real demand, the market has been artificially twisted and unevenly developed because local governments of all levels are the only purchasers of EPI products.

2.4.1.1 General analysis of demand

There is huge market potential in environmental protection in the Mainland but true market demand is yet to be realized

(1) Analysis of the demanding is

The demand for environmental protection products and services come from four sources, namely, companies, families, the government and outside markets.

- Companies

Strict environmental legal regulations can enhance the demand for environmental protection products and services. There is vast market potential in aspects of waste water treatment, air pollution treatment and waste management (recovery and utilization of the materials). At present, most of the pollution prevention and treatment techniques are low-end. In future, the EPI will provide more advanced solutions, and this process can be greatly improved by implementing laws governing cleaner production, wise use of resources, and recycling economics. New regulations should solve problems such as the recovery of waste, old tyres, and domestic electricity/facilities. Environmental impact studies have been vital in decision-making. Relevant businesses should adopt tested (best) practical technologies.

It is useless if the legal regulations are too strict or enforcement too lax. The State must establish separate and high quality law enforcement agencies and make clear their responsibilities. Enforcement requires constant testing and supervision, which is also another important aspect of the EPI. When the role of the private organization is improved and expanded, law enforcement will be strengthened. Under the supervision of the government agencies, companies will remain in compliance.

Implementing market-based legal regulations should be further strengthened. Increasing penalties for polluters can promote the development of the EPI. This is
because it can make discharge-reducing technologies attractive to more investors, thus resulting in effective economic solutions where investment decisions are made by the companies.

All governmental subsidies that have brought negative impacts on environment should be re-evaluated and reduced. This can make those that are environmentally friendly more appealing while sparing the expenses on more environmental beneficial products. Tax incentives to these products should also be considered (such as value added tax).

It is imperative to further encourage companies to implement the environmental management system (ISO14001). The government in its purchases should give priority to such certificated companies or companies that support such standards, and learning networks.

- **Families**

So long as the environmental-friendly products are more expensive than ordinary ones (although more polluting) of the same category, the EPI can only succeed in special markets (rich “green consumers” market). The government can increase the price by putting higher taxes on high polluting products (e.g. gasoline). If private families must pay for the complete (biological cycle of the products) cost (including the social cost) for products that they have used, the energy-saving, water-saving, waste discharge reduction will become more attractive. Poor people can be subsidized

The government should invest in raising public awareness levels of the environment and green/clean products. Information printed on organic food labels and other products can help reduce the cost of consumers’ acquiring information about green products. However, it is for the independent third party agency to control the product standards and actively promote the advantages of green products; only this can ensure the effectiveness and credibility of the awareness campaign.

As living standards of urban dwellers improve, demands for household environmental products and services will increase as well. And become the new growth impetus for future EPI.

- **Government**
Governments at all levels are monopolies for the most part. Due to the lack of effective supervisory mechanisms on government purchases, the EPI has been artificially twisted. Tenders are awarded without competition, increasing the lopsided development of the EPI.

At the same time, government agencies can play the role of “main consumers” by purchasing environmental friendly products, even when these products are more expensive than conventional substitutes. This can help the environmental protection companies to reduce costs. However, transparent and fair procedures must be guaranteed. A “Law on Green Procurement” must be formulated at the earliest possible time, to standardize and regulate government’s environmental products purchasing practices.

The government should greatly increase its investment in infrastructure projects, such as restoration of polluted water system, public transportation, waste recovery and recycling systems and ecological recovery programs. All infrastructure facility planning should include investment in the avoidance of or compensation for negative environmental factors. The government can finance long-term projects by issuing public bonds, and redeem them with usage fees. Independent environmental impact studies can prevent investing in projects without social benefits.

- Outside demands (export)

This area can be ignored for the time being, as current export competitiveness is still weak.

2 Analysis of leading factors

- Economic development

China’s economic development is still growing, and this has brought about great pressures and severe challenges for the environment. At present, 66.9% of cities have exceeded second level air quality standards, with an annual sulphur dioxide discharge of 20 million tons. Acid rain is affecting 30% of the territorial areas, causing an economic loss of over 100 billion Yuan each year. Among the seven main rivers, there is serious pollution in the Liao, Hai, Huai, Yellow, and Songhua Rivers. River segments flowing through cities are generally polluted. Among the 141 state-owned
city river courses, 63.8% of them have water qualities between Level IV to as low as Level V. The trend of maritime environmental pollution is yet to be effectively controlled. There is severe over rich nutrition in large freshwater lakes. There are 0.78 billion tons of solid industrial wastes produced each year, 10.15 million tons of which are dangerous wastes.

The huge environmental pressures and challenges and the implementation of national sustainable development strategy have provided the EPI with rare development opportunities. According to the recent statistics by the State Economic and Trade Commission, if about 5% of coal-fired power plants could install scrubbers to remove sulphur in their emissions treatment each year, 6 billion plus Yuan of annual income would be gained; if the automotive industry could produce complete mufflers and exhaust purifiers, over 4 billion Yuan of annual income would result. Moreover, a large garbage incinerator requires about 0.6 billion Yuan of investment. This constitutes vast market demands as there are more than 600 cities. Ecological projects also offer huge markets. Important ones are desertification prevention, soil erosion prevention and treatment, and mining ecological recovery zones.

In addition, according the “Tenth Five-Year Plan” on China’s environmental protection issued by the State Environmental Protection Administration, at least 7 billion Yuan is to be invested during the whole “Tenth Five-Year Plan” period. The main source of investment funds will come both from the government and business, or 56% and 44% respectively, of the total funds.

Please refer to Table 17 for the key environmental protection prevention and treatment projects and relevant funding requirements.

<table>
<thead>
<tr>
<th>Treatment Items</th>
<th>Engineering Requirements</th>
<th>Required Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Table 17 Investment Needs for the Key Environmental Protection Prevention and Treatment Projects during the Period of “Tenth Five-Year Plan” Planning (Unit: 100 million Yuan)
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution</td>
<td>5 million tons of reduction in COD discharge; additional capacity of 26 million tons/per day for the</td>
<td>additional capacity of 26 million tons/per day for the centralized disposal of urban polluted water, 2.5</td>
<td>2,700</td>
</tr>
<tr>
<td></td>
<td>centralized disposal of urban polluted water, 2.5 million tons annual reduction in chemical oxygen</td>
<td>million tons of annual reduction in chemical oxygen of industrial pollution resources, 0.5 million tons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>discharge, 2 million tons of annual reduction in chemical oxygen of industrial pollution resources, 0.5</td>
<td>of COD reduction in the scaled breeding of livestock and poultry, and comprehensive treatment of the lakes,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>million tons of annual reduction in chemical oxygen of industrial pollution resources, 0.5 million tons</td>
<td>rivers and seacoasts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of COD reduction in the scaled breeding of livestock and poultry, and comprehensive treatment of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lakes, rivers and seacoasts.</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air pollution</td>
<td>The investments are mainly used in coal cleaning, selection and processing, desulphurization of the</td>
<td>The investments are mainly used in coal cleaning, selection and processing, desulphurization of the</td>
<td>2,800</td>
</tr>
<tr>
<td></td>
<td>fire power-generation plants, clean energy for cities, industrial waste gas treatment. 4.6 million</td>
<td>fire power-generation plants, clean energy for cities, industrial waste gas treatment. 4.6 million</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tons of sulphur dioxide and 5 million tons of dust must be reduced, pollution prevention and treatment of</td>
<td>sulphur dioxide and 5 million tons of dust must be reduced, pollution prevention and treatment of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>combustion engine vehicles.</td>
<td>combustion engine vehicles.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid wastes</td>
<td>150 thousand tons per day of pollution-free rubbish treatment in newly established cities, 5,000 tons</td>
<td>150 thousand tons per day of pollution-free rubbish treatment in newly established cities, 5,000 tons</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>per day of dangerous waste treatment, 1,650 tons per day of medical waste treatment, and comprehensive</td>
<td>per day of dangerous waste treatment, 1,650 tons per day of medical waste treatment, and comprehensive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>utilization and disposal of industrial solid wastes.</td>
<td>utilization and disposal of industrial solid wastes.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological</td>
<td>To set up 15 ecological functional protection areas and 120 key ecological pilot areas, 100 ecological</td>
<td>To set up 15 ecological functional protection areas and 120 key ecological pilot areas, 100 ecological</td>
<td>500</td>
</tr>
<tr>
<td>conservation</td>
<td>agricultural forests, 40 agricultural pollution control pilot projects and 50 nature reserves, and to</td>
<td>agricultural forests, 40 agricultural pollution control pilot projects and 50 nature reserves, and to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>improve the management capability of current nature reserves.</td>
<td>improve the management capability of current nature reserves.</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Construction</td>
<td>Environmental supervision and surveys of biological/botanical varieties, ecological functional areas,</td>
<td>Environmental supervision and surveys of biological/botanical varieties, ecological functional areas,</td>
<td>100</td>
</tr>
<tr>
<td>of basic</td>
<td>environmental planning in river valleys, and</td>
<td>environmental planning in river valleys, and</td>
<td></td>
</tr>
<tr>
<td>capacities</td>
<td></td>
<td></td>
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</tbody>
</table>
New products and investors have provided tremendous incentives for EPI development. Based on the growth rate of the “Ninth Five”, during the period of the “Tenth Five-Year Plan”, China’s EPI has maintained an average annual growth of 10-15%. Incomplete statistics show that the total output of China’s EPI will exceed 200 billion Yuan, and the total may amount to 300 billion Yuan by 2005. Therefore, it is reasonable to believe that the EPI is about to be one of the most significant new economic growth engines in China.

- Environmental Management Policies

Two things are required to transform the EPI potential markets to reality; one is to increase the investment in environmental protection, and the other is strict environmental management practices and supervision efforts in environmental protection. Creating a practical market for EPI can be achieved by the compulsory and standardized application of the regulations governing the protection of the environment.

During the period of “Ninth Five-Year Plan”, the Chinese government formulated in succession the prevention and treatment planning on “Three Rivers and Three Lakes”, planning on “Two Control Zones” (sulphur dioxide and acid rain control areas), control over total waste volume and “One Control and Double Attainment” that greatly accelerated the transformation of environmental protection potential markets into real markets. The “Law of the People’s Republic of China on Air Pollution Prevention and Treatment” implemented in 2000 clearly stated that it was illegal to surpass the set standard, and pointed out that total volume control systems
and disposal of certified waste systems shall be established based on the law, with zero starting point charge. This helped to focus attention on the low discharge fee for polluted materials when compared with the treatment cost, which discourages companies from investing in pollution prevention and treatment. For instance, those newly built coal-fired power plants whose sulphur dioxide discharges cannot reach the required standard must set up coordinated smoke and gas desulphurization facilities. This has greatly enhanced the development of the smoke and gas desulphurization industry; for those existing enterprises whose waste discharge exceeds the standard, inspection and monitoring shall be conducted, ensuring that the firms take effective measures to accelerate pollution treatment and undertake renovations within definite time limits; for companies that can’t reach the required standard in time, measures such as closing, changing the line of production, cutting production and suspending production, to improve management and performance shall be taken based on the pertinent regulations. At present, relevant agencies have undertaken special action to severely deal with pollution that exceeds the current standard. This approach will have a positive impact on the creation of real EPI markets.

One of the key issues in the economic and social development during the period of “Tenth Five-Year Plan” is to reduce environmental pollution, contain the worsening of the ecological environment and improve the environmental quality in the key cities and surrounding areas. Seen from the macro perspective, the development of environmental protection is rather optimistic. Therefore, formulating practical economic policies and strengthening supervision management are the keys to nurturing environmental protection market demands and improving the development of the EPI.

3 Analysis of investment demands during the “Tenth Five-Year Plan” period

China’s EPI has a grand future and great investment needs, requiring government, society, and business to promote the industry and strengthen the market. Up to 2002, the nation-wide investment in environmental pollution treatment was 136.34 billion Yuan, or 1.33% of total domestic production. Among which, investment in urban environmental infrastructure construction was 78.53 billion Yuan, 18.84 billion Yuan
of investment in industrial source-pollution treatment (7.15 billion Yuan of investment in waste water treatment, and 6.98 billion Yuan of investment in waste gas treatment, 1.61 billion Yuan of investment in solid waste treatment and 3.1 billion Yuan of investment in other treatments); and 38.97 billion Yuan of environmental protection investment as required by the “Three Simultaneities” when building up new projects. With the implementation of these projects, especially thanks to State financial policies and funding, the market for the construction of environmental infrastructures on urban polluted water and urban rubbish has been comprehensively promoted.

According to the relevant statistics, during the “Tenth Five-Year Plan” period, the overall investments by government, society and business are:

- **Governmental investment**: includes construction programs such as urban environmental protection infrastructure, comprehensive treatment, ecological conservation and capacity building, totaling 394 billion Yuan or 56% of the total investment needs. This amount comes from local governments at all levels, and originates mainly from the maintenance fee of urban constructions, infrastructure investment and local fees and taxes. During the “Tenth Five-Year Plan” period, the State will increase its investment in environmental protection, which will be focused on aid for pollution treatment programs in major projects in Beijing, its environs, and some key areas, including the Three Gorges, diverting water from the south to the north, “Three Rivers and Three Lakes”, “Two Control Zones”.

- **Business investment**: 306 billion Yuan of investment has been required for industrial pollution treatment, amounting to 44% of total demand. Based on the principle of “Polluter Pays”, companies are expected to settle this by themselves. Among these projects are:

  About 170 billion Yuan of investment is required in environmental facilities of new industrial projects. With a view to controlling new source-pollution, it is imperative to strictly carry out the policy of “Three Simultaneities” and make environmental investments in the planning of new projects.

  About 86 billion Yuan of environmental protection investment is required in the old industrial pollution projects. Companies are expected to use their own funds or
apply for bank loans.

About 50 billion Yuan is required to phase out operations in polluted companies. These enterprises are expected to raise funds based on government policies.

With a view to speeding up the pollution treatment of such enterprises, the State will provide appropriate subsidies or interest-free loans to key treatment projects and pilot programs.

■ Social investment: to reform the systems of pollution discharge and raising capital for environmental protection. Enterprises are encouraged to attract public funding through market mechanisms.

In addition, the “State Project Planning on Environmental Protection in Key Engineering Projects” during the “Tenth Five-Year Plan” has promoted nation-wide pollution treatment and ecological conservation, ensuring the fulfillment of environmental protection objective in key areas. There are about 1,137 planned projects, requiring about 262 billion Yuan. Classification, number and investment amount of key projects in all provinces, autonomous regions and municipalities are as shown in Table 18.
### Table 18 - Key Projects Nation-Wide, in Various Provinces, Autonomous Regions, and Municipalities during the “Tenth Five-Year Plan” Period (Unit: ten thousand Yuan)

<table>
<thead>
<tr>
<th>Provinces and Cities</th>
<th>Water Projects</th>
<th>Air Projects</th>
<th>Solid Waste Projects</th>
<th>Ecological Projects</th>
<th>Total Projects</th>
<th>Total Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Investment</td>
<td>Number</td>
<td>Investment</td>
<td>Number</td>
<td>Investment</td>
</tr>
<tr>
<td>Beijing</td>
<td>32</td>
<td>1,566,768</td>
<td>25</td>
<td>2,977,616</td>
<td>11</td>
<td>226,436</td>
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<td>Tianjin</td>
<td>13</td>
<td>355,300</td>
<td>1</td>
<td>250,000</td>
<td>4</td>
<td>53,993</td>
</tr>
<tr>
<td>Heber</td>
<td>71</td>
<td>893,372</td>
<td>13</td>
<td>523,836</td>
<td>4</td>
<td>48,187</td>
</tr>
<tr>
<td>Shanxi</td>
<td>10</td>
<td>17,210</td>
<td>8</td>
<td>154,360</td>
<td>4</td>
<td>24,875</td>
</tr>
<tr>
<td>Inner-Mongolia</td>
<td>6</td>
<td>157,858</td>
<td>7</td>
<td>148,671</td>
<td>2</td>
<td>35,450</td>
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<tr>
<td>Liaoning</td>
<td>18</td>
<td>354,373</td>
<td>7</td>
<td>185,881</td>
<td>9</td>
<td>176,847</td>
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<tr>
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<td>11</td>
<td>253,685</td>
<td>6</td>
<td>174,009</td>
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<td>12</td>
<td>381,756</td>
<td>3</td>
<td>293,308</td>
<td>3</td>
<td>42,349</td>
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<tr>
<td>Shanghai</td>
<td>3</td>
<td>10,355,500</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>191,429</td>
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<tr>
<td>Jiangsu</td>
<td>40</td>
<td>644,846</td>
<td>3</td>
<td>231,338</td>
<td>8</td>
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<tr>
<td>Zhejiang</td>
<td>18</td>
<td>551,883</td>
<td>4</td>
<td>139,157</td>
<td>10</td>
<td>115,750</td>
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<tr>
<td>Anhui</td>
<td>32</td>
<td>406,166</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>22,912</td>
</tr>
<tr>
<td>Fujian</td>
<td>5</td>
<td>187,554</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>36,000</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>8</td>
<td>149,000</td>
<td>4</td>
<td>274,441</td>
<td>6</td>
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<tr>
<td>Shandong</td>
<td>57</td>
<td>572762</td>
<td>12</td>
<td>767654</td>
<td>14</td>
<td>548598</td>
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<tr>
<td>Henan</td>
<td>36</td>
<td>572639</td>
<td>12</td>
<td>140895</td>
<td>10</td>
<td>61971</td>
</tr>
<tr>
<td>Hubei</td>
<td>24</td>
<td>730855</td>
<td>14</td>
<td>436655</td>
<td>18</td>
<td>213190</td>
</tr>
<tr>
<td>Hunan</td>
<td>11</td>
<td>209097</td>
<td>11</td>
<td>155070</td>
<td>8</td>
<td>93154</td>
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<tr>
<td>Guangdong</td>
<td>15</td>
<td>436186</td>
<td>2</td>
<td>240000</td>
<td>6</td>
<td>164432</td>
</tr>
<tr>
<td>Guangxi</td>
<td>12</td>
<td>498891</td>
<td>13</td>
<td>268136</td>
<td>11</td>
<td>84798</td>
</tr>
<tr>
<td>Hainan</td>
<td>3</td>
<td>608800</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>16209</td>
</tr>
<tr>
<td>Chongqing</td>
<td>31</td>
<td>866263</td>
<td>3</td>
<td>120659</td>
<td>33</td>
<td>350850</td>
</tr>
<tr>
<td>Sichuan</td>
<td>20</td>
<td>369474</td>
<td>12</td>
<td>160300</td>
<td>20</td>
<td>183930</td>
</tr>
<tr>
<td>Guizhou</td>
<td>1</td>
<td>5,121</td>
<td>6</td>
<td>219,530</td>
<td>4</td>
<td>19,850</td>
</tr>
<tr>
<td>Yunnan</td>
<td>3</td>
<td>361,300</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>43,000</td>
</tr>
<tr>
<td>Tibet</td>
<td>1</td>
<td>23,000</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>6,700</td>
</tr>
<tr>
<td>Shanxi</td>
<td>12</td>
<td>154,921</td>
<td>8</td>
<td>169,518</td>
<td>7</td>
<td>47,077</td>
</tr>
</tbody>
</table>
During the “Tenth Five-Year Plan” period, 10 major projects with remarkable comprehensive profits are to be implemented by the State, requiring 145 billion Yuan of investment, among which:

- Construction of polluted water disposal plants in the “Three Rivers and Three Lakes” areas

31.7 billion Yuan are required for water pollution treatment in the “Three Rivers and Three Lakes” areas, 22.1 billion Yuan for the construction and expansion of 152 urban polluted water disposal plants in the “Three Rivers” areas, adding 10.64 million tons per day of polluted water disposal capacity, and 9.6 billion Yuan for the construction and expansion of 29 urban polluted water disposal plants and coordinated networks, adding 2.63 million tons per day of polluted water disposal capacity.

- Water Pollution Treatment Projects in the Three Gorges Area

14.6 billion Yuan is required for water pollution treatment in The Three Gorges area, among which 10.6 billion Yuan are needed for the construction of 88 polluted water disposal plants in cities and towns, adding 1.87 million tons per day of centralized urban polluted water treatment capacity; 4 billion Yuan required for the construction of 69 rubbish disposal plants in cities and towns, adding 13 thousand tons per day of rubbish disposal capacity.

- Pollution treatment projects in the program of “diverting water from the south to the north” (east line)

With a view to ensuring a Grade III level quality of the supplied water in the program of “diverting water from the south to the north” (east line), a total of 8.8 billion Yuan is needed for the construction of 73 urban polluted water disposal plants, adding 3.83 million tons per day of polluted water disposal capacities.

- Projects of the Action Plan of Green Sea of the Baohai
1.6 billion Yuan required for the construction of 11 urban polluted water disposal plants, adding 930 thousand tons per day of polluted water disposal capacity.

- Projects of power plants desulphurization in the “Two Controlled Zones”

12 billion Yuan required for the construction of 37 desulphurization projects of coal fired power plants in the “Areas with Two Controls”, reducing 1.05 million tons of sulphur dioxide discharge per year.

- Projects for nature preserves and ecologically functional protected areas

3 billion Yuan required for the key construction of 70 nature preserves, and 15 ecologically functional protected areas such as flood plains at sources of rivers of Yangzi, Yellow, Zhujiang, Huai and Liao; natural reserves at Dongting, Boyang lakes and Songhua (River Nen); Hei River district, lower end of Ta Li Mu River, North of Yin Mountain, Ke Er Qin “Wind Prevention and Sand Stabilization and the Qinling Mountains etc.

- Projects of centralized dangerous waste disposal

19.5 billion Yuan required for the construction of 8 regional stations for centralized dangerous wastes disposal and treatment, with an additional capacity of 720 thousand tons per year of centralized dangerous wastes disposal and treatment and 113 facilities for the centralized treatment of medical waste disposal.

- Construction projects of the state environmental monitoring networks

2.5 billion Yuan required for the construction and improvement of national-level environmental monitoring system and satellite data transmission networks, including the air pollution and acid rain monitoring networks, surface water monitoring network, maritime monitoring network, ecological environmental monitoring network, radioactive environmental monitoring network and nuclear emergency response center, online monitoring system of nation-wide key source-pollution, and the construction of a warning system on water quality of cross-section of key river valleys, the development and launching of 3 small satellites for environmental and disaster monitoring and other coordinated systems, and the strengthening the dissemination methods of environmental information.

- State projects of environmental scientific innovations
1.3 billion Yuan required for major scientific activities such as conducting researches on environmental soft science, environmental pollution and health of the human body, clean manufacturing, applications of satellite remote sense and environmental monitoring, key technologies to solving important environmental issues, ecological environmental protection, nuclear safety and on electromagnetism radiation, and developing environmental protection high tech creations and etc.

- **Projects of “Clean Water, Blue Sky” in Beijing**

  53.6 billion Yuan is needed to improve the environmental quality of Beijing, with 2.98 billion Yuan required for the 25 projects to improve air quality, and 11.7 billion Yuan required for the construction of 21 urban polluted water disposal plants and coordinated urban pipe network projects, 3 river dam projects and pipe networks, resulting in an additional 2.08 million tons per day of polluted water disposal capacities.

- **“Green Olympics” in Beijing**

  “Green Olympics” has been one of the three main themes of the Beijing 2008 Olympic Games. “Green Olympics” is referred to as “the harmonious unification between the environment and human existence and is to run through the whole process of the preparation and holding of the Olympics. According to the estimation, the investment of one Yuan in environmental treatment shall promote 0.5 Yuan of income in equipment sales for the EPI. Estimating the amount budgeted for environmental cleanup for the Beijing Olympics, this should generate sales of 22.5 billion Yuan for EPI. From 2003 to 2007, the Beijing municipal government will spend 45 billion Yuan on environmental protection and treatment in addition to the 46 billion Yuan spent from 1998 to 2002. Over ten years, the city will have spent up to 90 billion Yuan on improving the environment. For the Olympics, Beijing will make additional efforts to combat air pollution, improve sewage and solid waste treatment, and in the development of new energy sources, including wind, solar, and thermal energy and cleaner fuel supplies.

  While building the Olympic villages and stadium, 12 polluted water disposal plants and 3 rubbish disposal plants are to be constructed, fulfilling the objectives of
90% of urban polluted water disposal, 50% of reutilization of polluted water, 30% of rubbish reuse and 50% of classified collection of the rubbish. The industrial lands in the cities are to be reduced to below 7% by 2005, to completely rid the urban areas of the troubles of industrial pollution.

The environmental construction projects are certain to promote the development of the EPI, so vital to the success of the 2008 Olympic Games and the Capital’s sustainable development. Upto 2000, there were about 400 environmental protection enterprises and public institutions in Beijing, with a total output of 5 billion Yuan. Among such operations, the yields are as follows: EPI sales and facilities - 1.1 billion Yuan, recycling - 2.7 billion Yuan, of output of environmental protection service sectors -1 billion Yuan and 0.2 billion Yuan from other fields. Most of these operations are privately owned and managed.

Based on two surveys on the national EPI in 1997 and 2000, the annual growth rate of the EPI in the future is estimated to be about 15%. According to the “Outline of the Tenth Five-Year Plan on National Economic and Social Development in the Beijing Municipality”, Beijing Municipality is expected to have a 9% average annual growth of GDP during the “Tenth Five-Year Plan” period, six main environmental protection facility industries being the focus of the development.

Water pollution treatment techniques and facilities: the development is to center on the urban polluted water disposal technology with comprehensive, automated equipment. The complete set of facilities on effluent recycling in estates is also a major development. Comprehensive facilities for industrial waste water disposal are expected to expand the scale of water disposal facilities. It is also imperative to develop multi-functional and coordinated water disposal facilities, purification and sterilization facilities, and water resources recovery.

In solid waste treatment and disposal, the focus will be on the development of technologies and facilities to handle consumer waste and medical rubbish treatment. Technologies for daily rubbish collection, storage, transportation and sorting of food waste and garbage for composting, medium and big sized incinerators and surplus energy utilization facilities and toxic industrial wastes are to be developed.
Air pollution: the focus will be on the development of technologies and facilities to treat automobile emissions, CNG and LPG cylinder filling stations, and smoke and gas desulphurization. Among them will be pre-fire desulphurization technology, boiler coordinated desulphurization facilities for large power plants, wet denitrogen, dry denitrogen and simultaneous desulphurization and denitrogen facilities and technologies.

Noise and vibration control: The main focus will be on the development of noise and vibration control technologies, facilities and materials for industrial and civilian uses, low frequency and sound-absorbing structures in industrial and residential construction, effective, pollution-free materials for sound absorption and insulation, vibration insulation and dampening technologies and facilities, and highly effective sound-insulation technologies and facilities in places such as municipal engineering projects, expressways, railways, airports, and construction sites.

Environmental monitoring: The focus will be on the development of water quality monitoring equipment (automatic and continuous monitoring of sources of water pollution, inspection equipment for polluted water disposal plants), air monitoring equipment (of suspended matter and smoke dust, vehicle discharge), portable on the spot, quick and direct reading of surveying instruments.

Other environmental technologies: The focus will be to develop new technologies to improve the environment, such as: ozone protective refrigerants and the application of nano technologies in environmental protection facilities.

3 Analysis of investment advantages in the middle and western areas of China

In order to attract foreign businessmen to invest in the middle and western areas in China, the State Economic and Trade Commission, the State Development and Planning Commission and Foreign Trade and Economic Cooperation Ministry, have jointly formulated “List of Advantageous Industries with Overseas Investment in the Middle and Western Areas”, which was implemented after the endorsement of the State Council on June 16, 2000. The related environmental protection industries as listed in the “List of Advantageous Industries with Overseas Investment in the Middle
and Western Areas”, and shown in Table 19, are essential for the future development of the EPI in the middle and western areas.

**Table 19 List of Advantageous Industries with Overseas Investment in the Middle and Western Areas**

<table>
<thead>
<tr>
<th>Environmental Industries with Good Investment Prospects</th>
<th>Name of the Provinces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing of large environmental protection facilities</td>
<td>Hubei province, Chongqing Municipality</td>
</tr>
<tr>
<td>Projects of sustainable development, utilization and protection of the water resources</td>
<td>Hubei province, Chongqing Municipality, Guizhou Province, Gansu Province, Qinghai Province, Xinjiang Uighur Autonomous Region</td>
</tr>
<tr>
<td>Ecological environmental protection and treatment projects in hydroelectric dam areas</td>
<td>Chongqing Municipality</td>
</tr>
<tr>
<td>Development and manufacture of carbon fibers</td>
<td>Anhui Province</td>
</tr>
</tbody>
</table>

Source: “List of Advantageous Industries with Overseas Investment in the Middle and Western Areas”, 2000

### 4 Export market for environmental protection products

The environmental trades mainly include environmental protection products and services, economic and technical exchanges and cooperation in the field of environmental protection. At present, the international environmental trade imports exceed US$500 billion, more than half of which goes to China’s main trading partners. China’s export of environmental protection products is only US$ 2000 million plus each year, leaving a large trade deficit in this area.

The key to developing environmental trade is to develop an EPI to produce
various classifications and systems that meet industry standards and needs. This initiative should be based on the development of other industries, utilizing their new technologies, talents, and capital to create better products, marketing plans, and services. It is just for this reason that Europe, the United States, Japan and other developed countries have spared no amount of money and taken the lead in developing their EPIs. Korea, Thailand, Singapore and other Asian countries have also invested heavily in the EPI and given priority to its promotion.

Concurrently, the EPI has a dual characteristic of relying on high tech systems and existing companies. With problems like low technological levels, big consumption of resources, severe environmental pollution, and low economic benefit in some enterprises, it’s clear that firms must start by solving the environmental protection issues, developing high tech products, high utilization of resources, less pollution and sound financial management. New EPI products can form the launching pad for a whole new industry. To help, the State can provide special subsidies and low interest loans to the EPI. In 1994, the United States government made the EPI a key industry, deciding that the environmental protection products would enjoy export tax exemption. Later on, the European Union initiated the “Green Import and Export Policy”, giving preferential treatment to the EPI with respect of taxes, loans, and export terms.

Even though China’s EPI has been growing at a speed higher than that of the GDP in recent years, villages, towns and private enterprises still represent most of the industry, and can hardly form large scale systematic technology and product system, with their small manufacturing scale, low management skills, outdated technology, and low product and engineering quality. Very soon, China will seek for ‘high end’ projects to establish industrial groups motivated by science and technology and linked by projects, with skilled managers to push for reform in large and medium-sized state-owned enterprises, thus providing policy support to the EPI by increasing investment and reducing costs.
2.4.1.2 General analysis of supply

1 China’s environmental policy management system

- Main contents and classifications of China’s environmental policy

China’s environmental policy includes: environmental pollution control, ecological conservation and international environmental policy, among which, the pollution control policy is the main body of China’s environmental policy. The above policies can be further divided into compulsory environmental policy and environmental economic policy, based on implementation methods. Among them, the compulsory policy is referred as the compulsory and binding environmental policy carried out by the State towards the society; commanding the unconditional obedience of all economic bodies; the environmental economic policy is to provide the economic bodies with certain encouragements and restraints by using economic means, enabling them to profit from the actions of environmental protection and pollution reduction, thus guiding them to choose behaviors that are beneficial to the environment, out of self interests.

Compulsory policies mainly include: environmental impact evaluation system, “Three Simultaneities” system, pollution discharge fee system, objective and responsibility system of environmental protection, fixed quantity examination system of urban comprehensive treatment, pollutants discharge permit system, centralized pollutants control system, system of treatment within deadlines, control over the total amount of pollutants, rules for reaching the required standard or closing the enterprises within the specified time in some areas. Most of these systems carry legal status through environmental legislation, the rest, such as the system of reaching the standard or closing the enterprises within the specified time, operates under direct government orders. The environmental economic policies mainly deal with industrial arrangement and structural adjustment, policies on technical renovation and comprehensive utilization of wastes, policy of cleaner production, certification policy of environmental labels and commercial environmental management systems, policy on recycling, utilization of wastes, pollution discharge jurisdiction system, and pollution tax system.
Main problems in China’s environmental policies

The following problems have arisen in the process of the formulation and implementation of China’s environmental policy:

1) government dominated, “top down approach”, as government behaviors run through all areas and sectors in the environmental protection. Comparatively speaking, firms are the passive receivers of the environmental protection policies while the methods and channels for the public’s participation in the environmental protection are quite few as well.

2) China’s environment policy attempts to giving consideration to both the development of the environment and the economy, rather than the environment as a priority. This characteristic is directly related to the economic development stage China is at today.

3) The implementation mechanism of the environmental policy is quite sound, but the result is less satisfactory, as some environmental protection agencies lack policy-making and management capabilities; inefficient and incomplete monitoring of law enforcement is universal.

4) The compulsory nature in environmental policies is paramount while the applications of environmental economic policies through ‘encouragement’ are very limited. This is not consistent with the trends in other parts of the world.

During the period of the “Tenth Five-Year Plan”, the management of China’s environmental policy will undergo some changes in the following aspects:

- Environmental economic policies are to change from coordinating the relationship between the environment and development by simply using administrative methods, gradually to coordinating the relationship between the environment and development by the comprehensive utilization of economic levers that mainly include grants and preferential tax policies.

- Environmental technical policies are to move from single-factor legal regulations towards comprehensive development, strategic design and macro management, with the aim of enhancing the effectiveness of energy and resource
utilization and reducing the discharge of the pollutants, based on the situation and development requirements of China’s environmental technologies and through technical guidance.

- EPI policies are to emphasize the promotion of an optimized structure of the EPI during the strategic adjustment of the economic structure, enhancement of the scientific and technological content in environmental protection products; and to carry out measures to promote the socialization of EPI, marketing, and standardization of products.

- In the aspect of environmental social policies, it must be realized that the environmental issues are not just purely production problems; rather, they concern the productive people to people relations in society; to emphasize democratize decision-making and public participation; to stick to the principle of coordinated development between the environment and the society; to properly handle the relationship between states, the relationship between the state, the group, and the individual, to mobilize the enthusiasm of all groups to protect the environment and enhance the consciousness of environmental protection of all levels of the society; to value the study of environmental pollution and health and create an environmental management system that considers the people as the fundamental factor.

- In the aspect of international cooperation policy on environment, it is important to participate actively in environmental matters, while working whole-heartedly in domestic environmental protection. We should jointly promote regional and global environmental cooperation based on new partnerships and speed up the process of solving global environmental issues. We believe that international cooperation on environment must respect state sovereignty, and that the treatment of environmental issues must give considerations to the practical interests of all countries and the long term interests of the world.

2 Marketing of enterprises system change

The purpose of enterprises system changes is to establish a modern free enterprise system based on the principle of “clear property rights, definite rights and responsibilities, separation of business from politics, and scientific management”.

“Clear property rights, definite rights and responsibilities” requires that the responsibility-rights-benefits relationship of the business must be clear and definite. Firms are expected to develop economies of scale and collective management. A stronger management team will focus on working hard, in increasing production, creating benefits and enhancing their economic power by making use of new skills and technologies, reducing costs and man hours, reducing energy consumption, and improving the utilization of resources, reducing pollution discharge and strengthening environmental management. With the “separation of enterprise from politics” implemented, the enterprises are no longer linked to the government; rather, the government management model and management functions will undertake some transformations from being guided by direct control of the administrative orders to giving priority to the role of macro adjustment and administrative guidance, laying particular emphasis on functions of providing service, economic stimulation, assistance and guidance to business, while the environmental protection agencies are facing less intervention from the original enterprises main authority agencies and local governments, and are able to strengthen its law enforcement efforts, enforcing environmental law and regulations, and punishing violators. The decree of “Administrate based on the law” in environmental management will be strengthened.

In the meantime, with the transformation of the companies’ new property rights, owners also will notice the environmental risks which might affect the future of their firms, and realize that only if they value environmental protection and effective treatment of pollutants, can they survive and grow. With their concern for EP to be strengthened, this provides favorable conditions for environmental law enforcement.

At present, based on demands for free enterprise system reform and national financial investment and system reforms, the various parties for EPI will reform the financial investment and funding system. The main focus should be on defining the investors’ rights and responsibilities the relationship between central and local government, and between the government and the companies, based on proper distribution of environmental responsibilities of all main investment bodies, gradually moving towards multiple investment bodies, diversified financing channels, financial
fund management, and setting up an investment and financing system of the EPI conforming to the economic market economy.

3 Development of new environmental protection technologies

“Guide to the Current High Tech Industrialized Key Areas Which have been Preferably Developed” which is issued by the State Development and Planning Commission of the People’s Republic of China forms the basic direction of high-tech industrial development. It will be used in transforming the traditional industry with advanced technologies so as to enhance the scale of total economic volume, and clearly and definitely points out the key areas for the future development of China’s environmental protection. The Guide was formulated by both the State Development and Planning Commission and State Science and Technology Ministry based on “Tenth Five-Year Plan” special planning on scientific development and the “Tenth Five-Year Plan” special project of high tech industrial development planning. Refer to Table 20 for the future development areas concerning the EPI.

Table 20 -Key Areas of Future Development of China’s EPI

<table>
<thead>
<tr>
<th>Categories</th>
<th>Name of Facilities and Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution prevention and treatment</td>
<td>1. Smoke desulphurization, dust-removing technology facilities</td>
</tr>
<tr>
<td></td>
<td>2. Vehicle emission purifying equipment and cleaner fuel for automobiles, mixed-fuel vehicles coordinated system</td>
</tr>
<tr>
<td></td>
<td>3. Complete set of equipment for purification and recovery of steel-making converter gas</td>
</tr>
<tr>
<td></td>
<td>4. Recovery of hydrogen in the waste gas of steel-plants</td>
</tr>
<tr>
<td>Water pollution prevention and treatment</td>
<td>1. Urban polluted water disposal and utilization facilities</td>
</tr>
<tr>
<td></td>
<td>2. High concentration industrial waste water disposal technologies and facilities</td>
</tr>
<tr>
<td></td>
<td>3. Technologies and facilities for chemical production and application of treated water.</td>
</tr>
<tr>
<td></td>
<td>4. Utilization of effluent of the sea water</td>
</tr>
</tbody>
</table>
### Waste substances and their reuse

1. Urban consumer waste disposal technology and facilities
2. Dangerous solid waste disposal and treatment technologies and facilities
3. Comprehensive utilization of waste resources

### Others

1. Environmental and pollution source automatic monitoring systems
2. Ecological environmental construction and coordinated technologies
3. Whole process of cleaner production
4. Comprehensive utilization of difficult gold mine resources
5. Petro-related pollution control technologies and facilities

*Source: “Guide to the Current High Tech Industrialized Key Areas Which have been preferably Developed”, State Development and Planning Commission of the People’s Republic of China, 2001*

### 4 Import of environmental goods

According to the APEC statistical data, China’s import of environmental goods comes out on top among the APEC members, among which imports of equipment and facilities for monitoring/analysis, solid wastes/dangerous waste disposal, drinking water disposal, heat/energy management and etc. are found most frequently. The total amount of imports is No.5, taking up 7.48% of the total imports of environmental goods by APEC members, after the US (27.69%), Canada (9.88%), ROK (9.80%) and Japan (9.73%).
### Table 21 - Environmental Goods Imported by APEC Member and China’s Place

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>sort of goods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>3.70%</td>
<td>3.27%</td>
<td>3.08%</td>
<td>5.02%</td>
<td>3.87%</td>
<td>2.24%</td>
<td>1.67%</td>
</tr>
<tr>
<td>Brunei</td>
<td>0.02%</td>
<td>0.02%</td>
<td>0.05%</td>
<td>0.02%</td>
<td>0.02%</td>
<td>0.00%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Canada</td>
<td>6.13%</td>
<td>12.55%</td>
<td>21.91%</td>
<td>4.13%</td>
<td>8.49%</td>
<td>6.93%</td>
<td>3.83%</td>
</tr>
<tr>
<td>Chile</td>
<td>1.08%</td>
<td>1.34%</td>
<td>0.25%</td>
<td>0.52%</td>
<td>1.70%</td>
<td>0.30%</td>
<td>0.65%</td>
</tr>
<tr>
<td>China(listing)</td>
<td>8.97% (3)</td>
<td>5.75% (6)</td>
<td>2.89% (9)</td>
<td>5.39% (6)</td>
<td>7.92% (5)</td>
<td>10.19% (4)</td>
<td>8.99% (3)</td>
</tr>
<tr>
<td>Taipei, China</td>
<td>6.40%</td>
<td>3.59%</td>
<td>3.15%</td>
<td>4.69%</td>
<td>2.17%</td>
<td>4.64%</td>
<td>6.65%</td>
</tr>
<tr>
<td>Hong Kong ,China</td>
<td>1.67%</td>
<td>4.97%</td>
<td>5.43%</td>
<td>8.38%</td>
<td>1.45%</td>
<td>2.56%</td>
<td>4.02%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4.83%</td>
<td>3.29%</td>
<td>0.74%</td>
<td>1.31%</td>
<td>3.39%</td>
<td>1.60%</td>
<td>3.93%</td>
</tr>
<tr>
<td>Japan</td>
<td>8.41%</td>
<td>6.64%</td>
<td>3.66%</td>
<td>9.57%</td>
<td>21.84%</td>
<td>8.99%</td>
<td>6.51%</td>
</tr>
<tr>
<td>ROK</td>
<td>12.50%</td>
<td>10.04%</td>
<td>2.63%</td>
<td>6.87%</td>
<td>8.98%</td>
<td>14.54%</td>
<td>11.47%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>5.39%</td>
<td>2.21%</td>
<td>0.62%</td>
<td>3.82%</td>
<td>2.52%</td>
<td>6.38%</td>
<td>5.25%</td>
</tr>
<tr>
<td>Mexico</td>
<td>3.74%</td>
<td>4.85%</td>
<td>8.05%</td>
<td>3.28%</td>
<td>2.88%</td>
<td>2.04%</td>
<td>2.43%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.58%</td>
<td>0.70%</td>
<td>0.20%</td>
<td>0.44%</td>
<td>1.08%</td>
<td>0.58%</td>
<td>0.33%</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.98%</td>
<td>1.26%</td>
<td>0.13%</td>
<td>0.41%</td>
<td>0.80%</td>
<td>7.66%</td>
<td>1.10%</td>
</tr>
<tr>
<td>Singapore</td>
<td>6.25%</td>
<td>6.19%</td>
<td>1.27%</td>
<td>10.91%</td>
<td>5.38%</td>
<td>13.35%</td>
<td>3.84%</td>
</tr>
<tr>
<td>Thailand</td>
<td>6.50%</td>
<td>5.07%</td>
<td>3.88%</td>
<td>1.57%</td>
<td>2.38%</td>
<td>3.07%</td>
<td>5.23%</td>
</tr>
<tr>
<td>U.S.</td>
<td>22.86%</td>
<td>28.26%</td>
<td>42.05%</td>
<td>33.67%</td>
<td>25.13%</td>
<td>14.92%</td>
<td>34.09%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Based on the pool of APEC complete list of code statistical data, submitted by New Zealand in its draft resolution on WTO negotiation.

At present, the development of China’s environmental goods and services is
immature. However, in the developed countries this sector has already entered into the mature period with supply exceeding demand. Those countries are trying to open up overseas markets and expand their trade, through WTO, APEC and other international agencies.

Currently, the main purpose of some OECD developed countries promoting environmental products and service trade liberalization is for their domestic interests. As a new member of the WTO, China has promised to open its market in environmental service areas including sewer service, solid waste disposal service, waste gas cleaning service, noise-reducing service, except for the areas of environmental quality monitoring and source-pollution inspections. However, we also clearly realize that, at present, China does not have the capability of competing with the developed countries in environmental goods and services and still maintain a status of import nation in many areas, thus impacting on the fast opening up of markets.

For this reason, the WTO has also showed concerns to the possible influence in economic trade on its members after opening up the markets, allowing the members to establish their own guarantee system conforming to the WTO regulations so as to provide their domestic (regional) industries with rational and proper protections. For instance, members are allowed to provide temporary protection to their domestic industries that are producing the same kind of products, when facing a great amount of imported products and steadily growing import pressures. The government can provide assistance to the development of some special industries (as immature industries); the WTO permits its members to oppose unfair trade, like anti-dumping, anti-subsidy. Moreover, there are improved trade dispute resolution mechanisms in the WTO. Once there are disputes between domestic producers and overseas producers, the government will help companies to protect their own interests and to reduce costs by using the above-mentioned measures.

2.4.1.3 Market management assessment

There are things like government falling vacant or offside in the management of
EPI and product market. It is the government’s duty to set rules and act as a referee, rather than to participate in the market competition and act as player.

It is inappropriate for government to define “the best” market structure and/or “the best” company scale. If the environmental protection companies are too small and non-competitive, market forces will apply the rules of selection and elimination, as long as there is no governmental intervention. However, the government should determine and control the rules of the game. Small and medium-sized enterprises are at the core of the EPI and are enjoying rapid development and complete structure, and should be granted preferential treatments, instead of being given too heavy burdens, like bureaucracy and etc.

The market is supposed to be free entry oriented. However, the market is not absolutely free entry oriented. Rather, it is only open to companies conforming to certain quality standards. If the market risk is not high, these standards can be very low. It is imperative for markets of harmful waste disposal to set up rather high market entry standards. Third party agencies (environmental protection industrial association) can support the government in aspects of company acceptance and supervision.

China is a big market. If the local protectionism is to be avoided, it is necessary that large enterprises should greatly promote economic development. In aspects of public investment and purchasing decision-making, it is inappropriate to provide preferential treatment to local suppliers.

2.4.2 The prospects and development of focal points in some key areas during the “Tenth Five-Year Plan”

As clearly defined in the “The ‘Tenth Five-Year Plan’ of National Environmental Protection” endorsed by the State Council of the Central Committee of the Communist Party of China, the environmental pollution situation will be reduced by 2005, the worsening tendency of ecological environment will be preliminarily contained, air and water quality will be improved in cities and towns, especially in big and medium sized cities and key areas, and environmental protection laws, policies
and management systems will conform to the socialist market economy and will be
strengthened.

To fulfill the above objectives, and with the fundamental aim of improving the
environmental quality, we must stick to the sustainable development strategy and
work hard to complete three tasks, namely, control over total volume of pollutants,
environmental treatment in key areas, and ecological environmental protection, by
relying on environmental laws, social monitoring, scientific and technological devices
and market forces. In order to reach this target, about 700 billion Yuan of investment
will be required, accounting for 1.3% or so of the total GDP of the same period.
Moreover, this environmental protection investment will be collected mainly through
channels like governmental investment, social investment, private fund raising, and
overseas investment. It is estimated that, during the period of “the Tenth Five-Year
Plan”, the environmental protection related industries will grow at a rate of 10-15%,
and likely reach 300 billion Yuan of total annual income by 2005.

Currently, China’s economy is undergoing strategic adjustments, thus creating a
good opportunity for optimizing and improving industrial and for solving the problem
of industrial pollutants.

In recent years, the State Environmental Protection Administration has launched
beneficial pilot projects to promote and enhance free enterprise in market oriented
pollution treatment. Since 1998, the EPI have developed fast in China’s key eastern
developed areas. Up to the end of 2001, there were altogether 220 companies engaged
in pollution treatment facilities and operations that achieved quality certification,
developed other relevant businesses, and achieved good environmental and social
profits. Thus, environmental pollution treatments and concerns have gradually been
accepted by the public, professional, and market forces. To ensure the earliest possible
promotion of industry and market oriented pollution treatment across the nation, the
state will formulate laws, regulations for reciprocal investment, franchise management,
and economic policies to strengthen the financing of urban waste water and rubbish
disposal.

During the “Tenth Five-Year Plan” period, key areas of development of the
environmental protection related industries are:

- New technologies: a whole set of facilities in urban sewage treatment; high concentration and difficult industrial waste water treatment technologies, and technologies and facilities to treat dead lakes; desulphurization and denitrogen technologies and facilities, automobile tailing gas treatment technologies; online monitoring systems of pollution sources; technologies and facilities of resource reutilization of urban consumer wastes;
- Cleaner energies, purifying technologies and products, organic foods;
- Environmental consultation service, operation and management of the environmental treatment facilities, global environmental trade;
- Waste recycling utilization technologies and facilities; toxic and harmful waste disposal technologies and facilities;
- Ecological conservation, recovery and treatment technologies and facilities.

Following is the comprehensive classifications, from the angle of environmental technologies, products and service markets

**Environmental technologies and products**

1. Water pollution treatment

   - Urban sewage

     Key developments: urban sewage disposal technologies and completed facilities with over 200 thousand tons per day of disposal capacity; sewage disposal technologies and completed facilities with less then 100 tons per day of disposal capacity in small and medium sized cities and towns; residential districts sewage disposal and recovery technologies and comprehensive facilities.

   - Industrial waste water

     Key developments: multi-functional and coordinated water disposal technologies and facilities; high concentration and organic waste water disposal technologies and facilities (used in pharmaceuticals, paper-making, chemical industries, coal industry, salt industry, butchery processing, livestock and poultry breeding, waste water disposal areas), in-depth disposal of waste water, purifying, sterilizing technologies
and comprehensive facilities; membrane disposal, micro-filtration, advanced oxidizing technologies and facilities.

- Water saving and sewage reuse

Key developments: water saving technologies and facilities for high water-consuming sectors like coal fire power generation, textile, petro chemical industry, paper-making, metallurgy and etc; technologies and facilities of industrial polluted water recovery and utilization, recycling water and mixed-used water, technologies and facilities of enhancing the concentration of the recycling of cool water and of recovery and utilization of cool water, technologies and facilities of urban polluted water comprehensive recycling technologies and facilities, the recycling of effluent in residential areas and big public buildings; technologies and facilities of comprehensive utilization of sea water, and desalination techniques.

- Water-body pollution treatment

Technologies and facilities include sediment dredging and disposal, technologies of highly effective utilization of agricultural chemical fertilizer, technologies and facilities of livestock and poultry breeding waste disposal and utilization.

Pollution prevention and treatment in coastal areas: to develop cargo ships with waste water (inclusive of domestic waste water) holding tanks and disposal units, marine oil extracted from waste water (inclusive of domestic waste water) disposal, marine petroleum leakage pollution treatment, waste water treatment technologies and facilities in port anchorages and harbors.

Micro pollution water treatment technologies: to develop various technologies and facilities of water treatment and micro polluted water disposal.

2 Air pollution treatment

- Smoke desulphurization, dust removing technologies and comprehensive facilities

Key developments: coal-fired power plants desulphurization technologies and facilities; facilities for medium size industrial boilers desulphurization.

To control the development of conventional electronic dust removers, expand their application into areas of high concentration, high rank resistance smoke, dust,
and corrosive gases; to develop coordinated monitoring equipment and facilities: to improve computer lectotype technologies, to develop facilities of pulse power generation, microcomputer control, changeable voltage power generation; to develop reasonably small and medium sized electronic dust removers used in various stoves and kilns.

Pocket dust removers will improve the operation and performance of electrical products; to develop heat-resistant and erosion-resistant filter and fiber materials; to develop pocket dust removers that can handle more 1000 thousand square meters of wind quantity per hour and operate at 250 degrees and last over three years.

- Technologies and facilities of motorcar pollution control

Key developments: high performance purifying catalytic converters, overall design and manufacturing of automobiles and motorcars’ emission purifiers, scaled production of diesel vehicle discharge carbon particles and nitrogen oxides purifying catalytic converters; to speed up the development and industrialization of natural gas, liquefied petroleum gas, mixed fuel engines technologies and related tailing gas purifying technologies.

- Dangerous and harmful gas purifying facilities

Key developments: technologies and facilities of organic waste treatments such as highly effective and energy saving catalytic combustion, and carbon fiber recovery and utilization; technologies and facilities of industrial dangerous gas, ecological treatment of noxious gas.

3 Solid waste disposal and treatment

- Urban domestic waste disposal technologies and comprehensive facilities

Key developments: collection, selection, and pre-disposal technologies and facilities adapting to the characteristics of Chinese rubbish; medium and large rubbish incineration disposal technologies, including full facilities for rubbish incineration, power generation, surplus heat utilization; hygienic land-fill technologies and; full facilities for the recovery and utilization of the land-fill gas, new materials for burying using anti-leakage lining and covering materials, special burying machines and tools, full facilities for rubbish burying leakage filtering and liquid disposal; large rubbish
compost and simple compost technologies and facilities, technologies and facilities for organic rubbish anaerobic digestion, and resource technologies and facilities for changing rubbish into composting and construction materials.

- Technologies and facilities of dangerous solid waste disposal and treatment

Key developments: technologies and comprehensive facilities of centralized storage and regional disposal and treatment of dangerous wastes, high-temperature technologies and facilities for safe incineration of poisonous substances, resource utilization technologies, technologies and engineering of wet metallurgy extraction of metals of valences.

- Recycling utilization of resources

To improve the comprehensive development and utilization of confederate mineral resources, new technologies for the comprehensive recovery of metal, silver, iron, rare earth, niobium, vitriol, in nonferrous metal confederate mineral resources; coal-related confederate mineral resources focused on super delicate, brightening, modification of kaolin as, giving impetus to the development of comprehensive utilization technologies of bauxite, refractory clay, sulphur iron ore, diatomaceous earth; to speed up the development and application of technologies of garbage ore production, construction products processing and utilization.

Comprehensive utilization of industrial solid wastes: to select products of waste composites such as chemical industry, metallurgy, nonferrous metal and other industrial waste so as to make new light construction materials, and to establish a group of representative pilot projects of high level technology, outstanding overall profits and reaching certain scales, gradually forming applicable and advanced resourceful and whole set of facilities and technologies.

Recovery and utilization of waste materials: the recovery and disposal of waste materials of household appliance and used computers; mechanized centralized dismantlement of scrapped cars; recovery and utilization of waste paper, waste glass, waste plastic, waste tires, waste batteries etc.

Develop advanced recovery and utilization of surplus heat and surplus pressures.

Support and develop a recycling economy, and create ecological industrial pilot
project areas.

4 Noise and vibration pollution treatment facilities

Key developments: multi-functional mufflers, sound-absorption component parts, a series of vibration isolators and shock absorbers, a series of low noise air blowers, automobile mufflers and silencers and shock absorbers used in compact and revolving facilities and special industrial functions.

5 Monitoring equipment and facilities

Key developments: automatic sampling facilities and pre-sampling disposal equipment; polluted water and smoke discharge surveying instruments: CODcr; continuous and automatic monitoring systems of the main pollutants in water and air, including BOD5, total phosphorus, total nitrogen, ammonia, nitrogen oxide, volatile mineral oil, smoke and dust, sulphur dioxide etc; emergency monitoring instruments and alarm systems for facilities with pollution accidents, on the spot fast and direct reading surveying instruments, and electromagnetic wave pollution.

6 Environmental treatment materials

Key developments: (solid) sulphur drops, highly effective water disposal additives, membrane materials, heat-resistant, erosion-resistant, long life filters, special materials for covering land-fill sites, high performance sound-absorption materials, shock absorbers and sound insulators.

Environmental service industry

1 Environmental technical service

To establish technological and innovative system of the EPI, which is “industry-intellectual-scientific” coordinated and has environmental protection enterprises as the principal part, promoting the industrialization of environmental technologies; strengthen qualification acceptance system of the environmental-related monitoring institutions, promoting public acceptance of environmentally related monitoring.

2 Environmental consultation service

To promote the ISO14000 environmental management system and institutions,
develop third party certification of environmental labeling products, environmental technologies, environmental protection products and organic foods; to develop consultation services like environmental management consultations, environmental engineering consultations, cleaner production auditing, environmental technological consultations, consultations on investment and capital funding information, to enhance environmental decision-making; to promote public environmental project supervision and engineering.

3 Operation of the environmental pollution treatment facilities

To promote the market need for the construction and operation of the environmental infrastructure to handle urban polluted water and rubbish, public support of industrial pollution treatment, to create a centralized, multiple investment, public service, market operation, with enterprise management skills and a professional team for pollution treatments, so as to form a regulated, highly efficient, and low cost service system.

4 Environmental trade and financial service

To develop environmental technical expansion and trade systems, and promote the import and export trade of environmental technology, cleaner products, organic foods and complete set of pollution treatment facilities.

To reform the existing pollution disposal system and environmental protection fund raising system for waste treatment facilities; to promote the development of the capital market and financial service industry in the EPI.

5 Natural ecological conservation

To promote the development, application and sampling of the technologies of large scale soil erosion and desertification prevention; development, application and sampling of the technologies of recovery and reconstruction of the endangered vegetations under extreme circumstances; technologies of water collection, water storage and water retention in arid areas, sand areas and karsts areas, and selection and nurturing of drought-resistant, saline-sodic resistant plant species, and the industrialization of assembled and the coordinated projects; technologies of three dimensional multi-species, multi-layered and multiple vegetation plantations, and
modeling assembled and coordinated sampling of forests, agriculture, fruits and woods; repair technology of the polluted soil.

6 Cleaner technology and products

Up to 2000, sixty technical requirements for the environmental labeling of products had been amended in China, and thousands of the products of over 400 firms met the environmental labeling certification standards. In this field, organic foods, and green household furniture products have taken the lead in starting the market. In future, we will accelerate the process of getting the environmental labeling of products aligned with international practice, and develop degradable and recoverable, low pollution, low discharge, energy-saving, water-saving, healthy green products


3.1 Analysis of the Status of the Development of International EPI

3.1.1 Definition and connotation of an EPI

As a rising industry, EPI has an undefined industrial boundary and content with strong penetration in other industrial sectors. At present, there has not been a universal definition of EPI. According to the Organization for Economic Co-operation and Development (OECD), there is a definition in narrow sense and a definition in a broad sense as follows.

EPI is a general reference to technology development, product development, commercial communications, resource utilization, information services, project contracting and other activities for the purpose of controlling environmental pollution, improving the ecological environment and protecting natural resources. The narrow definition of EPI mainly refers to terminal administration of environmental issues, including wastewater treatment, wastes treatment, atmospheric quality control, noise control and soil improvement etc.; the definition in the broad sense mainly refers to the whole life cycle of products, not only including their contents but also including the cleaner technology used in their manufacturing process, when in use, they reflect energy saving technologies and skills as well as green design in which recovery would
be considered, making the products accord with ecological identification standards affecting production and consumption.

In expanding on the connotation and extension of the definition, OECD added the contents of EPI with relation to equipment, services and products etc. in 1996.

Environmental protection equipment: wastewater treatment equipment, waste management and recycling equipment, air pollution control equipment, noise elimination equipment, monitoring equipment, research and laboratory equipment as well as facilities used for natural environmental protection and improvement of urban environmental comfort.

Environmental protection services: operations in wastewater treatment, wastes treatment, air pollution control and noise elimination, services in analysis, monitoring and protection, technical and engineering services, environmental research and development, environmental training and education, audit and legal services, consultation service, ecological tourism and other services of environmental affairs.

Cleaner technology and cleaner products: cleaner production technology and equipment, highly effective energy development and energy saving technology and equipment as well as ecological products etc.

In view of the development trend of EPI, the narrow definition is the core content of current EPI, which will adopt a posture of gradual and steady development along with the enhancement of society’s environmental protection awareness, increase in environmental investment, maturity of environmental protection technology and skills, improvement of quality and maintenance of ecological balance, while the EPI in broad sense has an indefinite scope for development and will be the direction of future development of EPI.

Today, different countries adopt different definitions of EPI. For example:

Most European countries, such as Germany, Italy, Norway and the Netherlands, mainly adopt the definition in the broad sense; while Japan adopts the definition in the narrow sense, dividing its EPI into six sectors: environmental protection, wastes treatment and cyclic utilization, environmental return, environmentally friendly energy supplies, cleaner production and cleaner products.
The United States takes the middle ground between Europe and Japan, dividing the EPI into three major sectors: services, facilities and resources, among which services include analysis services, solid waste management, hazardous wastes management, environmental consultation and engineering; facilities include water pollution control equipment, air pollution control equipment, hazardous wastes treatment equipment, pollution control and prevention technical equipment; and resources including public water resources return and environmental energy.

3.1.2 Status Quo and Characteristics of the Development of International EPI

3.1.2.1 Status of the development

In mid 1950s, the industrially developed countries started to gradually pay attention to the manufacturing of environmental protection equipment so as to control the worsening environment. By the end of 1960s, an independent industrial system had taken shape basically in these countries, which brought about a rapid growth of EPI in the whole world. In 1970s, an environmental protection market with pollution control equipment as the backbone formed in major developed countries and saw a steady development. From 1980s to now, by virtue of improvement of public environmental awareness, green products have been well accepted in the whole world and the environmental protection market has seen steady growth.

In the light of the world market, the market scale of EPI has seen a steady growth. According to incomplete statistics, the total market of world EPI had reached about 600 billion USD by 2001, just second to the IT industry. Furthermore, this market is still in the process of rapid growth and ascending. On the other hand, there is an unbalanced situation in development speed among different areas. For example, the OECD market takes 80% of the world market share. Developed countries with monopoly positions include the U.S., Germany and Japan. Along with the development of the world economy, environmental protection markets in Asia, Latin America and Eastern Europe are gradually opening to the world and will also see a trend of rapid growth.
At present, world markets for EP equipment and services are mainly dominated by the developed countries and regions like America, Japan, and Europe. Because the environmental protection technologies of these countries are quite similar and the demand of their domestic markets nearly saturated, the world environmental protection market is becoming severely competitive. The desulphurization and denitrification process of the U.S., the dust removal and garbage disposal technology of Japan and the wastewater treatment technology of Germany are far ahead of the rest of the world. The obvious backwardness of developing countries’ environmental protection technology makes them the market the developed countries are scrambling for. They adopt various kinds of measures to encourage the export of environmental protection technologies. The U.S. Government once publicly announced that the environmental protection products would enjoy export tax exemption and export credit preferential policies. The U.S. Commerce Department also established the Environmental Protection Products Export Office for world marketing of environmental protection products. The Japanese Government put forward “the Program of Green Earth Century Activities” and actively supports its domestic EPI. Successive German governments have put the environment development as a high priority. Some other countries like the Netherlands, Australia and Italy also have their unique advantages in environmental protection technology.

At the same time while scrambling for overseas markets, developed countries also constantly introduce new “environmental standards” so as to build up new trade barriers. The U.S. and Europe lengthen the embargo list in the name of environmental protection, or make the environmental quality standards for imported products even stricter. For example, Germany, France, the Netherlands and some other countries have imposed azo-free inspection on the imported textile dyestuffs, then on February 13, 2003, the EU announced Directive 2002/96/EC on waste electrical and electronic equipment (WEEE Directive) and Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive). China and other developing countries will encounter new trade barriers in exporting
electrical and electronic products to Europe. The two Directives cover a wide range of products, imposing heavy restrictions on electrical and electronic products to be exported to European countries, and even on the future development of the whole electrical and electronic products sector.

3.1.2.2 Characteristics of the development of EPI

The mass enthusiasm to protect the global environment is impacting the whole world. In order to meet the demand of environmental protection, the orientation of product development has greatly changed in developed countries; “green products” have become the mainstream of market. The concept of balancing “ecological interests” and “economic interests” has been gradually accepted by the public. “Comprehensive utilization of resources and adoption of non-waste technology” have been raised to the heights of international marketing strategies. Now the development of the EPI has following major characteristics:

(1) High-tech industry and EPI are interpenetrative. The maturation period of environmental protection science and technology has been greatly shortened and new technologies and processes in EPI are being generated constantly. Advanced technologies, highly effective equipment, highly automated controls and new alternative materials reflect the characteristics of the development of the EPI. Bio-engineering is used in EPI more and more widely. The constant development of the bio-engineering industry will address those environmental pollution issues that cannot be addressed with traditional engineering technologies. Electrical technology has been used more and more in bio-engineering and gradually became a newly emerging force in the EPI. Electronic technology software has been developed for and applied in environmental protection operations such as automation of wastewater collection, automatic analysis and various kinds of status simulation of the atmosphere, water quality, ocean and heat polluted wastes etc. Electronic technology is used in hardware development and applications to reduce error to the minimum.

(2) Ever closer cooperation with the management technology industry makes EPI a “rising industry” one supported by the government. Foreign countries mainly depend on laws and regulations as well support of science and technology to manage
the environment. We can say EPI is the fusion of science and technology and an important means to address environmental problems.

(3) “Green products” and clean techniques have become the mainstream of the EPI. Global environmental crises have made people deeply aware of the fact that to address the problems of environment it is not only necessary to control from the tail but also necessary, and even more important, to control from the head to make fullest use of the resources and energy and eliminate pollution in the process of production. “Green industry” covers a wide range. Governments of some developed countries had adopted active policies to promote the development of the green industry. For example, the developed countries adopt compulsory means to implement standards for discharge of pollutants, give tax preference to cleaner technology and mark the product with appropriate symbols like regenerated, pure, natural, pollution-free, in accordance with standards of environmental protection and so on. At present, overseas EPI is already able to provide air pollution control equipment, water pollution treatment equipment, solid wastes treatment equipment, noise control equipment, specialized environment protection equipment and medicament, specialized environmental monitoring instruments and comprehensive analysis equipment, which can be divided into 6 systems, 80-plus categories and 1,000-plus varieties of products with ability to treat all kinds of pollution already recognized by humans. Furthermore, their pollution controls have been oriented to resource and energy savings, i.e. converting the wastes into regenerated resources. In developed countries pollution control initiatives are close to 100% coverage.

3.2 Market Prospect of EPI in the World

3.2.1 Key Factors Influencing Market Prospect of EPI in the World

3.2.1.1 High-tech oriented environmental protection facilities, technologies and products

Environmental protection technologies of developed countries are becoming more sophisticated, and the products are becoming more popular and standardized.
Now, new equipment, new energy saving technologies and bio-engineering technologies are being introduced to EPI in an endless flow.

(1) **Air pollution control technologies and equipment**

Major air pollution control technologies can be divided into dust removing technology, desulphurizing and denitrifying technology, hazardous wastes removing and deodorizing technology etc.

Modern electronic technology has gradually been introduced into the dust removal devices in developed countries. The electronic dust removing devices are now using an impulse charge. For example, the cyclone dust remover can remove 10-100mc power, with tilted bottom board and twisted bottom board etc. In order to enhance control of particles and collection of high ratio resistance ash with fiberglass carded felt, Teflon fiber and stainless steel fiber, Japanese firms have developed a super high pressure, wide interval, dust catcher and two-stage precipitator, while steam dust catchers, 3-electrode-board precipitators and shielded electrical precipitators are used in the U.S.

Moreover, some new dust removing technologies are being tested, such as acoustically assisted ash removal, particle cohesion technology, high-pressure steam ejection, electrified wet cleaning and compound cleaning. All these new technologies will inject new vitality to the traditional dust remover sector. For example, in desulphurizing technology, the Selective Catalytic Reduction system (SCR) is widely adopted in Japan and Europe, achieving a removal rate of nitrogen oxides of 60-80%, while the U.S. has adopted an up-to-date improved system of Selective Non-Catalytic Reduction (SNCR), increasing the removal rate of nitrogen oxides to 80%. New technology to reduce nitrogen oxides and SO$_2$ is still under development, but the prospects are very promising.

(2) **Technology and equipment for wastewater pollution control**

Developed countries use various kinds of water treatment equipment with reliable results. Water treatment equipment mainly includes industrial wastewater treatment equipment, urban sewage treatment equipment, dejection treatment equipment and sludge treatment equipment.
In industrial wastewater treatment technology, application of high-tech products has given the developed countries an absolute advantage in the world market. For example, the ultra-filtration equipment developed by the UK is widely used around the world in industrial wastewater treatment and other sectors like papermaking and food processing. Japan’s Dawang Paper Making Company has the world largest ultra-filtration wastewater treatment unit. In the U.S., about 10 reverse osmosis and ultra-filtration systems have been used in nuclear power plants.

The market for urban sewage treatment equals the industrial market. Most developed countries usually construct sewage treatment plants to treat urban sewage collectively. The treatment rate of urban sewage there usually exceeds 60% and these plants are used in over 90% of cities. The running capacity of technology and equipment is much higher than that of developing countries.

(3) Technology and equipment for solid wastes treatment

Solid wastes mainly include industrial wastes and urban garbage. Developed countries mainly use resource recovery and harmless technologies to treat such wastes. Industrial wastes treatment processes mainly include recycling, landfill, incineration, intermediate storage and overseas treatment etc. Along with improvements in legislation and management systems for solid wastes, developed countries generally give priority to research and technology development in this area, making all efforts to reduce initial generation of wastes and then recycling wastes before treatment or disposal as the final step.

At present, the developed countries use sanitary landfill; composting and incineration to treat urban garbage, and also build rubbish powered generating stations. In Japan, there are definite provisions on classification and collection times of domestic garbage. The garbage is divided into five classes: recyclable, combustible, incombustible, toxic, and large-size. In the treatment of “white pollution”, developed countries mainly depend on high technology to develop light degradable plastics, fully biodegradable plastics and light/biologically degradable plastic in addition to strictly forbidding or limiting the use of disposable plastic products, by legislation. Moreover,
the development of plant plastics through genetic engineering is a significant breakthrough.

3.2.1.2 World economic development and EPI

As estimated by economists, under the influence of uncertain political and economic factors such as international political pressure, unemployment, inflation and a financial credit crisis faced by the developed countries like the U.S., Europe and Japan, the economic recovery was slow and the outlook for economic growth was not positive in 2003. On the contrary, according to the World Bank forecast for the next two years, Asia will be the bright spot of the world’s economy. China is still the country with the fastest economic growth. With government investment in capital construction and other economic measures, the growth rate of China’s economy will reach 7.49% in 2003. Ranking just behind China, South Korea and India also will see vigorous economic development, with growth rates at 5.38% and 5.11% respectively.

Along with the development of the world economy and specialization in the international work force, the production of ‘world’ products that enjoy international acceptance is becoming the norm. The demand for environmental protection products and services is gradually changing along with the world economic development in manufacturing, trade and investment sectors. In a panoramic view of the world, EPI is developing from miniaturization and decentralization to intensification of scale and from low level and single operation to high-tech and systemization. In the recent decade, emerging industrial countries and regions including developing countries like China, Mexico, India and Thailand have seen rapid growth in the demand for environmental protection equipment and services. All countries are scrambling to improve their environmental protection technology to occupy the ‘high ground’ in the international environmental protection market and promote trade in environmental protection products and services.

The discouraging economic situation in the U.S., Europe and Japan has made trade protectionism prevail in the world and trade frictions with anti-dumping, anti-subsidy and safeguard mechanisms as the major weapons have become “the war without fire” in the economic development of each country. Most recently, some
developed countries constantly use various kinds of green barriers like green technical standards, green environmental standards, green packaging standards, green health quarantine systems and green subsidies in the world market to restrict foreign goods from entry to their domestic market. This is virtually a new kind of trade protection means adopted by developed countries against the developing ones. In the future, developed countries will likely adopt even more rigid environmental standards as well as laws and regulations. This will create a serious adverse impact on the production and export of the developing countries.

3.2.1.3 A new round of WTO negotiation on environmental protection products and services

**1 Focal points of the negotiation**

In November 2001, the Ministerial Conference of Doha announced in the Doha Ministerial Declaration (DMD) the Doha Development Agenda, marking the start of a new round of multilateral trade negotiation.

According to the requirement of paragraph 31 (iii) of DMD on “reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services”, countries are rushing to prepare the negotiation strategies on the topic of goods and service trade. The developed countries will pay much attention to this, because:

- There is not a coherent definition on environmental products and services in the world and DMD makes no further definition of “environmental products and services” either. At the same time, the level of environmental products and services has a large gap between developed and developing countries. In these circumstances, how to define environmental products and services is one of the focal points of the negotiation. At present, the discussions are mainly concentrated in whether the list of environmental goods and services would be based on the list of APEC or OECD and whether the list will be brought into PPM.

- The site and task division of the negotiation on trade liberalization of environmental goods and products will influence the results, and the status of the negotiation on this topic in the new WTO round and its relationship with other topics
and balancing interests are also important factors, influencing the starting points in the talks.

- Trade liberalization of environmental products and services is beneficial to the developed countries, but their technology transfer to the developing countries is under various kinds of restriction. Therefore, issues about the transfer of environmentally friendly technology are a concern to developing countries in the talks.

(2) Analysis of the factors influencing trade liberalization of environmental goods

Because the negotiation will focus on the definition of scope of environmental goods, the factors influencing trade liberalization of environmental goods can be analyzed as follows:

- Tariff. In general, the average tariff of environmental goods of Canada, Europe, Japan and the United States is very low. With respect to individual goods, the actual customs duty rate is no more than 6% or even lower than 3%. Only a few non-chemical products imported into the EU and Canada carry a rate of 10-12%, the peak value of tariff (much higher than the average duty rate on industrial products).

According to the analysis on the other three OECD members (South Korea, Mexico and Turkey), the average actual customs duty rate and bound duty rate are 9% and 25% respectively. Only South Korea’s average bound duty rate was lower than 10% in the Uruguay Round.

Similar patterns are shown in the analysis on the 7 emerging developing countries (Argentina, Brazil, Chile, Malaysia, India, Indonesia and Thailand), but their protection level is a little too high. The average actual duty rate of the whole industry is 18% and average bound duty rate is 29%. But actual duty rates on many products are 35% and 40%, and in India, the actual duty rate on many products is as high as 100% or 150%.

At present, EPI goods usually fall into capital output or intermediate input of production. Their import plays an important role in the development of domestic industries and their price tends to be lower than other consumer goods (governments
often provide protection to domestic producers). Usually, developing countries are rather unwilling to compete with developed countries with their domestic EPI, but only adopt low tariff strategy for some specified goods in test/analysis and assessment areas such as precision instruments.

- Public procurement. Another factor influencing trade liberalization of environmental goods is government procurement. It is very difficult to quantify the trade obstacles in public procurement, but on the other hand, government procurement is also beneficial to many environmental service providers. According to quantitative statistics of OECD, the results of comparison between the central government procurement mode and the private sector import mode in major OECD countries show that the discrimination degree of the former’s preferential treatment of domestic products is equivalent to a tariff increase of 8-18%. And as shown by the results of an investigation of the U.S. International Trade Commission (ITC) on U.S. air pollution control enterprises, discrimination is very serious in all the procurement activities of both the government and private sectors. Today, governments can use domestic suppliers’ environmental goods mainly by influencing policy on water supply and treatment, wastewater collection and disposal, energy systems, cleaner technologies and so on.

- Technical barriers on trade. Domestic laws and regulations on the environment usually determine the varieties of goods meeting the environmental requirements, and the environmental goods suppliers of the producing countries have to make adjustments to meet the requirement of the domestic laws and regulations. Strict domestic environmental requirements are decisive factors of competitive advantage, impacting the trade of environmental goods.

Design modes of environmental standards can enhance or restrain the possibility for them to become technical barriers on trade. On the other hand, if environmental standards are established for the purpose of matching the superiority of domestic suppliers (or specified foreign suppliers), the risks to generate technical trade barriers will exist in the process of management and control. With respect to developing countries, if the rules and regulations on environment are instituted with help of
foreign experts, they would be beneficial to the environmental goods producers of the country that has provided the advice and skew the market.

- Export promotion policies, development assistance and export credit. Almost all OECD member countries have export promotion policies, including market information projects, export credit programs and qualified assistance. The activities of sub agencies make the export market a real open market.

In general, OECD countries realize that SMEs undergo a comparatively difficult period to build up infrastructure for overseas operations and most of the infrastructure would be oriented to SMEs with a very large part of the EPI. So, it is rather difficult to promote the development of an EPI.

From 1992 to 1996, donor countries of OECD’s Development Assistance Committee (DAC) added 22.7 billion U.S. dollars to develop water and water treatment projects, renewable energy projects and common environmental protection projects, among which 14.6 billion U.S. dollars belong to capital investment, usually equipment investment. About one quarter is conditional assistance (used to buy donor countries’ export goods) or partly unqualified assistance (with relation to the exports of the donor countries and all developing countries). About 5% of this amount is “mixed credit” also used to support equipment exports of the donor countries. Germany, the Netherlands, Norway and Spain expanded their export credit for renewable energy and common environmental protection projects. Australia, Belgium, Canada, Finland, Italy and Sweden also expanded their export credit for water and sanitation projects. At present, China is the country that receives the largest amount of export credits for purchase of environmental equipment.

- Intellectual property rights (IPR). In case a country importing goods and services does not have a proper IPR protection system, the overseas exporters with the desired technology would be unwilling to provide services because they cannot get reasonable benefits and protection of their ideas and technologies. As shown by the results of an investigation on obstacles of scavenging technology transfer made by OECD in 1992, most exporters and importers expect their governments to reduce customs duty on scavenging technology, withdraw the provisions on the ratio for
self-manufactured content or limitation on buying foreign goods and enhance patent protection. In actual operations, trade policies’ influence on technology transfer is not so much. The real crux of the matter is the strictness of the laws and regulations on the environment adopted by each country and their effectiveness in application.

- Support to renovation and proliferation of technologies. Many OECD countries’ policies on renovation and proliferation of technologies are concentrated in providing financial support for increasing the supply of scavenging technologies.

As proved by the experiences of developing countries, order-plus-control policies can promote rapid proliferation of environmental technologies though they may restrict innovation. If order-plus-control policies block innovation, they also can promote the rapid proliferation of current environmental technology and at the same time influence the research and development of innovative technologies. OECD countries have already given attention to the relationship between technology policies and environmental policies, and are aware that environmental policy tools have different affects on innovation and proliferation. The focal point that the OECD countries need to discuss is how to design a mode that not only encourages innovative environmental policy tools but also promotes the innovation and technology proliferation policies to support the availability of scavenging technologies and products in a method according with cost-performance but not causing trade distortion results.

3.2.2 Comparison and analysis of regional environmental protection technology development and its market potential

3.2.2.1 Comparison of environmental protection technology development

The superiority of European and American countries’ key EPI is rooted in their basic industry or on their unique domestic conditions. For example, American heavy industry has emphasized the division of upstream and downstream, from which derived the world largest environmental consulting groups, with powerful ability of environmental assessment. Germany boasts excellent basic machinery industry, which has developed the world’s leading, large-scale air pollution control equipment and
wastes incinerator. The Netherlands, which pays much attention to research on drinking water and environmental protection, has seen much success in the development of water treatment technology. Environmental protection instruments need precision and sound quality management, and only Switzerland, the U.K and the U.S.A are the leaders in the precision instruments market and manufacturing capacity.

The major trend in world environmental protection technologies is the gradual transfer of development priorities from terminal treatment of wastewater and exhaust gas to management and reduction of wastes. Taking the evolution of U.S. environmental laws and regulations for example, the United States promulgated the Clean Air Act in 1970 and then promulgated the Federal Water Pollution Control Act in 1972. Several years later, it was found that large amounts of sludge and ash generated in the process of wastewater and exhaust gas treatment had no place to go, becoming the so called phase ‘shift of pollution’. As a result, the United States promulgated a series of new laws and regulations with relation to waste clearing, resource protection and cultivation and soil pollution control, starting from 1976 in succession, widening the environmental protection management from control of manufacturing sector’s emission of wastewater and exhaust air to the control of wastes.

Echoing to such a trend, advanced countries’ technology of terminal treatment of wastewater and exhaust gas was further developed to the level of treating micro-toxic wastes, but this also increased investment and operational costs at the same time. Therefore, the development speed of relatively new technologies dropped, thereby giving opportunity to improvement of current technologies and integration of unit technologies. At the same time, all countries actively supported the concept of upstream environmental control such as “industrial waste reduction”, “pollution prevention” and “cleaner production” to replace the traditional concept of treatment and disposal after generation of wastes.

In 1990s, environmental protection technology was gradually oriented to resource recovery and high level treatment technologies of wastes, making traditional environmental engineering and technologies lose competitiveness and at the same
time give special isolation technology (in large chemical companies or new material developers) and enterprises such as manufacturers of waste reclamation equipment, classification and regeneration equipment a prime spot in the emerging environmental protection market.

According to analysis, the growth situation and potential advantages of the markets in different countries and regions are quite different with different problems of regional environment. See Table 22 for details.

**Table 22 - Comparison of the growth situation and potential advantages of the EPI in major countries and regions**

<table>
<thead>
<tr>
<th>Country or Region</th>
<th>High-Growth</th>
<th>Mid-Growth</th>
<th>Low-Growth</th>
<th>Development Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Europe</td>
<td>Monitoring</td>
<td>Soil renewal</td>
<td>Wastes management</td>
<td>Monitoring</td>
</tr>
<tr>
<td>Germany</td>
<td>Reclamation of high-tech products</td>
<td>Air pollution control</td>
<td>Wastes management; Water treatment</td>
<td>Measurement and analysis; Soil renewal; Waste disposal; Wastewater treatment</td>
</tr>
<tr>
<td>France</td>
<td>Wastes management</td>
<td>Noise pollution monitoring service</td>
<td>Air pollution</td>
<td>Wastewater reclamation</td>
</tr>
<tr>
<td>U.K.</td>
<td>Soil renewal; Wastes management</td>
<td>Monitoring</td>
<td>Wastes treatment; Air pollution control</td>
<td>Wastes treatment; Wastewater treatment</td>
</tr>
<tr>
<td></td>
<td>Soil renewal</td>
<td>Air pollution control</td>
<td>Wastewater treatment</td>
<td>Wastes management</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------</td>
<td>-----------------------</td>
<td>----------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Europe</td>
<td>Water and wastewater</td>
<td>Air pollution control</td>
<td>Wastes management</td>
<td>Water quality</td>
</tr>
<tr>
<td>U.S.</td>
<td>Soil renewal; Wastes management</td>
<td>Air pollution control</td>
<td>Water and wastewater</td>
<td>Air pollution control, bio-techniques, solids recycling, nuclear energy, mining, agriculture, chemical use and monitoring</td>
</tr>
<tr>
<td>Canada</td>
<td>Wastewater</td>
<td>Air pollution control</td>
<td>Wastes management</td>
<td>Industry and resources; Emission of toxic wastes</td>
</tr>
<tr>
<td>Japan</td>
<td>Air pollution control</td>
<td>Wastes management</td>
<td>Water and wastewater</td>
<td>Air pollution control; Urban and industrial planning</td>
</tr>
<tr>
<td>Australia</td>
<td>Water and wastewater; Consultation service; Mining areas reclamation</td>
<td>Atmospheric monitoring; Cleaner production; Industrial pollution</td>
<td>Solid wastes management; Air pollution prevention and control</td>
<td>Consultation service; Mining areas reclamation</td>
</tr>
</tbody>
</table>
As we can see from the regional division shown in Table 22, Western Europe mainly sees a rather higher growth of the wastes management market; Northern Europe is strong in the monitoring market with potential advantages, secondary in soil renewal and rather poor in growth of wastes management; Southern Europe is strong in water and wastewater treatment; the United States sees a high growth in wastes management and soil renewal markets with air pollution control coming second and potential advantages mainly in monitoring and control systems; Canada is superior in wastes treatment market with potential advantages mainly in toxic wastes emission and control; Japan sees a high growth in air pollution control market, with wastes management coming second and water, wastewater treatment market in low growth and potential advantages mainly in air pollution control; Australia is mainly good at mining renewal, consultation services and wastewater treatment markets with potential advantages mainly in mining renewal and consultation services.

Moreover, according to data provided by the U.S. Department of Commerce Technology Administration Office of Technology Policy in 1998, the comparative competitiveness of the five major export countries – the U.S., Germany, Japan, U.K. and France – is summarized as follows:

- The United States is competitive in instruments and information systems, solid wastes management, hazardous wastes management, consultation and engineering services, innovation or industrial services, analysis service and environmental energy.
- Germany is superior at water treatment equipment, air pollution control equipment, wastes management equipment, resource reclamation and environmental energy.
- The U.K. and France are superior in water treatment service and water resources utilization.
Japan is competitive in water treatment equipment and environmental energy.

3.2.2.2 Comparison and analysis of potential of environmental protection markets

According to recent statistics, the shares of the U.S., Europe and Japan in the major environmental protection markets of the world were 37.4%, 31.6% and 17.7% respectively in 2000. However, along with the rapid growth of the emerging environmental protection market in Asia (except Japan) and other regions, such shares are expected to drop to 35.6%, 31.2% and 16.3% (Table 23) respectively by 2005. From 1995 to 2000, Asia (except Japan) will see the quickest growth among the world environmental protection markets, up to 16%, Latin America comes second (12%), and then Africa (10%) and Eastern Europe and Middle East (6%). The average growth rate of these areas is higher than that of the whole world (5%). (See Table 24)

**Table 23 - Trend of World Environmental Protection Markets (unit: 1 billion USD)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Market scale of the whole world</td>
<td>507.9</td>
<td>533.3</td>
<td>684.1</td>
<td>715.5</td>
</tr>
<tr>
<td>Distribution rate of world Markets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>38.7%</td>
<td>37.2%</td>
<td>35.4%</td>
<td>35.2%</td>
</tr>
<tr>
<td>Europe</td>
<td>29.6%</td>
<td>28.4%</td>
<td>27.1%</td>
<td>26.9%</td>
</tr>
<tr>
<td>Asia (except Japan)</td>
<td>4.6%</td>
<td>4.7%</td>
<td>5.9%</td>
<td>7.2%</td>
</tr>
<tr>
<td>Japan</td>
<td>15.9%</td>
<td>14.7%</td>
<td>14%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Other areas</td>
<td>11.2%</td>
<td>15%</td>
<td>17.6%</td>
<td>17.1%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
In the light of the growth trend of environmental protection products, water and wastewater treatment equipment amounting to 60 and 83 billion USD respectively in 1990 and 2000, at a growth rate of 4% in this period; waste management equipment amounted to 40 and 63 billion USD respectively at a growth rate of 6.4% in the same period; air pollution control equipment saw a growth rate of 4.4% from 1990 to 2000; the growth rate of other environmental protection equipment is estimated at 5.1%; growth rate of the whole world environmental protection equipment from 1990 to 2000 was estimated at 5%. Environmental protection service saw a growth rate of 7.4%, a little higher than that of environmental protection equipment. As shown in Table 25, there is little difference among the growth rates of various kinds of environmental protection products and environmental protection services are still the projects with the most potential.

<table>
<thead>
<tr>
<th></th>
<th>1994</th>
<th>1995</th>
<th>94-95</th>
<th>1996</th>
<th>95-96</th>
<th>95-00</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>165.9</td>
<td>170.4</td>
<td>2.7%</td>
<td>171.8</td>
<td>0.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>127.4</td>
<td>129.9</td>
<td>2.0%</td>
<td>133.8</td>
<td>3.0%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Japan</td>
<td>84.2</td>
<td>85.4</td>
<td>1.4%</td>
<td>87.1</td>
<td>2.0%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Asia except Japan</td>
<td>14.2</td>
<td>16.3</td>
<td>15.0%</td>
<td>18.9</td>
<td>16.0%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Latin America</td>
<td>7.4</td>
<td>7.8</td>
<td>6.0%</td>
<td>8.8</td>
<td>12.0%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Canada</td>
<td>10.8</td>
<td>11.2</td>
<td>1.0%</td>
<td>11.7</td>
<td>4.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Australia</td>
<td>6.2</td>
<td>6.5</td>
<td>1.0%</td>
<td>6.8</td>
<td>5.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>East Europe</td>
<td>6.4</td>
<td>3.7</td>
<td>5.0%</td>
<td>7.1</td>
<td>6.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Middle East</td>
<td>3.8</td>
<td>4.1</td>
<td>7.0%</td>
<td>4.3</td>
<td>6.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Africa</td>
<td>1.8</td>
<td>2.0</td>
<td>10.0%</td>
<td>2.2</td>
<td>10.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Total</td>
<td>428</td>
<td>440</td>
<td>2.9%</td>
<td>453</td>
<td>2.8%</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Table 24 - Growth Trend Comparison of Major Regional Environmental Protection Markets around the World (unit: 1 billion USD)
Table 25 - Comparison of Production Value and Growth Rate of Environmental Products around the World (1 billion USD)

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>2000</th>
<th>Annual growth rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>152</td>
<td>220</td>
<td>5.0</td>
</tr>
<tr>
<td>Water and waste</td>
<td>60</td>
<td>83</td>
<td>4.0</td>
</tr>
<tr>
<td>Water treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastes management</td>
<td>40</td>
<td>63</td>
<td>6.4</td>
</tr>
<tr>
<td>Air pollution control</td>
<td>30</td>
<td>42</td>
<td>4.4</td>
</tr>
<tr>
<td>Others</td>
<td>22</td>
<td>32</td>
<td>5.1</td>
</tr>
<tr>
<td>Services</td>
<td>48</td>
<td>80</td>
<td>7.4</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>300</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Data source: OECD

In comparison with the development of the environmental protection markets in Asian countries, the growth rates from 1997 to 2000 are 3-5%. Among them, the growth rate of Japan’s environmental protection market is 2%; South Korea 0-4% and Singapore 6-8%. The markets of China and India are in taking off and the growth rates are the highest at 10-14% and 12-16% respectively (Table 26).

With regard to the production value of environmental protection products, in Japan the market of environmental protection equipment, water treatment equipment and chemical equipment amounted to 5.5 billion USD, air pollution control equipment amounted to 3.3 billion USD, instrument and monitoring systems, US$1 billion, wastes management equipment 9 million USD, manufacturing and prevention technologies 500 million USD; in Japan’s environmental protection service market, solid wastes management amount to 29.2 billion USD, hazardous wastes management
3.8 billion, consultation and engineering 1.1 billion, analysis service 500 million, water treatment 9.5 billion; and in Japan’s environmental protection of resources, water public utilities amount to 10 billion and resource reclamation 12 billion. The whole EP market for Japan amounts to 85.9 billion USD.

South Korea’s share in the environmental protection market is about 4.27 billion USD with major components in the market including water utilities, air pollution control equipment, solid wastes management, water treatment, water equipment and chemical equipment. Singapore’s share in the environmental protection market reaches 870 million USD with major components including water utilities, solid wastes management, water treatment and air pollution control equipment. The environmental protection market in China is about 2.93 billion USD with water and chemical equipment, solid wastes management and water treatment as the major components.

Table 26 - Comparison of Environmental Protection Markets Production Value and Growth Rate of Major Countries and Regions in Asia and Australia (Unit: 1 billion USD)

<table>
<thead>
<tr>
<th>Country or Region</th>
<th>Growth Rate (%) (1997-2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>2</td>
</tr>
<tr>
<td>Australia</td>
<td>3-5</td>
</tr>
<tr>
<td>New Zealand</td>
<td>3-4</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>4-8</td>
</tr>
<tr>
<td>Singapore</td>
<td>6-8</td>
</tr>
<tr>
<td>South Korea</td>
<td>0-4</td>
</tr>
<tr>
<td>Taiwan</td>
<td>4-8</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2-6</td>
</tr>
<tr>
<td>Malaysia</td>
<td>6-10</td>
</tr>
<tr>
<td>The Philippines</td>
<td>6-10</td>
</tr>
<tr>
<td>Thailand</td>
<td>2-6</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>------</td>
</tr>
<tr>
<td>Mainland China</td>
<td>10-14</td>
</tr>
<tr>
<td>India</td>
<td>12-16</td>
</tr>
<tr>
<td>Others</td>
<td>10-12</td>
</tr>
<tr>
<td>Total</td>
<td>5-6</td>
</tr>
</tbody>
</table>

4. Policy Recommendations on the Development of EPI in Macao

Macao has made great achievements in environmental management and strategic policies, but still there is a gap when compare with the Mainland and Hong Kong. The basic condition for the development of an emerging industry is mainly decided by market demand. Supply and demand in the industry and the development of an industrial market have close ties with the region’s policies, plus legal, social, economic, cultural and educational factors. Therefore, to develop Macao’s EPI, it is necessary to design a long term sustainable development strategy, attract qualified scientists and technicians for environmental protection, perfect laws and regulations on environmental protection steadily, raise public awareness on environmental concerns, and encourage public participation in environmental protection, so as to create a demand for an industrial market that will promote industrial sales and innovations, raise cost-effectiveness, and show constant improvement by keeping the strong and eliminating the weak players. By adopting these approaches, Macao will create a ‘win win’ situation for simultaneous development of environmental protection, society and the economy.

4.1 Supplement and perfect current laws and regulations on environmental protection

Macao’s legal framework and structure of environmental protection are not perfect. In the long term, a perfect system of laws and regulations on environmental protection is an indispensable important link in the development of a broad-based EPI.

The environmental problems of Macao are mainly caused by domestic wastes and the pollution of basic supply facilities of household energy. So, it is recommended
that Macao’s environmental legislation should be perfected, strictly based on the theme of “municipal management”.

4.1.1 Perfecting legal management of municipal environmental protection

What is necessary is to perfect environment and development integrated decision-making mechanisms, with an accountability system in accordance with principles of environmental protection and community responsibility, enhance target management of integrated environmental renewal projects, establish unified supervision and feedback mechanisms, prosecute violations of the law on environmental protection. In the process of carrying out urban overall planning and specified project planning, the SAR should consider current needs and practice of environmental protection.

At present, all the costs of waste and sewage treatment in Macao are born by the SAR government without collecting an effluent charge from the residents. In the last decade, the amount of waste in Macao has been steadily increasing, putting pressure on the piling fields and incinerators. With constant expansion of the economy and its impact on the environment, legislation on hazardous waste management and automobile exhaust standards management is urgently needed. With the risk of infectious diseases such as SARS, laws, regulations and operational standards should be promulgated on toxic and hazardous wastes generated through accidents.

Over the long haul, Macao should gradually introduce the ‘polluter pays principle’ (PPP); taking into account residential development, business construction projects, and environmental protection; protect the interests of taxpayers and polluters alike; emphasize effective resource usage, wastes reclamation, etc., through gradual legislation to create a clean and green city.

4.1.2 Enhance environmental supervision

Perfect the environmental protection legal system. Promulgate and amend standards for noise, hazardous wastes, automobile exhausts and air pollutant emissions and emission standards for volatile organic pollutants; consider a pollution charge on SO2, nitrogen oxides and other pollutants, carry out strict collection, sterilization, disposal and management methods for infectious solid and liquid wastes;
enforce existing environmental laws by providing more trained supervisors and managers, and publicizing their law enforcement capacity.

Taking the practices in the Mainland and Hong Kong for reference, Macao should improve management systems to realize overall control; gradually establish and strengthen emission policies, registration and licensing systems within a prescribed time limit; perform risk assessment, post assessment and environmental policy assessments on construction projects in environmentally sensitive areas.

Establish an environmental pollution monitoring center to integrate and update current scattered monitoring systems; develop a modern environmental emergency response system and relief forces; attend to the role of advanced environmental protection techniques and give priority to developing an environmental technology service.

4.1.3 Carry out relative environmental economic policies

Enhance the study of environmental economic policies adaptable to the requirements of a market economy; analyze the economic viability of eco-environmental protection measures; introduce a ‘user pays’ system on urban garbage and sewage treatment, strengthen policies on the use of clean and renewable energy, garbage reclamation, residential and commercial demolitions and comprehensive use of wastes; invite public input on the development of environmental economic policies; attract investment and enhance international cooperation.

4.2 Constitute Sustainable Development Strategy and Guideline and Forge Ahead with Macao’s Sustainable Development

4.2.1 International communities are actively forging ahead with sustainable development

In the decade after the Rio Declaration at the UN Conference on Environment and Development 1992, held in Rio de Janeiro, to the Johannesburg Declaration on Sustainable Development at the World Summit on Sustainable Development 2002, in Johannesburg, all countries and international organizations have recognized the
significance of sustainable development and have begun to constitute their own Agenda 21 and sustainable development strategies according to the consensus reach at the Rio Conference and their own conditions. The development and implementation of such agenda and strategies have been the keys to promoting sustainable development everywhere.

International consensus on the basic value principle of sustainable development has been gradually enhanced in the following three respects:

(1) About 100 countries and regions have written their own Agenda 21 or sustainable development strategies. Some state or regional governments have not yet adopted Agenda 21 or perhaps their sustainable development strategies are not called “Agenda 21”, such as “Sustainable America: A New Consensus” introduced by the United States and “Stride Toward Sustainable Development – Implementing the UN Decision on Environment and Development” passed by the Swedish congress. Others have adjusted their national development strategy in accordance with Rio’s Agenda 21, such as Australia’s “National Strategy for the Conservation of Australia’s Biological Diversity”, Canada’s “Green Program”, Japan’s “Rising Sunlight Program”, the EU’s “Fifth Community Program of Policy and Action in Relation to the Environment and Sustainable Development” and so on. All these countries and regions have made sustainable development part of their own development strategy and put forward a series of specific action programs. At the same time, the work of constituting and implementing Agenda 21 and sustainable development strategies has been pushed rapidly to local levels from the state level. More than 2,000 regions in the world have created their local Agenda 21 or sustainable development strategies.

(2) After the world conference on environment and development, more than 150 countries have established national committees or coordination mechanisms for sustainable development and several dozens of countries submitted reports on implementation of Agenda 21 to the UN Sustainable Development Commission, reflecting their progress and achievements in efforts to realize their targets. Some developed countries like Germany, Finland, Sweden and the U.S.A. established their own sustainable development commissions or similar institutions (such as the
President’s Council on Sustainable Development of the United States). Among developing countries, South Korea established State Environmental Commission on the foundation of the former State Environmental Protection Commission, which not only effectively coordinated the country’s environmental policies but also promulgated a series of measures to cooperate with UNEP. Specified institutions in charge of the national sustainable development of Thailand are the State Economic and Social Development Commission and the State Environmental Commission; The Philippines, South Africa, Brazil, India and others also established councils or commissions on sustainable development. In general, all countries, both developed ones and developing ones, have established, adjusted or perfected related institutions in order to implement their sustainable development strategies even better.

(3) Many international organizations or world bodies have adjusted their structures or promulgated new guidelines according to the principle of sustainable development and a lot of new international organizations, international conferences and international treaties on sustainable development came into being. For example, as proposed by the Conference on Environment and Development, the UN system set the UN Commission on Sustainable Development (UNCSD) under ECOSCO; the UNDP set up Capacity 21 as its specific executive agency for sustainable development in each country. To support each country to implement the sustainable development strategy, the World Bank made overall adjustments to the loan items and constituted strategies to support, industries and regions to promote settlement of issues related to world sustainable development. The Asian Development Bank (ADB) increased its support to environmental and resource protection projects and classified them based on their degree of influence to the environment. Regional organizations like EU and ASEAN also constituted their own sustainable development strategies and action plans. The World Business Council for Sustainable Development (WBCSD) and the Earth Council are typical non-government organizations born after the UN Conference on Environment and Development. By using their influence in business circles, they are trying to promote world wide sustainable development. Moreover, various kinds of international conferences, resolutions, treaties and statements on
sustainable development, sponsored or organized by the UN, governments or NGOs are ‘in the pipe’. Some acts passed at the Conference on Environment and Development are also under implementation or negotiation.

4.2.2 Sustainable development strategy of the Mainland


At the same time, China also enhanced its legal and management systems for sustainable development. By the end of 2001, the country had promulgated or improved one law on population growth and family planning, six laws on environmental protection, 13 laws on natural resource management and 3 laws on disaster control and relief. The State Council has promulgated 100-plus rules and regulations on population, resources, environment and calamities, providing a series of practical and feasible systems for enforcement. The People’s Congress also established the Environmental and Resources Protection Committee that plays an important in role in drafting laws and supervising their implementation.

In 2002, government submitted the “State Report on Environment and Development of the People’s Republic of China” to the Summit Conference on Sustainable Development, giving an overall summary of the situation and the
achievements of government in implementation of a sustainable development strategy since 1992, and especially since 1996. It described the process in using related documents of the UN Conference on Environment and Development, China’s implementation of sustainable development strategy in the future, and China’s basic and principal views on several international issues about sustainable development. In July 2003, government issued the “Action Plan for Sustainable Development in China in the Early 21st Century”, clarifying the targets, basic principles, key sectors and measures for China to carry through on its sustainable development strategy.

China has been actively and effectively driving the implementation of its sustainable development strategy and has made outstanding achievements in different sectors. This was especially important during a time of overall economic development, social changes, and a steady rise in living standards. As a result, population growth was effectively controlled, natural resources protection and eco-system management were enhanced, the pace of ecological construction was quickened and the environmental quality in some cities and regions was improved.

4.2.3 Sustainable development strategy of Hong Kong SAR

The Hong Kong Special Administrative Region (HKSAR) started policy research on sustainable development rather earlier, with the establishment of a sustainable development committee that had met three times by September 15, 2003.

The task of this committee was to prepare for the promulgation of a sustainable development strategy. Sustainable development in Hong Kong has wide implications, including social environment, economic and environmental. So, the committee developed 8 guidance standards and 39 indexes for sustainable development. Establishing this committee was one of the measures adopted by the Chief Executive and its terms of reference mainly included:

- Provide recommendations on promoting priority projects of sustainable development to the government;
- Provide recommendations for a set of sustainable development strategies, integrating economic, social and environmental factors;
- Encourage community participation to promote Hong Kong’s sustainable
development through different channels, including grants from the sustainable development fund;

- Promote public recognition and understanding of the principle of sustainable development.

Members of the committee were appointed by the Chief Executive, and were composed of high government officials and well experienced specialists from environmental protection, public service and business circles. The sustainable development committee helped to stimulate the whole society to discuss the sustainable development of HKSAR and encourage various figures and groups to exchange ideas on these topics. A sustainable development task force, reporting to the CE’s office provides practical support to the sustainable development committee.

At present, the government of HKSAR has established a fund of 100 million HKD to finance the sustainable development and related research.

4.2.4 Necessity and feasibility to promote sustainable development in Macao

To implement sustainable development strategy in Macao, consideration should be given to several aspects including social development levels, economic strength, government attitude and control and regional cooperation:

- Social development

Macao’s is a dynamic and safe community which is enjoying improved living conditions and better health care. Improvements are still needed in law enforcement, education, science and technology, cultural affairs and hygiene.

- Economic strength

Economic strength is sustained by wise use of resources, including natural, financial, and human and the ability to attract overseas investment or to develop a market for exports.

Macao has few natural resources and is very small when compared with its immediate neighbors, Mainland China and HK. Only by implementing a sustainable development strategy to gradually improve the relationship between society, economy
and the environment, shall the existing shortcomings be offset allowing Macao to be truly competitive.

- **Government Position**

  The Macao government is in a strong position and has shown great skill in managing the economy, especially during this unique period of rapidly expanding revenues from the gaming industry. It enjoys the confidence of its citizens. These factors are effective assurance for Macao to be able to implement a sustainable development strategy in the future. However, compared with the Mainland and Hong Kong, Macao still lags in the formulation and implementation of a sustainable development strategy. Therefore, the top priority at present is to enhance scientific research and investigation.

- **Regional cooperation ability**

  Macao officially signed Closer Economic Partnership Arrangement (CEPA) with the Mainland on October 17, 2003. Now, with CEPA in its initial phase, Macao will make joint efforts with Hong Kong and the Pearl River Delta to promote local development. At present, Macao is comparatively weak in economic structure, human resource, geographic resources and natural resources. Therefore, only by constantly perfecting its economic and social conditions, persistently developing science and technology and continuing to develop a truly unique city can Macao play its key role in the region.

4.2.5 **Construct a city of sustainable development**

  It is necessary to consider ecological costs to the whole society in the process of economic and social development planning and decision making in order to build a model city on the sustainable development principle.

  To carry out the policy of “one country, two systems and Macao people administering Macao” with a high degree of autonomy, Macao should maintain wide international connections. It’s especially important to maximize its connections with Portuguese speaking countries. Pilot sustainable development projects in Macao will greatly promote the development of a local EPI. Among others, the key construction
sectors include: research and establishment of related policies and legal systems, integration of existing management and supervisory departments, integration of scattered environmental analysis monitoring and information systems, popularization and application of city three wastes control techniques, cultivation and heightening of civic education on environmental protection and environmental ecology awareness, establishment and development of regional cooperation mechanism, and international cooperation.

Along with new work in these aspects, scientific research on ecological environment and a consultation industry should be established with analytical institutes established. This would not only generate a batch of self-developing enterprises and organizations, but also attract a large number of young intellectuals into this industry and increase the employment rate of Macao.

4.3 Develop Environmental Education and Foster Environmental Awareness

Environmental education is not only important to the environmental protection cause, but it is an important element in developing ‘quality’ citizens. Only with sound development of environmental education as the basis can the whole EPI be seen as a virtuous centre of appropriate, sustainable development.

Environmental education concepts in Macao have taken root just in the last dozen years. In the early 1990s, a consensus on the importance of environmental education was reached among different circles, but it is still at the initial phase of “each goes his own way”. In order to perfect Macao’s environmental legislation, promote EPI development and realize sustainable development, the following recommendations are set forth including basic education, professional education, training, social education and publicity.

4.3.1 Basic education on the environment

Basic education is oriented to primary children. The major tasks include teaching environmental protection knowledge, organizing environment-related activities and cultivating their environmental awareness. At present, the environment as a discrete
subject has not been added to Macao’s middle and junior school programs, and environmental studies are usually integrated into other courses such as general knowledge, geography, physics, biology and chemistry.

It is recommended to list the content of environmental education in the working plan of middle and junior schools. One or two middle and junior schools can be selected to start a pilot environmental education program under the support and financial aid of the government. The selected schools can design the content and select the textbooks to create green schools. When these ‘pilots’ have been tested and refined, the government should introduce a city-wide environmental education curriculum and teaching materials for middle and junior schools to implement.

In the Mainland, environmental education has been listed in MOE’s “General Outline to Enhance Education about National Conditions in Middle and Primary Schools” and “Outline of Each Subject in Compulsory Education in Primary and Middle Schools”. According to statistics, there are already more than 50 versions of middle and primary school teaching materials, reading materials and guidance materials edited by the departments in charge of environmental protection and education. More than 2 million copies have been issued. More than 50,000 middle and primary schools around the country offer courses in environmental education, creating a network of basic education on environment in the country.

It is recommended for Macao to cooperate with bodies in charge of environmental publicity and education in the Mainland to promote exchanges of personnel involved in environmental educations in middle and primary schools between the Mainland and Macao, cultivate local talents in environmental education and push forward the development of basic education about environment through communications between students of the two areas and establish a network of linked classrooms.

4.3.2 Education and research on environmental specialties

Targets of the environmental specialty education are the students of secondary schools, universities and colleges in environmental specialization, and main task is to
cultivate and nurture scientific and technological personnel and management talents for the EPI.

In environmental specialty education, there are only the civil and environmental academic degree programs in the Science and Technology Department of Macao University and related programs in Macao Polytechnic Institute. Environmental research mainly includes academic environmental research as well as monitoring and study on specific environmental issues by academic institutes, professional bodies and independent scholars from Macao University, Macao Development Strategy Research Center and different government departments such as the Environment Committee, Meteorological and Geophysical Bureau, Port Authority, The Civic and Municipal Affairs Bureau and Department of Health. The major research subjects are air pollution sources, automobile exhaust, noise, hydrographic surveys, sea bottom sludge pollution, drinking water quality, coastal water quality, traffic and transportation pollution, POPs, environmental management, urban development strategy, environmental mathematical models and legislation on environment.

Macao boasts rich education resources and 14 public and private universities and colleges. The per capita education resources of Macao rank very high in the world. It is recommended to make full use of Macao’s education resources to expand specialization and infrastructure of current universities and colleges under the guidance of policies and market demand. For example, with a view to becoming more internationalized than the Mainland in public affairs management and administration and to attain superiority in knowledge acquisition and language study, Macao’s education system should consider adding programs about environmental management and gradually broaden and deepen such specialties so as to attract Mainland students and promote the development of an environmental education industry.

At present, more than 140 universities and colleges in the Mainland provide environmental specialties, including 206 undergraduate courses with 223 units granting master’s degrees, and 39 specialty doctoral programs with 77 units granting doctorates and post-doctorate positions. Compared with Macao, large cities like Beijing and Shanghai have superiority in education and research on environmental
engineering specialties. Macao can invite talents in environmental engineering and environmental monitoring sectors from the Mainland for discussions based on local demand to promote technology development of local EPI and enhance cooperation with Mainland research institutes on actual projects.

4.3.3 Training and education on environment

Training and education mainly include on-the-job training and continuing education. The main purpose is to upgrade the professional standards of those employed in EPI.

In professional training on education, Macao’s government departments, academic institutes and social groups have organized different programs, such as environmental protection, summer vacation teacher training programs, environmental voluntary work training classes, environmental noise monitoring programs, environmental legal programs, training programs on design standards for city water supply and discharge engineering, advanced training programs on remote-sense technique, advanced training programs on geographic information systems and others. Among these, IT management and application are comparatively weak in the Mainland. It is recommended that Macao could cooperate with the Mainland local environmental information departments to open joint workshops to promote the development and application of environmental protection techniques and organize technical experts to provide consultation services to the Mainland. Moreover, Macao boasts a lot of market oriented management expertise in incinerators, sewage treatment plants, power plant and waterworks operations, which also can be developed as pilot experiment stations to attract the Mainland specialists.

Moreover, the Mainland also holds various kinds of professional training classes and on-the-job training classes on environmental protection in universities, colleges and different training institutes around the country to train the management personnel in science and technology development, monitoring and supervision in environmental protection system. Among them, personnel in very specialized areas such as environmental impact assessment are valued highly in the Mainland, but they must
pass strict examinations and receive competence certificates before being employed. It is recommended that Macao could actively cultivate professional personnel specialized in environmental impact assessment and technical monitoring aspects and give emphasis to the expansion of the varieties of environmental education by using for reference the experiences of the Mainland in these aspects. At the same time to cultivate local talents and open the EPI market, Macao also can get involved in the Mainland environmental management and consultation market by means of joint ventures.

### 4.3.4 Social education and publicity

Social education has a wide range of targets in various circles, and the main challenge is designing suitable teaching materials, promulgating environmental protection knowledge, encouraging environmental protection behavior and strengthening environmental ethics and awareness. In recent years, Macao has achieved certain progress in social education and awareness on the environment, but the participants are mostly volunteer workers, students and members of social groups. There is a certain limit to their effectiveness.

It is recommended to give emphasis to business and consumer-oriented environmental education to promote long-term changes in manufacturing and living styles.

Those businesses and consumers with investment and consumption ability can have a positive or negative impact on the environment in their spending habits so they should be the major targets of environmental education. The environmental education oriented to business and its decision makers should reinforce the concepts about environmental direct and indirect costs of economic activities, to persuade businesses to willingly adopt recycling in their production mode, conduct environmental impact assessments on their products and spare no efforts to reduce or deny any economic decision or action that is detrimental to the environment. Consumer-oriented environmental education should encourage the consumers to turn to an environmentally friendly living style voluntarily, and make the consumers fully aware
of the concept that their purchases and personal choices are important ways of voting ‘green’. The government should promote a green consumption movement, impart knowledge about selecting real green goods, guide consumers to make conscious decisions to select environmentally friendly goods and support companies that provide environment-friendly goods.

Macao’s environmental publicity and education also can be combined with environmental expositions and international workshops, and communications between Macao and other areas, particularly the Mainland, on environmental publicity activities by organizing environmental education and publicity seminars.

4.4 Gradually Establish and Perfect EPI Development System

Gradually establish and perfect the coordinating mechanism and system for EPI development, promote scientific research on environmental technologies and enable the EPI platform to see a steady development through cooperation and communications among private citizens, business and government.

(1) Through EPI social groups, businesses or government departments, the Mainland counterparts can be organized for site visits in Macao and inspection of Macao’s EPI infrastructure and enterprises. At the same time, Macao’s business leaders could also visit the Mainland to exchange ideas about EPI enterprises;

(2) The Internet should be used to build up an information platform for Macao’s EPI. At the same time to enhance education and publicity to business and consumers with ability to invest and consume, it is also necessary to build up a network for exchange of environmental products information, reaching the level accepted by the rest of the world so the investors or business owners can get related information quickly and build up their confidence in the EPI market gradually.

(3) The concepts of environmentally friendly construction and green infrastructure must be established. It is expected that the construction industry will flourish in the next few years along with the economic
development in Macao and therefore, green construction should be promoted. Environmentally friendly building materials, energy-saving equipment and environment-friendly technologies like wastewater reutilization, wastes classification and reutilization and exhaust gas treatment should be comprehensively used in the architecture design and construction process to promote the development of environment-friendly construction. Moreover, in the process of sewage pipeline design for building construction or reconstruction, environmental consideration should be given so as to prevent the spread of disease. The development of an effective, low pollution public traffic system should also be considered.

(4) Ecological tourism with Macao characteristics should be developed. In the light of the development target of Macao with tourism and gaming industry as the backbone, sound environment quality is one of the critical elements. On the other hand, multivariable tourist pattern is another important factor alluring tourists to stay in Macao. In addition to the developed gaming tourism and cultural tourism, there are also lots of ecological resources. For example, in the ecological zone, the SAR government is now trying to construct in the reclaimed area between Taipa and Coloane, there are mangrove forests with extremely high ecological value, many endangered birds like Platalea make short annual visits, and the Sousa Chinensis also can be seen. All these are the base to develop ecological tourism. Furthermore, in the light of the geological connection between Macao and the Mainland cities like Zhuhai, it is also possible to make full use of the system of CEPA and Guangdong-Macao joint conference to enhance cooperation with neighboring Mainland cities to construct an ecological tourist circle and share ecological tourist resources similar to the current Hong Kong-Macao tourism structure.

4.5 Consideration of Constructing a Model City of Sustainable Development

To carry out the policy of “one country, two systems and Macao people
administering Macao” with a high degree of autonomy, Macao should maintain wide international connections. It’s especially important to maximize its connections with Portuguese speaking countries. Pilot sustainable development projects in Macao will greatly promote the development of a local EPI. Among others, the key construction sectors include: research and establishment of related policies and legal systems, integration of existing management and supervisory departments, integration of scattered environmental analysis monitoring and information systems, popularization and application of city three wastes control techniques, cultivation and heightening of civic education on environmental protection and environmental ecology awareness, establishment and development of regional cooperation mechanism, and international cooperation.

Along with new work in these aspects, scientific research on ecological environment and a consultation industry should be established with analytical institutes established. This would not only generate a batch of self-developing enterprises and organizations, but also attract a large number of young intellectuals into this industry and increase the employment rate of Macao.

The core of developing a model city of sustainable development is to gradually build up the concept of ecological capital in the society, to integrate the environment and resources effectively with economy and society during planning strategy. This is also the basic force of development various types of environment enterprises.

5. Superior Areas of EPI Cooperation between Macao and the Mainland

5.1 Analysis on the Basic Situation of EPI Cooperation between Macao and the Mainland

Like Hong Kong, Macao is an independent member of the WTO. The SAR occupies a special position in China’s political and economic decision making. In the regional economy of the “large Pearl River Delta” and even the whole Southeast Asian economic circle, Macao plays an indispensable role like Hong Kong. In comparison with the Mainland, Macao’s superiority is mainly embodied in financial
strength, management experience and connection with Portuguese countries, and also embodied in the ecological environment concept in the governmental functions and implementation of policies.

5.1.1 Finance

In the Mainland, manufacturing of environmental protection products will grow along with a stronger economy. But because the Mainland enterprises are small in scale, weak in finance and technical research and development ability and lacking effective international marketing channels, EPI exports are very low.

There will be a greater potential for Macao to cooperate with the Mainland EPI enterprises in operations and joint development of world markets. Macao also can learn in this process to reform its industrial structure, develop business opportunities in environmental protection and raise its ability to provide market-orientation and economic services to the Mainland in EPI.

In the future, the Mainland will outstrip Macao in the production of EP products and achieving reduced manpower costs. So it is expected that the Mainland will be devoted to production of environmental protection goods while Macao will focus on capital flow and technical research and development and at the same time play a decisive role in exploring world markets.

With the limits of its industrial structure, production technical strength and human resources, it would be rather difficult for Macao to develop simple new environmental technologies, but with its location in the Pearl River Delta, Macao has advantages - its stronger integration ability. It would be rather easy for Macao to develop capital markets and promote the Mainland through trade contacts with Portuguese speaking countries and Southeast Asian countries with EP products.

5.1.2 Management Experience

Macao boasts rich management experience in market-oriented operation of urban garbage treatment and sewage treatment. Restrained by the geographic condition, the enterprises of Macao are not large, but they boast unique characteristics with high productivity and small sites under standardized enterprise management systems. All
these can be used for reference by the Mainland cities, especially the southeast coast area as well as the middle and lower reaches of the Yangtze River where the market environment is in comparatively healthy condition.

Block 1- Garbage Treatment of Macao: Collection, Storage, Transport and Incineration

For landfill of construction wastes and ash, different sanitary landfill sites have been constructed. The former is in the charge of the Civic & Municipal Affairs Bureau and the latter is in the charge of the Construction & Development Office.
5.1.3 Connections with Portuguese-speaking countries

In the light of its special connections with Europe and Portuguese speaking countries, Macao keeps close economic, trade and social contacts with all the Portuguese-speaking countries. In 1992, Portugal, then the rotating chairman of EU, urged Macao to sign an economic trade agreement with the EU, making Macao a bridge between the EU and Asia. From then on, Macao has maintained economic and trade contacts with Portuguese speaking countries on the basis of its special relationship with Portugal. Today, there are 8 Portuguese speaking countries in the
world: Portugal, Brazil, Mozambique, Angola, Cape Verde, Guinea-Bissau, East Timor, and Sao Tome and Principe, with a population of more than 200 million. Most of them are developing economies where cheap and high-quality Chinese goods are well accepted. Economic and trade cooperation has great potential. With close connection with these countries and advantages of history and language, Macao can play an important role as a bridge and agency between China and the Portuguese speaking countries.

Today, the Mainland economy has entered into a new period of industrial transition and needs to keep even closer contacts with neighboring areas. Compared with the developed countries, the emerging EPI market of the Mainland still has a long way to go in technical management, market information and market operation mechanisms. This situation provides an opportunity for Macao to be a bridge for foreign economic cooperation and contacts. In the initial period after China’s entry into WTO, Macao still can play such a role and the Mainland also can learn from Macao’s experiences in power supply, sewage treatment and drinking water supply, and make full use of Macao’s superiority in financial and information sectors, and cooperate in marketing EPI products and services as well as EPI investment and fund raising. It can be said that the existing experiences and channels of Macao are important to the Mainland EPI. For a long period after China’s entry into the WTO, the Mainland EPI enterprises may still partly use Macao’s distribution channels and market network to access the world markets.

With respect to Macao’s balance of trade, exports are a very large proportion in the GDP of Macao between 30%-35%. After China’s entry into the WTO, the trade will be gradually liberalized, which should double the influence of Macao’s exports. On the one hand, Macao’s exports have always been concentrated in several large countries of the EU and the United States, occupying 70-80 percent of the total. Along with the slowing of the economy and of import demand in Europe and the United States as well as China’s entry into WTO, Macao will need to make adjustments to the export market, increasing exports to the Mainland and keeping steady growth of its export processing industry. On the other hand, after China’s entry into WTO, the
strongest impact on Macao’s intermediary role may be in the area of goods transshipment. Like Hong Kong, Macao was an important transshipment harbor for the Mainland exports. After China’s entry into WTO, the obstacles in management system and policies would be gradually eliminated and the steady development of the Mainland harbor facilities would enable a lot of goods to be exported directly from the Mainland. As a result, Macao’s superiority in this aspect will be gradually reduced. However, after entry into the WTO, the trade volume of the Mainland will increase year by year. In the long term, the demand for a transshipment harbor will still be strong. With powerful international trade connections as an official or auxiliary member of 21 official or non-official organizations, Macao has signed multilateral agreements with 155 countries and regions and keeps sound trade relations with the EU through Portugal. Therefore, for a quite long time, Macao still can play a very important role in transshipments.

5.2 Establish a Closer Cooperative Relationship in Environmental Cooperation with the Mainland

5.2.1 Cooperative Suggestions on the Policy Level

1 Promote environmental cooperation and development in the general framework of CEPA

Along with the establishment of CEPA between the Mainland and Hong Kong, the Mainland also signed CEPA with Macao on October 17, 2003. Under the general framework, the three parties should take advantage of each other as early as possible and enhance tri-level cooperation.

Under the precondition of constant widening and deepening of the scope of cooperation among Guangdong, Hong Kong and Macao, enhancement of environmental cooperation among the three areas also becomes more and more important. Environmental pollution has no boundary. As important parts of the large Pearl River Delta, Hong Kong and Macao cannot be self-centered. As the economies of the three areas become more closely integrated, new environmental issues spring
up. Therefore, it is necessary for the SAR government to cooperate with the Mainland for the future sustainable development.

Compared with Hong Kong, the progress of environmental cooperation between Macao and the Mainland is rather slow. In the future, CEPA and existing environmental cooperative arrangements will be used to promote the exchange of professional personnel and policy information and promote Macao’s environmental policies and sustainable development strategy.

2 Actively participate in environmental planning for Guangdong, Hong Kong and Macao

The State Environmental Protection Administration (SEPA) and Guangdong Provincial People’s Government (GPPG) will jointly study and develop three important plans in the next two years: “Pearl River Delta Environmental Protection Plan”, “Guangdong Province Environmental Protection Plan” and “Guangdong, Hong Kong and Macao Regional Environmental Protection Plan”. SEPA and GPPG are working on the “Pearl River Delta Environmental Protection Plan” first.

Both the Pearl River Delta Environmental Protection Plan and the Guangdong Province Environmental Protection Plan should concentrate on the target of strategic, overall, predictive and scientific characteristics. In guidelines and measures, these plans should embody a series of concepts and requirements, suitable to the state conditions and adaptable to the world trends towards sustainable development.

A large Pearl River Delta regional development plan, the “Guangdong, Hong Kong and Macao Regional Environmental Protection Plan”, should avoid traditional ways of thinking in environmental control planning and consider things in light of the larger need to protect the environment, promote economic development and address environmental issues in the process of regional cooperation and development.

Then, the government of Macao can make full use of the regional planning projects and be an active participant in developing environmental contacts division of work with Mainland cities like Zhuhai, Foshan and Panyu, devote more efforts to policy studies, and improve the economy and environment in Macao to promote sustainable development for everyone’s benefit.
5.2.2 Cooperative Suggestions on the Marketing Level

(1) Introduce experience of market-oriented operation of public facilities to the Mainland

Current environmental technical services in Macao like sewage treatment and city garbage treatment, although small-sized and highly automated, have certain cost advantages. But in the large Pearl River Delta, Macao’s environmental protection technology may have no comparative superiority. Therefore, it is recommended that Macao should cooperate with the cities in the middle and lower reaches of the Yangtze River and Central West China and offer consultation and technical services in different sectors such as technical agent, personnel training and joint ventures.

(2) Try to be the agency of information and technology exchanges between the Mainland and Portuguese speaking countries

Make full use of Macao’s superiority in contacts with Portuguese countries to promote the cooperation and exchange between the Mainland EPI and Portuguese speaking countries. Macao can make use of its consulting companies and funds as the third party to establish information exchange platforms to help the Mainland to exchange environmental market information with these countries, provide the Mainland environmental protection enterprises with specific information on international environmental protection science and technology and promote international trade. At the same time, through the Mainland organizations like EPI associations, funds and market bodies, Macao also can ask the Mainland EPI for information about its environmental protection projects and products.

As an agent for mature, high quality environmental products of the Mainland, and working through consulting companies, Macao can learn of the world market demand for environmental products, especially the supply and demand situation of some commonly used environmental products, and emphasize the superiority of the Mainland products, their comparatively low cost, to explore the world market jointly, especially in the Portuguese speaking countries of the third world.

(3) Promote Sino-foreign joint ventures and cooperation in EPI

Macao’s capacity as a capital market can be used to look for joint venture
partners. The emphasis should be on introducing funds for Macao and the neighboring cities. The experiences and superiority of Macao’s business management can be used to develop joint ventures in environmental protection enterprises in middle and small cities.

5.2.3 To Cooperate with the Mainland and Develop Environmental Protection Exhibition Economy

Along with the progress of Macao’s foreign environmental cooperation, the exhibition economy in environmental protection also will grow. The SAR government should promote the development of Macao’s EPI exhibition industry by focusing on Macao’s uniqueness and excellent venues to hold international conferences or product fairs particularly for vendors from Portuguese speaking countries and EU members and producers from the Mainland.

Restrained by geological conditions, Macao also needs to enhance cooperation with related Mainland departments, particularly the cities in Pearl River Delta and schedule exhibitions to avoid conflict in time and content and ensure highly effective management and orderly competition among regions. “China International Environmental Protection Exhibition and Conference” (CIEPEC) sponsored by SEPA and organized by China Association of EPI (CAEPI) is held every two years. CIEPEC is influential, but the turnover is not satisfactory and does not reflect the degree of influence of the organizing body. **It is recommended that the Macao Association of EPI (MAEPI) cooperate with CAEPI to move part of the CIEPEC to Macao or encourage related groups in Macao to expand their influence.**

Please see Appendix I for the comprehensive analysis on the development of an exhibition economy in Macao.

Environmental publicity and education are natural extensions of an environmental exhibition economy and also a service market of EPI. Macao does not have a deep reserve of talent in environmental technology and environmental management and the current structure of EPI human resources is not helpful to its EPI development. Therefore it is recommended to:

1 Improve and extend professional cooperation with the Mainland’s famous
universities and colleges to formulate regular talent exchange plans under the aegis of SEPA and educational institutes and then promote Macao’s EPI development through such talent exchanges.

2 Make use of the Mainland experience to cultivate professional talents in EIA and technical monitoring, giving emphasis to expansion of environmental educational themes.

3 Use environmental education regulations to promote sustainable development in Macao.
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13. Category of EPI Equipment (products) the State Encourages to Develop (Second batch), Chin Cleaner Production
Appendix

Appendix I: Feasibility Analysis on Development of Exhibition Economy in Macao

Appendix II: Analysis of Environment Protection Industry of Guangdong Province

Appendix III: Analysis of Shanghai EPI

Appendix IV: Analysis of EPI of Jiangsu Province

Appendix I: Feasibility Analysis of Development of Exhibition Economy in Macao

1. Promotion Conditions of Exhibition Economy

As a “booster” of city economic development, exhibitions need to have certain conditions to develop. In the light of the international exhibition industry, the construction of an exhibition stadium and gymnasium and business interest in exhibitions are often concentrated in the regions with a developed economy, financial infrastructure and trade or cities with regional characteristics, or some industrially developed and comparatively world famous sites.

Therefore, to develop an exhibition economy, a city must have the following conditions:

- Developed economy. As an economic “barometer”, exhibitions are closely linked with local development. All the countries with a developed exhibition industry, such as Germany, France and the United States, have powerful economic strength. Rapid growth of economy and expansion of aggregate economic volume will certainly generate powerful demand for exhibitions and help the exhibition economy to develop at a high speed.

- Wide opening. To develop an exhibition economy, a city must have opened wide to the outside world.

- Comparatively developed tertiary industry. The Exhibition industry is a kind of systems engineering closely connected with traffic, communications, lodging, food and drink, tourism and business, and needs perfect related services to meet the diversified demands of the exhibition participants.

- Characterized city industry. For those cities with an international exhibition
industry, a very large part of that industry has been linked to their industrial
development, such as Germany’s Hannover Messe.

- Abundant tourism resources. Tourism and exhibitions can complement each
  other. A city’s abundant tourism resources will raise the attraction of the
  city’s convention activities.

In addition to the above objective conditions, to develop an exhibition economy,
a city must have support of government in the areas of urban infrastructure
construction, exhibition infrastructure construction and related laws and regulations.
Only with the above-mentioned preconditions can a city establish the perfect market
development system of exhibition to ensure the exhibition economy will develop
healthily and rapidly.

2. Basic Resources for Macao to Develop an EPI Exhibition Economy

(1) Support from Government. In the policy statement of 2003 fiscal year,
Macao government reaffirmed: “… the government will continue to foster and
support the conference and exhibition industry, offshore service industry, logistics
industry, traditional Chinese medicine industry, EPI and emerging industries. The
government hopes to stimulate the social development energy to provide more options
for the development of individual residents through fostering and supporting emerging
industries …”; “… To drive Macao to develop step by step as a contact platform and
cooperation bridge between China and the world EPI, especially the SMEs so as to
promote economic prosperity and sustainable development…”. Government’s support
and preferential policies will be greatly helpful for Macao to develop an EPI
exhibition and other specialized exhibitions.

(2) The regional characteristics of Macao. Macao is well known as “East Monte
Carlo” and is called one of the world’s three gambling cities with Las Vegas of the
U.S. and Monte Carlo of Monaco. With its unique image deeply rooted in the hearts
of the people, Macao attracts millions of tourists from around the world each year. At
the same time, Macao has been a city of converging culture and religion of China and
the West for long time, with museum-like municipal scenes and a rich historical and
cultural heritage. Only if exploited fully and systematically, these unique city resources and tourist attractions will play a powerful role in raising the profile of an exhibition industry in sustainable development.

(3) Combination of Macao’s advantages in free port, status and international network. Like Hong Kong, Macao is another free port and separate customs territory with lower operating costs, improved infrastructure, and a financial environment superior to the Mainland. On the other hand, Macao is distinguished from Hong Kong by its economic character and its international market contacts. Macao is situated on the western side of the Pearl River Delta; to the northwest along the West River is the wide economic hinterland of the river’s middle and lower streams, while in international contacts, the emphasis is the EU and Portuguese speaking countries. It can be said that Macao boasts unique advantages in the development of an exhibition/convention economy.

(4) Macao’s exhibition scale and existing EPI exhibition experience

Macao has some experiences of successfully holding large-scale international conferences, which has laid a sound foundation for future growth of this sector. For example, the first China-Portuguese Countries Forum on Economic and Trade Cooperation was held successfully in Macao in September 2003. Sponsored by the central government and organized by Macao SAR government, the forum is actually a ministerial conference with economic cooperation and development as the themes. This forum with Macao as the platform will be held every three years. Moreover, as the first international conference on EPI in Macao, the “2000 International Workshop and Exhibition on Sustainable Development and EPI” was held at the end of 2001 with the Environmental Committee as the sponsor, CEPA as a specially invited supporter and CEPA’s Industrial Association as the specially invited organizer.

In general, Macao has potential and resources for the development of an exhibition economy. The top priority at present is finding an entry point to give play to its unique character and advantages to advance the links between the Mainland, the EU, and Portuguese speaking countries. Macao should push forward economic plans to form fixed conference and exhibition timetables and promote the overall EPI
development, using its advantage of lower costs and maximizing each other’s strengths.

3. Recommendation on promoting Macao to develop an EPI exhibition economy

(1) Leaders should devote more efforts to providing preferential policies and improving managerial quality.

In the competition involving Macao, Hong Kong and other cities in the Pearl River Delta and in the classification of content and forms of existing conferences and exhibitions (like the financial conference in Hong Kong, the Shenzhen High-tech Fair, Dongguan International Computer Expo, Guangzhou Commodities Fair, Shunde International Appliances Expo and Flowers and Plants Expo), the Macao SAR government should try to find the proper entry point. Gambling and EPI exhibitions should be considered as the key support projects.

Under the limitations of geographic location, industrial structure and exhibition scale, EPI may have fewer economic returns, but properly scaled international EPI conferences and industrial expos held at fixed intervals (for example every two or three years) can lift Macao’s international image, promote the city’s sustainable development, and development of other sectors (such as business, tourism, restaurant, catering, advertising, and transportation), thus killing several birds with one stone.

Development of an EPI exhibition economy needs administrative support and a certain level of management. This not only refers to the demand for necessary exhibition space and support from related industries, but also refers to the need for practical measures and preferential policies. It is recommended to reduce or cancel participants’ stall fees and transaction costs in the primary phase of developing an EPI exhibition economy so as to convince the organizers and participants to make joint efforts to drive the development of an EPI exhibition economy.

(2) Enhance inter-regional coordination and contact with ICCA and other conference or exhibition bodies
In order to prevent conflict between conferences or exhibitions in time and content, it is recommended that Macao SAR government or industrial associations should invite the neighboring cities, countries and related departments of the central government to inform the times, contents and patterns of the exhibitions in environmental protection or other industries expected to be held in certain period by holding joint conferences on exhibitions every two years or other communication methods, and organize industrial workshop to promote communications and cooperation. Such pattern of building up strategic partnership on exhibition would not only raise the efficiency and effectiveness of Macao’s exhibition economy but also directly elevate the policy understanding level of Macao’s exhibition industry.

It is also recommended to enhance interactive contacts with ICCA and other international or regional conference and exhibition associations on personnel training, conference assessment, conference information and other aspects.

(3) Plan urban infrastructure construction through market-oriented operations

Development of an exhibition economy also needs an effective urban infrastructure, particularly exhibition sites. It is recommended that the government use current infrastructure assets and carefully investigate future requirements liquidizing unused assets and promote Macao’s sustainable development through exhibition/convention projects.

(4) Formulate long-term development targets

Macao’s EPI exhibition brands cannot be cultivated at one stroke. The ideal results can be got only through long term government planning, market development and recruitment of talent. Th long-term development targets should be embedded in the whole process of exhibition organization.

Appendix II: Analysis of the Environmental Protection Industry of Guangdong Province

1. EPI Status of Guangdong Province

In 2000, the GDP of Guangdong Province’s EPI amounted to 17.693 billion Yuan,
annual income 14.35 billion Yuan, ranking fourth, accounting for 1.86% of the GDP of the whole province, net profit 1.007 billion Yuan, tax payable 1.773 billion Yuan, introduced contract amount 386 million USD, total export 493 million USD.

In 2000, the fixed assets used in production operations totaled 259.963 billion Yuan, the fixed assets investment in EPI totaled 3.442 billion Yuan, and the investment in development of environmental protection technologies totaled 524 million Yuan. There were 1,564 enterprises and institutions involved in EPI in the province, ranking third in the country, including 1,276 firms, accounting for 81.6%, and 288 institutions, accounting for 18.4%; 1,145 enterprises and institutions were specialized in environmental protection, accounting for 73.2%, 419 enterprises and institutions were partly involved in environmental protection, accounting for 26.8%. 158 had passed ISO9000 authentication and 613 had the ability to develop environmental protection technologies. As classified according to the nature of enterprises, there were 1,368 joint ventures, accounting for 87.5% and 196 foreign and Hong Kong/Macao/Taiwan enterprises, accounting for 12.5%. There were 110,071 professional personnel specialized in environmental protection in the province including 3,273 with senior professional titles and 8,842 with intermediate professional titles. Professionals with titles above this level accounted for 11.0% of the total professional force. The composition of industrial sectors with relation to environmental protection of the whole province in 2000 is shown in Table 27.

Table -27 Compositions of Industrial Sectors with Relation to EPI of Guangdong Province in 2000

<table>
<thead>
<tr>
<th>Production of environmental protection products</th>
<th>Cleaner products</th>
<th>Environmental protection services</th>
<th>Comprehensive utilization of resources</th>
<th>Natural ecological conservation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of</td>
<td>249</td>
<td>127</td>
<td>592</td>
<td>660</td>
<td>128</td>
</tr>
<tr>
<td>enterprises and institutions</td>
<td>Work forces of EPI (person)</td>
<td>Annual output (10,000 Y)</td>
<td>Share in total (%)</td>
<td>Annual profit (10,000 Y)</td>
<td>Output profit rate (%)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------</td>
<td>--------------------------</td>
<td>-------------------</td>
<td>--------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td></td>
<td>11,114</td>
<td>101,184.2</td>
<td>5.72</td>
<td>12,241.1</td>
<td>12.09</td>
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<tr>
<td></td>
<td>16,779</td>
<td>258,992.3</td>
<td>14.64</td>
<td>29,293</td>
<td>11.31</td>
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<tr>
<td></td>
<td>20,133</td>
<td>170,581.9</td>
<td>9.64</td>
<td>14,494.2</td>
<td>8.49</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>11,0071</td>
<td>176,9335</td>
<td>—</td>
<td>102,524.2</td>
<td>5.79</td>
</tr>
</tbody>
</table>

Unit: 49.2 230.7 24.5 60.3 52.6 65.6
2. Analysis of the Status of EPI Development in Guangdong Province

- EPI has seen obvious progress in scope and a number of projects

  With nearly 30 years of development, the EPI of Guangdong province has formed an industrial system with certain parameters and a complete range of industries. Comprehensive resources utilization, cleaner industrial production and environmental protection services are the principal parts of the EPI of Guangdong Province. Environmental products production, natural ecological conservation and construction have been steadily improved. The production and sales of environmental products as well as the turnover of environmental services have increased significantly. Almost 100 firms with an output value over 50 million Yuan have come into being. There are already many large-sized companies involved in waste and old resources reclamation. Companies with annual sales of over 180 million Yuan account for one seventh of the whole country.

- Environmental protection became new investment hot spot

  Listed companies, private enterprises and foreign investment in EPI are becoming more important. Overseas investments from Canada, Hong Kong and other countries and regions, listed companies like Shenzhen Energy Investment Co., Ltd and Guangdong Shaoneng Group Co., Ltd., and private enterprises like Shenzhen Dows Garbage Treatment Technical Co., Ltd and Guangdong Xingxingmei are all involved in the EPI.

  New sewage and garbage treatments have been gradually perfected, outstripping the whole country and reaching the world’s advanced levels in technology development, practical utilization and commercial operation, are models for the whole country. For example, the central district sewage power plant in Longgang, Shenzhen

* Some enterprises and institution are involved in several sectors at the same time, so the numbers of units and employees are larger than the actual ones.
has been listed by the SETC as a new energy source pilot project and the Guangzhou Jinma Power Equipment Group has been listed by the SPC as an environmental protection equipment supplier worthy of receiving key support.

- A credit rating system has been established to standardize the EPI market.

According to CEPA’s Management Measures of Environmental Engineering Design Certificates, Guangdong Province established environmental engineering design management measures. By now, five design institutions have received Class A Environmental Engineering Design Certificates and 44 institutions have been granted Class B Environmental Engineering Design Certificates from the province. The province has issued 76 class C environmental engineering design certificates and 46 institutions have received EIA competency certificates. Effective and standardized environmental engineering designs and the environmental assessment market has raised the quality of environmental pollution control engineering.

Moreover, Guangdong Province has introduced an environmental protection facilities operation competency certification system. There are already 22 institutions able to certify environmental protection facilities. Such measures have organized and guided firms to establish facilities operation management systems, lifting the operational service level and realizing market orientation and specialization.

- Exploitation and industrialization of environmental protection technologies has seen initial success

Guangdong Province has 613 firms and institutions able to develop environmental protection technology. Some companies have established their own laboratories or worked in cooperation with universities, colleges and research institutes, on practical techniques to improve their competitiveness in the market. Additionally, the EPI of Guangdong Province has cooperated with foreign and domestic partners in environmental protection technology. Through joint ventures and technology transfers, the province has introduced a lot of advanced environmental protection technologies. For example, Guangdong Jinma, Guangzhou Guangyi Group, Shenzhen Dows Group and Guangdong Shilong Coal Mine Machinery Factory have introduced, respectively, advanced equipment for water treatment and garbage incineration through cooperation with foreign companies and raised technical levels of Guangdong’s EPI and enhanced its competitiveness in domestic and international markets. Products of Foshan Analytical Instrument Factory, Guangzhou Yiwen Co., Ltd., Guangdong Environmental Protection Instrument and Equipment Factory and
Guangdong Coal Mine Machinery Factory have a larger share of the domestic market.

- Authentication and consultation services on ISO14000 Environmental Management Systems have seen rapid development

By the end of 2000, there were 5 certified institutions of the ISO14000 Environmental Management System in Guangdong Province and 13 consulting institutions. According to incomplete statistics, by the end of 2000, nearly 200 firms had met the standards of the system, ranking the top in the country in number. Large scale introduction of ISO14000 standards have lifted the environmental management levels of Guangdong Province, effectively controlled pollution, saved energy resources, raised market competitiveness and promoted coordinated development of Guangdong’s environment and economy.

3. Analysis of the problems in EPI development in Guangdong Province

- Industrial structure is irrational

The small size of enterprises makes it hard to achieve economies of scale. Among 1,564 environmental protection enterprises in the province, only 4 were among the top 100 in the country. The annual output value of EPI in 2000 was 17.693 billion Yuan, only accounting for 1.86% of the GDP. Among the firms and institutions involved in EPI, there were 1,362 small-sized economic units with fixed assets of less than 15 million Yuan, accounting for 86.9% of the total number of enterprises and institutions involved in EPI; 112 middle-sized economic units with fixed assets between 15 to 50 million Yuan, accounting for 7.2 % of the total and 92 large-sized units with fixed assets over 50 million Yuan, accounting for 5.9 % of the total. The sector directly involved in pollution control services only accounts for 9.64 % of the annual output of the whole EPI when compared with 37.9 % of other environmental protection enterprises.

The mixture of environmental protection products is also irrational, with fewer high-grade, precision and advanced products but more low-level products. Standardization of equipment is also at a low level.

The gross value of industrial output of environmental product manufacturing in 2000 was 10.118 billion Yuan, including 248.863 million Yuan of water pollution control equipment, accounting for 24.6%; 219.16 million Yuan of air pollution control equipment, accounting for 21.7%; 81.605 million Yuan of solid waste treatment
equipment, accounting for 8.1%; 133.899 million Yuan of noise vibration control equipment, accounting for 13.2%; 9.12 million Yuan of radioactive and electromagnetic pollution prevention equipment, accounting for 0.9%; 169.357 million Yuan of chemical materials, accounting for 16.7% and 147.838 million Yuan of environmental monitoring instruments, accounting for 14.8%.

Production of environmental protection products is mainly centered in water and air pollution control equipment, accounting for 46.3% of the annual gross industrial output of all environmental protection products. Among water pollution control equipment, production of physical treatment equipment takes the lead, with annual gross industrial output value of 150.63 million Yuan, accounting for 45% of the product range and 60.5% of the annual gross industrial output value. But problems still exist in most of the products in mass production, low technical standards of equipment manufacture, standards and automation. And there are still many pollutant treatment products requiring immediate attention.

An important part of the composition of Guangdong Province’s EPI with an annual output accounting for 66.28% of the gross product of EPI includes the comprehensive use of resources mainly centered in recovery of discarded metals, recycled paper making with recovered waste paper as the major material, and plastics fabrication with reclaimed waste plastic. In these areas, the technology is mature, but the products’ technical content is rather low.

- Enterprises are short of capacity to develop technology

Small in size, with low efficiency, short of funds to develop technology and without access to information, most of the environmental protection enterprises find it hard to bear the cost and risks of development. Government investment in this area is insufficient; scientific and technological innovation systems have not been established; technical innovation is not yet perfected; only a few enterprises depend on their own ability to raise funds for patents and be aggressive in the market. Most of the current technical development initiatives are found in universities, colleges and research institutes not in technical development centers with companies as the main partners. The enterprises are short of talented staff, information and funds necessary for product research and development, which impacts their capacity for innovation and make them unable to respond quickly to new achievements and market demands.

- Market-orientation and industrialization mechanism of EPI has not been established
The status of environmental service and specialized operation of environmental facilities as a sector of tertiary industry has not been widely accepted by government and society. Market-orientation and industrialization policies on urban domestic sewage and domestic garbage have not been defined. The potentially large environmental protection market cannot be transformed into an actual market, as market mechanisms promoting development of EPI do not exist yet.

- Geographical imbalance in EPI development

Guangdong Province’s EPI development is mainly concentrated in the economically developed area of the Pearl River Delta (PRD). The annual gross output of EP industries in the PRD amounts to 13.817 billion Yuan, accounting for 78.09% of that of the whole province. The developments in Foshan, Shenzhen, Dongguan and Guangzhou are in the lead and account for 23.09%, 16.71%, 10.09% and 10.08% respectively, of the gross output of EP industries of the whole province.

4. Prospects for Guangdong Province’s EPI development

EPI is the technical support for government to realize environmental protection targets and therefore should be developed in earnest. The investment in EPI in five years will be increased by 2.5% of the GDP from current 1.8% of the GDP. In the Pearl River Delta, the percentage will reach 3%. Annual gross output of Guangdong’s EPI will exceed 40 billion Yuan, or even reach 50 billion Yuan by 2005. In the light of the great tendency of China’s rapid and steady economic growth and the historic opportunity of China’s entry into WTO, Guangdong’s EPI will develop rapidly for the following reasons:

- The investment orientation of some listed companies, private enterprises and large-sized transnational groups is gradually transferring to EPI. Their participation will bring money and energy and speed up the restructuring and technical upgrading of the EPI.

- Market-orientation and industrialization of urban domestic sewage pollution control is imperative and will strongly promote the development of EP operational services. Enterprises involved in market-oriented operation of EP control facilities will become prominent in the EPI.

- The focal point of pollution control has shifted from industrial pollution to domestic pollution. According the “Green Water Engineering Project of Guangdong
Province”, all the cities at or above prefecture level should construct secondary sewage treatment plants to ensure treatment rates exceed 40% by 2005. It is planned to invest 9.32 billion Yuan to construct 36 city sewage treatment plants with a capacity of 4.38 million ton/day before 2005 and then add 9.72 billion Yuan to construct (or expand) another 24 city sewage treatment plants with capacity of 4.57 million ton/day. Annual average investment is about 2 billion Yuan. Because domestic pollution control projects need large amounts of investment, many large scale EP companies will form, changing the “large in number but small in size” structure of the province’s EPI, enhancing its strength and altering its structure.

● The industrial pollution control market has bright prospects. According to the “Blue Sky Engineering Project of Guangdong Province”, air purification, mainly composed of power plant flue gas desulfurization, industrial kiln and burner dust alleviation, urban automobile exhaust gas and domestic oil smoke treatment, will receive an investment of 5.7 billion Yuan by 2010. Additionally, along with the steady growth of Guangdong’s economy, investment in the industrial “three wastes” treatment will be 13 billion Yuan, among which EP investment will be 900 million Yuan, or 7%.

● In the recycling sector, comprehensive regenerated utilization of wastes will see even greater development. Its value in 2000 reached 11.7 billion Yuan with an annual growth rate expected to exceed 15%. By 2005, the recycling sector’s value will exceed 27 billion Yuan. In the treatment of urban domestic garbage, Guangdong Province is leading the whole country. Rubbish burning power generation industry has sprung up in the PRD where the daily output of rubbish amounts to 50,000-plus tons. If incineration power generation technology is adopted, 20 billion Yuan will need to be invested just in the PRD and newly increased power generation capacity will be 750mw with annual power output value amounting to 3 billion Yuan.

● The tidal wave of green consumption and a green economy will promote the development of cleaner production technology and products. Along with increased environmental awareness of the whole society, the implementation of a sustainable development strategy and the rise in living standards, people will demand even stricter requirements on air and water quality. Green products, pollution-free or low pollution products and all-natural products will win even more favor with consumers. Because green demand will become a hotspot in future markets a green products market has great potential. In 2000, sales of Cleaner products in Guangdong Province reached
2.569 billion Yuan, and the estimated growth rate exceeds by 15%, the average growth rate of the whole RPI. By 2005, the value will exceed 5.3 billion Yuan.

- Even more efforts will be devoted to enhancement of ecological conservation. Along with the implementation of “Guangdong Province Plan on Ecological Environmental Construction”, new products and new technologies will hit the market. The value of the ecological conservation industry (ECI) reached 650 million Yuan in 2000 with a growth rate of over 15%. By 2005, the value will exceed 1.5 billion Yuan.

5. Strategies to promote development of the EPI

During the Tenth Five-Year Plan, the overall idea for the EPI development of Guangdong Province is: to follow market forces, relying on technological advances, concentrating efforts in the two cities (Guangzhou and Shenzhen) and one area (the PRD), using large companies and superior products as the dragon head, and concentrating on quality and market management. By formulating preferential policies, creating an environment beneficial to the industrial development and forming an EPI system covering all aspects of the industry, EPI can become a key pillar that supports a sustained and healthy economy and society.

Policies and measures to be adopted to speed up EPI development:

- Transform conceptions, treat pollution control as an important part of EPI and establish suitable policies and mechanism. In the past, city sewage and garbage treatment came under the social and public affairs bureau. New waste treatment technology was considered to be a sideline not a discrete economic entity. So no consideration was given to investment costs or economic benefits, thus severely limiting the development of the EPI. In fact, operation of environmental pollution control projects is an important part of the EPI. The critical issue is to transform people’s conceptions and implement business-style policies and mechanisms.

- Raise the charges for disposing of pollutants. The current charges are below cost and discourage commercial investment. Only when the waste disposal charges rise to a level that generates profits will EPI become a significant industrial sector.

- The Principle of ‘polluter pays’, centralized treatment plants and business-like operations” should be used in urban domestic pollution control systems.

The establishment of industrial parks has created conditions for concentrated treatment of industrial wastewater and makes it possible to carry out the principle of
‘polluter pays’, centralized treatment plants and business-like operations.

- Devote greater effort to environmental law enforcement and raising awareness levels to ensure that new construction projects meet the Three-Simultaneous Regulation. That is to say the devices of pollution control must be designed, built and put into operation simultaneously for any main project to be built, renovated or expanded. Discharge pollutants must be within standards, projects must adopt scientific management methods, install on-line monitoring instruments at key pollution sources and black boxes on common pollution sources to stop secret discharge and ensure the pollution control rate and discharge rate are within the defined standards. Raising awareness and upgrading the standards and quality of environmental pollution control facilities and construction will help promote public and industrialized operation of the environmental protection facilities.

- To ensure the increase of investment into environmental protection, the governments’ investment should be listed in the budget and raise funds through market mechanisms. The implementation of environmental protection plans and programs as well as the form of environmental protection market must rely on the guarantee of funds. Guangdong Province’s investment in environmental protection has increased to 2.5% of the GDP in the same period of the Tenth Five-Year Plan-Year Plan from 1.8% of the GDP in the same period of the Ninth Five-Year Plan. Clear economic policies, beneficial to the EPI, will help to attract investment and funding of EP projects.

  Governments at different levels and departments concerned should follow and implement the state provisions on EP economic policies and funding for capital construction, technical renovation, comprehensive utilization, taxation, credit and foreign investment, and establish supervision, inspection and examination systems to ensure implementation.

  Governments should increase environmental investment in the light of fiscal reforms. Governments at different levels should allocate and increase special funds for EP annually, using the figures for 2000 as the benchmark.

  Do everything possible to attract foreign capital. In the light of key local EP issues, identify important project and carry out feasibility studies and other pro-active works, establish a database of key EP projects, create conditions to make full use of grant and preferential loan from international organizations or foreign governments, and try to increase investment to city and regional centralized treatment facilities.
The governments should encourage business to invest in the EPI by issuing treasury bonds and implementing BOT mode, and including pension funds to increase investment in EPI, to improve the environment and realize sustainable development.

- Establish an EPI development fund to encourage EPI to speed up development in science and technology in specific high need areas of EPI development, accelerate transfer and issue of excellent EPI scientific and technological achievements, combine technological introduction with assimilation, absorption and innovation, promote updating and upgrading of environmental protection products, speed up localization of key technology and equipment of EPI and give them support as important parts of the National Major Technological Equipment Localization Innovation, Research and Development Projects”. Organize and implement local pilot projects and finance them with industrial development or public funds. Form local key enterprises of EPI on the basis of the pilot projects, and take ‘the technological high ground’. Support 3-5 EPI high-tech local pilot projects each year and use them to form a high-tech business group over a five year period and raise the scientific and technological level of Guangdong Province’s EPI.

- Give full play to the role of concerned government departments and trade associations in organizing, coordinating, serving, guiding and standardizing the market. From a broad perspective, the EPI needs common efforts and great support from different regions and related departments. Provincial and municipal governments and departments, particularly the economic and trade commissions and environmental protection bureaus should enhance leadership in EPI, establish and improve inter-departmental coordinating mechanisms and make joint efforts to promote the rapid healthy development of an EPI. Encourage EPI associations to publicize and implement their policies and plans, conduct investigations and studies, develop consultation services and popularize technology, make EPI technological exchange and cooperation with foreign and domestic partners, encourage industrial self-discipline and help governmental departments manage and standardize the EP market.
Appendix III: Analysis of Shanghai’s EPI

1. Status of Shanghai’s EPI

At present, the Shanghai Municipality has 1,084 enterprises and institutions involved in the following six EP sectors: EP products manufacturing, Cleaner products manufacturing, EP services (including technology development, distribution of EP products, environmental engineering, technology services, operation and management of pollution control facilities), comprehensive use of resources, natural ecology conservation and environmental trade business. Among these there are 107 scientific research and design institutions with 125,000 workers (including 12,082 technicians and managers, 7,288 with middle professional titles and 4,794 with senior professional titles). The total assets amount to 23.11 billion Yuan with 43 out of which have assets over 50 million Yuan, 61 have 15 million to 50 million Yuan and the assets of the other 980 are less than 15 million Yuan (most of the 980 are less than 5 million and many just registered as 0.5 million). Staffed with certain professional talents, service conditions and service capacity, 172 enterprises have passed ISO9000 authentication and have basically formed a rather perfect EPI system composed of information exchange, scientific and technological development, products manufacturing, resource utilization, engineering management, market trade, environmental service and ecological conservation, providing sound market services for protecting and improving the ecological environment. The annual output is estimated at 17.298898 billion Yuan and the profits 1.512043 billion Yuan.

The structural distribution of Shanghai’s EPI is not so rational and development is unbalanced because a lot of enterprises are growing spontaneously, based on their own judgment of the market demand and likely prospects judged from their own viewpoints and without correct planning guidance.

At present, there are 400 enterprises with 36,761 workers involved in the production of EP products, accounting for 36.90% of the EPI enterprises of Shanghai. The assets amount to 12.300281 billion Yuan, accounting for 53.24% of the total assets of Shanghai’s EPI. The annual sales value amounts to 2.562919 billion Yuan with profits of 371.654 million Yuan. Among them are:

102 enterprises with 27,771 workers are involved in production of Cleaner products, accounting for 9.41% of the total number of Shanghai EPI enterprises. The assets amount to 7.704833 billion Yuan, accounting for 33.35% of the total assets of
Shanghai EPI. Annual sales value amounts to 10.519975 billion Yuan with profits of 810.612 million Yuan.

458 enterprises with 35,822 workers are involved in EP services, accounting for 42.25% of the total number of Shanghai EPI enterprises. Annual income amounts to 2.668202 billion Yuan with profits of 157.426 million Yuan.

101 enterprises with 19,996 workers are involved in recycling accounting for 9.32% of the total number of Shanghai EPI enterprises. The assets amount to 3.100087 billion Yuan, accounting for 13.41% of the total assets of Shanghai’s EPI. Annual sales value amounts to 1.435425 billion Yuan with profits of 156.715 million Yuan.

23 enterprises with 4,733 workers are involved in natural ecological conservation, accounting for 2.12% of the total number of Shanghai EPI enterprises. Annual income amounts to 112.377 million Yuan with profits of 15.636 million Yuan.

2. Productive structure of Shanghai EPI products

Shanghai EPI products are generally centered in water pollution control equipment, air pollution control equipment, solid wastes treatment and disposing equipment, noise and vibration control equipment, radioactivity and electromagnetic wave control equipment, medicine materials and environmental monitoring instruments and equipment. In general, there is competition in various ranges and categories, basically meeting the requirements of environmental pollution prevention and control, environmental monitoring and environmental impact assessment. But there is still a problem of imbalance in some respects. Some companies are developing very fast with sound management, quality control, and market credit, but there are also many small enterprises that cannot keep up with market demands. Some of their products have low technical standards and quality. As first generation examples, these products can be used, but urgently need upgrading. Market distribution and economic benefits of air pollution control equipment and chemical materials is good with favourable sales income and profit.

Table 28 - Structure of EP Products
<table>
<thead>
<tr>
<th>Product Category</th>
<th>Total Units</th>
<th>Annual Output (10,000 Yuan)</th>
<th>Annual Profit (10,000 Yuan)</th>
<th>Annual Sales Income (10,000 Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution control equipment</td>
<td>183</td>
<td>79,256.1</td>
<td>9,573.5</td>
<td>75,180.1</td>
</tr>
<tr>
<td>Air pollution control equipment</td>
<td>117</td>
<td>79,315.3</td>
<td>11,478.1</td>
<td>57,226.3</td>
</tr>
<tr>
<td>Solid wastes control and disposal equipment</td>
<td>43</td>
<td>23,526.7</td>
<td>4,423.5</td>
<td>19,356.4</td>
</tr>
<tr>
<td>Noise and vibration control equipment</td>
<td>31</td>
<td>13,112.8</td>
<td>1,035.7</td>
<td>11,235.8</td>
</tr>
<tr>
<td>Radioactivity and electromagnetic wave pollution protection equipment</td>
<td>1</td>
<td>245.8</td>
<td>20.3</td>
<td>225.7</td>
</tr>
<tr>
<td>Chemicals</td>
<td>52</td>
<td>33,258.7</td>
<td>5,873.7</td>
<td>32,158.3</td>
</tr>
<tr>
<td>Environmental monitoring instruments</td>
<td>40</td>
<td>27,576.5</td>
<td>4,760.6</td>
<td>26,637.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>256,291.9</strong></td>
<td><strong>37,165.4</strong></td>
<td><strong>222,020.1</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Table-29**  
Sales Income and Profits of Various Kinds of Water Pollution Control Equipment

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Sales Income (10,000 Yuan)</th>
<th>Percentage of Total Sales Income</th>
<th>Profits (10,000 Yuan)</th>
<th>Percentage of Total profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical treatment equipment</td>
<td>24,740.4</td>
<td>32.91</td>
<td>3,105</td>
<td>32.43</td>
</tr>
<tr>
<td>Chemical treatment equipment</td>
<td>5,831.1</td>
<td>7.80</td>
<td>1,247</td>
<td>13.03</td>
</tr>
<tr>
<td>Product Category</td>
<td>Sales Income (10,000 Yuan)</td>
<td>Percentage of Total Sales Income</td>
<td>Profits (10,000 Yuan)</td>
<td>Percentage of Total profits</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------</td>
<td>----------------------------------</td>
<td>------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Dust removing equipment</td>
<td>45,844.0</td>
<td>80.11</td>
<td>8,341.1</td>
<td>72.67</td>
</tr>
<tr>
<td>Defogging and degreasing equip.</td>
<td>3,788.4</td>
<td>6.62</td>
<td>558.9</td>
<td>4.87</td>
</tr>
<tr>
<td>Gaseous pollutant purifying equip.</td>
<td>6,157.5</td>
<td>10.76</td>
<td>1,828.5</td>
<td>15.93</td>
</tr>
<tr>
<td>Steam power plant FGD fitting equip.</td>
<td>269.1</td>
<td>0.47</td>
<td>151.5</td>
<td>1.32</td>
</tr>
<tr>
<td>Others</td>
<td>1,167.3</td>
<td>2.04</td>
<td>598.1</td>
<td>5.21</td>
</tr>
<tr>
<td>Total</td>
<td>57,226.3</td>
<td>100</td>
<td>11,478.1</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 30 - Sales Income and Profits of Various Kinds of Air Pollution Control Equipment

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Sales Income (10,000 Yuan)</th>
<th>Percentage of Total Sales Income</th>
<th>Profits (10,000 Yuan)</th>
<th>Percentage of Total profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitting equipment</td>
<td>28,336</td>
<td>37.50</td>
<td>3,581.4</td>
<td>37.39</td>
</tr>
<tr>
<td>Total</td>
<td>75,180.1</td>
<td>100</td>
<td>9,573.5</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 31 - Sales Income and Profits of Various Kinds of Solid Wastes Disposing Equipment
Production of Clean/Green products

Clean/Green products refer to those products that are environmentally friendly in the whole process of production. With widespread public acceptance, such products have great prospects. Green products, innocuous products, energy-saving and water-saving products and quiet appliances are being developed in Shanghai. Sales and profits of green, friendly, healthy products are quite satisfactory.

Table 32 - Production of Various Kinds of Clean/Green Products

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Annual Output 10,000 Yuan</th>
<th>Annual Sales Income 10,000</th>
<th>Percentage of Total Sales Income</th>
<th>Annual Profit 10,000 Yuan</th>
<th>Percentage of Total Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveying and storing equipment</td>
<td>599.5</td>
<td>3.10</td>
<td>146</td>
<td>3.30</td>
<td></td>
</tr>
<tr>
<td>Separating equipment</td>
<td>833.3</td>
<td>4.31</td>
<td>193.7</td>
<td>4.38</td>
<td></td>
</tr>
<tr>
<td>Cracking and pressing equipment</td>
<td>821</td>
<td>4.21</td>
<td>187.3</td>
<td>4.24</td>
<td></td>
</tr>
<tr>
<td>Incineration equipment</td>
<td>7,939</td>
<td>41.02</td>
<td>1,576.9</td>
<td>35.65</td>
<td></td>
</tr>
<tr>
<td>Hazardous waste treatment equipment</td>
<td>6,535.6</td>
<td>33.78</td>
<td>1,391.3</td>
<td>31.45</td>
<td></td>
</tr>
<tr>
<td>Recycling equipment</td>
<td>2,150.8</td>
<td>11.11</td>
<td>814.4</td>
<td>18.41</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>477.2</td>
<td>2.47</td>
<td>113.9</td>
<td>2.57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19,356.4</td>
<td>100</td>
<td>4,423.5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yuan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Innocuous products</td>
<td>117,325.1</td>
<td>99,271.6</td>
<td>11.74</td>
<td>10,827.4</td>
<td>13.36</td>
</tr>
<tr>
<td>Low discharging products</td>
<td>25,990.4</td>
<td>21,837.4</td>
<td>2.58</td>
<td>3,639.6</td>
<td>4.49</td>
</tr>
<tr>
<td>Water-saving products</td>
<td>643.1</td>
<td>629.5</td>
<td>0.07</td>
<td>89.9</td>
<td>0.11</td>
</tr>
<tr>
<td>Biodegradable products</td>
<td>8,3125.1</td>
<td>71,135.8</td>
<td>8.42</td>
<td>3,647.9</td>
<td>4.50</td>
</tr>
<tr>
<td>Low-noise products</td>
<td>2,421</td>
<td>2,013.1</td>
<td>0.24</td>
<td>278.4</td>
<td>0.34</td>
</tr>
<tr>
<td>Organic foods</td>
<td>20,463.9</td>
<td>18,536.2</td>
<td>2.19</td>
<td>1,524.0</td>
<td>1.88</td>
</tr>
<tr>
<td>Others</td>
<td>802,028.9</td>
<td>632,073.1</td>
<td>74.76</td>
<td>61,054</td>
<td>75.32</td>
</tr>
<tr>
<td>Total</td>
<td>1,051,997.5</td>
<td>845,496.7</td>
<td>100</td>
<td>81,061.2</td>
<td>100</td>
</tr>
</tbody>
</table>

- Environmental protection services (EPS)

An environmental protection service system is composed of enterprises and institutions involved in environmental protection science and technology development, environmental protection technological service and consultation, environmental protection product distribution, environmental engineering, and operation and management of environmental pollution control facilities. In view of the EPI investigation in 2000 and more recently, EPS basically meets market demands. Most of the units involved in environmental engineering design and construction of various kinds of pollution control projects are self-reliant, especially with respect to water pollution control and air pollution control projects. Enterprises and institutions involved in EPS and consultation have seen rapid growth in recent years, creating conditions for future services and market exploitation in environmental standards and product quality, verification, examination of cleaner production technology, environmental impact assessment, and enhancement of industrial self-discipline and development of green designs.
### Table 33 - Composition of Environmental Protection Services

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Income 10,000 Yuan</th>
<th>Percentage of Total Amount</th>
<th>Annual Profits 10,000 Yuan</th>
<th>Percentage of total profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP scientific and technological research and development</td>
<td>10,581.3</td>
<td>3.97</td>
<td>1,531.1</td>
<td>9.73</td>
</tr>
<tr>
<td>EP product distribution</td>
<td>32,713.2</td>
<td>12.26</td>
<td>4,781.0</td>
<td>30.37</td>
</tr>
<tr>
<td>Environmental technological service and consultation</td>
<td>11,207.5</td>
<td>4.20</td>
<td>1,203.2</td>
<td>7.64</td>
</tr>
<tr>
<td>Environmental engineering</td>
<td>191,483.2</td>
<td>71.76</td>
<td>6,973.7</td>
<td>44.30</td>
</tr>
<tr>
<td>Operation and management of pollution control facilities</td>
<td>20,835</td>
<td>7.81</td>
<td>1,253.6</td>
<td>7.96</td>
</tr>
<tr>
<td>Total</td>
<td>266,820.2</td>
<td>100</td>
<td>15,742.6</td>
<td>100</td>
</tr>
</tbody>
</table>

- Recycling

As shown by the 2000 EPI study and in the period since, businesses are mainly involved in market-oriented recycling of steel slag, coke exhaust and waste. Today, recycling has become a hot subject receiving wide attention from scientific research, design, and production enterprises as well as greater and growing support from society.

### Table 34 - Composition of Recycling Sector

<table>
<thead>
<tr>
<th>Item</th>
<th>Annual Sales</th>
<th>Percentage of Total Sales</th>
<th>Annual Profits</th>
<th>Percentage of Total Profits</th>
</tr>
</thead>
</table>

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### Natural ecological conservation

Natural ecological conservation includes nature reserves, construction and management of ecological demonstration sites and ecological restoration and control, mainly involved in creation of nature reserves, restoration and control, agriculture, animal and plant protection, green zone technology, and eco-systems. The total income of Shanghai’s natural ecological conservation industry amounts to 112.377 million Yuan, with annual profits totaling 15.636 million Yuan.

#### Table 35 - Composition of Natural Ecological Conservation Industry

<table>
<thead>
<tr>
<th>Item</th>
<th>Income 10,000 Yuan</th>
<th>Percentage of total income</th>
<th>Annual profits 10,000 Yuan</th>
<th>Percentage of total profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of nature reserves</td>
<td>623</td>
<td>5.6</td>
<td>87</td>
<td>5.6</td>
</tr>
<tr>
<td>Construction of</td>
<td>4,083</td>
<td>36.3</td>
<td>676.4</td>
<td>43.3</td>
</tr>
</tbody>
</table>
ecological demonstration spots

<table>
<thead>
<tr>
<th>Ecological restoration and control</th>
<th>Income 10,000 USD</th>
<th>Percentage of Total Income</th>
<th>Exports in 10,000 USD</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>11,237.7</td>
<td>100</td>
<td>1,563.6</td>
<td>100</td>
</tr>
</tbody>
</table>

International trade

Shanghai’s EPI international trade is distributed across different sectors. The majority use ideas introduced from overseas mainly for recovery, processing and utilization of some resources like metal from imported old or waste instruments and equipment. The exported products mainly include organic foodstuffs, degradable products and other Clean/Green products. The main components are shown in Table 36.

Table 36 - World Trade Composition and Distribution of EPI Related Industrial Sectors

<table>
<thead>
<tr>
<th>EPI Related Sector</th>
<th>Income 10,000 USD</th>
<th>Percentage of Total Income</th>
<th>Exports in 10,000 USD</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of EP products</td>
<td>—</td>
<td>—</td>
<td>567</td>
<td>9.31</td>
</tr>
<tr>
<td>Production of clean products</td>
<td>—</td>
<td>—</td>
<td>4,664.8</td>
<td>76.56</td>
</tr>
<tr>
<td>EP services</td>
<td>2,293</td>
<td>20.29</td>
<td>839.9</td>
<td>13.78</td>
</tr>
<tr>
<td>Recycled Products</td>
<td>7,736.7</td>
<td>68.45</td>
<td>21.5</td>
<td>0.35</td>
</tr>
<tr>
<td>Natural ecological conservation</td>
<td>1,273.5</td>
<td>11.26</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>11,303.2</td>
<td>100</td>
<td>6,093.2</td>
<td>100</td>
</tr>
</tbody>
</table>
3. Scale and efficiency

Many factors like market demand, competition, management, enterprise scale, service, product quality and pricing have direct or indirect influence on business efficiency.

- Scale and efficiency

According to the 2000 EPI study on recent findings, scale has great influence on efficiency. There are 1,041 SMEs in Shanghai with assets of less than 50 million Yuan, accounting for 96.03% of the total, but annual sales income of just 3.173796 billion Yuan and profits of 468.513 million Yuan. There are only 43 large firms with assets of over 50 million Yuan, that accounts for 3.97% of the total, but their annual sales income is 8.928797 billion Yuan, exceeding the total of the SMEs by 5.755001 billion Yuan; the profits amounting to 1.04353 billion Yuan, exceed the total of SMEs by 575.017 million Yuan. The gap between SMEs and large companies is so great due to scale of production, management quality, and price.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Number</th>
<th>Annual Sales Income 10,000 Yuan</th>
<th>Annual Profits 10,000 Yuan</th>
<th>Profit Rate %</th>
<th>Per-capita output</th>
<th>Per-capita profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>43</td>
<td>892,879.7</td>
<td>104,353</td>
<td>1.168</td>
<td>31.67</td>
<td>3.70</td>
</tr>
<tr>
<td>Middle</td>
<td>61</td>
<td>76,504.5</td>
<td>8,335.3</td>
<td>10.90</td>
<td>4.02</td>
<td>0.44</td>
</tr>
<tr>
<td>Small</td>
<td>980</td>
<td>24,0875.1</td>
<td>38,516</td>
<td>15.99</td>
<td>3.09</td>
<td>0.49</td>
</tr>
<tr>
<td>Total</td>
<td>1,084</td>
<td>1,210,259.3</td>
<td>151,204.3</td>
<td>12.49</td>
<td>9.68</td>
<td>1.21</td>
</tr>
</tbody>
</table>

Note: 'Small' refers to those with assets of less than 15 million Yuan 'middle' to assets between 15-50 million Yuan, and 'large' to assets over 50 million Yuan.

- Economic efficiency of different sectors

Economic efficiency of different sectors is influenced by the market, particularly
the infrastructure, capacity, growth and adaptability of technologies, quality assurance of products and services, rationality and market acceptability of price and available credit. According to the study in 2000 and recent findings, the development of different specialized sectors of Shanghai’s EPI is linked to a balanced economic efficiency in general. Cleaner products, resource recycling, and environmental services have a sound foundation for future development.

Table 38 - Efficiency of Different Sectors of Shanghai’s EPI

<table>
<thead>
<tr>
<th>Item</th>
<th>Sales Income 10,000 Yuan</th>
<th>Annual profits 10,000 Yuan</th>
<th>Profit Rate %</th>
<th>Per-capita Output 10,000 Yuan</th>
<th>Per-capita profit 10,000 Yuan</th>
<th>Number of workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP products</td>
<td>256,291.9</td>
<td>37,165.4</td>
<td>14.50</td>
<td>6.97</td>
<td>1.01</td>
<td>36,761</td>
</tr>
<tr>
<td>Clean/Green products</td>
<td>1,051,997.5</td>
<td>81,061.2</td>
<td>7.71</td>
<td>37.88</td>
<td>2.92</td>
<td>27,771</td>
</tr>
<tr>
<td>EP technical services</td>
<td>266,820.2</td>
<td>15,742.6</td>
<td>5.90</td>
<td>7.45</td>
<td>0.44</td>
<td>35,822</td>
</tr>
<tr>
<td>Recycling</td>
<td>143,542.5</td>
<td>15,671.5</td>
<td>10.92</td>
<td>7.18</td>
<td>0.78</td>
<td>19,996</td>
</tr>
<tr>
<td>Natural ecological conservation</td>
<td>11,237.7</td>
<td>1,563.6</td>
<td>13.91</td>
<td>2.37</td>
<td>0.33</td>
<td>4,733</td>
</tr>
</tbody>
</table>

- Environmental and social efficiency

In recent years, the development of Shanghai’s EPI and the entry into the market of large scale technology products have provided effective service to the users and helped to control and improve Shanghai’s water, air, noise environments and the overall appearance of the city.

4. Analysis of the problems in Shanghai’s EPI development

Shanghai’s EPI has seen rapid growth, but such growth is not satisfactory in light of current conditions. In these initial stages, “natural development”, enterprises
structure, size, construction, management, product categories and varieties are not always suitable to the EPI development, leaving a large gap between Shanghai and the rest of the major growth areas in the country.

- Firms are small, short of funds and uneven in development. There are only 43 enterprises with assets over 50 million Yuan, accounting for 3.97% of the total. Large and medium-sized ‘foundation’ companies are scarce. There are 980 small-sized enterprises, accounting for 90.41% of the total and the registered capital of many such enterprises is between 0.5-1 million Yuan. The small size and shortage of funds inhibit new growth, recruitment, technology development, equipment upgrading, management, and social relationships, making many such enterprises lacking in development status, understaffed, weak in technology, equipment levels, and technical content. These companies find it difficult to replace old equipment and continue to manufacture old models based on current sales and unable to improve productivity. Furthermore, because they cannot keep pace with the competition and market development, their survival is threatened.

- EPI scientific exploitation and research cannot keep pace with development. Shanghai boasts outstanding advantages in organizational, forces, equipment and conditions for EPI scientific and technological research, but such advantages have not been allowed to flourish for the following reasons:

  Policy support for research and development is not strong enough to promote technical and scientific research institutions. Preferential policies encouraging EPI scientific and technological research, innovation approaches to science and technology, development of new technologies and new products have not been implemented and management systems are weak. Related economic policies, to promote popular acceptance of environmental protection technologies and speed up the use of the new technologies and new products have not been adopted successfully. Thus there is no impetus for new products or related EPI research and development.

  With weak management, research institutions that lack planning, guidance and coordination, it’s especially important that timely announcements about research developments and new products be publicized. The lack of an infrastructure to test new products means that some new technologies are introduced but not developed, causing a lot of problems in market development. The lack of financial support for those scientific and technological projects that are urgently needed hampers innovation.
The development of information technology is quite slow in the EPI; and channels for sharing new information do not really exist to any significant extent. Consulting services are just in their primary phase and there is an urgent need to develop methods collating and dispersing new ideas in order to maximize market efficiency.

- EP services are lagging behind and slow to be developed.
- Management of the EP market is weak. Although government departments and private companies have agreed to tighten management methods, much work needs to be done to allow market forces to influence development.

5. Prospects for Shanghai’s EPI Development

Shanghai occupies an important position and plays an important role in the growth of the whole country. To create in Shanghai a modern ecologically sound metropolis that is a centre for international finance, trade and shipping is one of the goals of the “Tenth Five-Year Plan-Year Plan” and the Second Third-Year Program. At the same time ensuring that the national economy can sustain, rapid and soundly based development, presents both immense challenges and stunning opportunities for the EPI.

  
The primary environmental target defined in Shanghai’s Second Three-Year Action Plan on EP is to upgrade the quality of air and water to a level that is among the best of any large city in the whole country by 2005. This would make Shanghai one of the most livable cities in the country and the world, with the river courses in the central and suburban districts clear, clean, and free of noxious odors. Construction of city sewage treatment plants would be accelerated, the treatment rate of city sewage would increase by over 70%, the number of days with an air quality index at class 2 or better would reach at least 85%, and efficient garbage collection/disposal systems and safe treatment of hazardous wastes would be realized. The greening of 4.7 hectares in central urban areas that would yield 8m² per capita, would be undertaken, a large forest belt of about 2,000 hectares would be planted in the suburbs, achieving the target of a national garden-like city. Chemical fertilizer use would drop to the lowest level in the whole country, annual pesticide application would increase by 40%, pollution from domestic animal manure would be sharply lowered and the agricultural ecological environment...
would be gradually improved.

- Give full play to role of Shanghai Academy of Sciences, scientific research and design institutions, universities and colleges and research institutes and maximize their current advantages to initiate mutually beneficial cooperative ventures in different sectors of the EPI.
- Start research on EPI application technologies and management. Use scientific and technological innovations to expand the market, provide services for standardizing industrial waste management, and encourage international cooperation.

For EPI research to realize the targets defined in the 10th Five-Year Plan and the 2nd Three-Year Action Project on EP and construction, the sector needs better technologies and products. With a large available work force, the Mainland has certain advantages over the developed countries, so Shanghai should focus future efforts to developing EP technologies and products to earn foreign exchange through exports; to develop green technologies to protect and improve the environment and living standards.

The major goals of EPI management research should include expanding the domestic and overseas markets, complying with the rules of international markets, and promoting standards and economic policies suitable to China’s actual situation. Such research will enhance market exploitation, raise profits and promote EP development.

Keep doing a good job of introducing technologies because China still has a long way to go in comparison with the developed countries. So, it is of great significance to enhance international science and technology exchange. Using internationally developed advanced technologies and products is an important way to promote and expand Shanghai’s EPI. In the introduction of technologies and products, consideration should be given to the economic benefits and market acceptance and penetration. With careful decision-making, it will be possible to produce local technologies and products.

- Encourage business to promote new commercial developments. A large majority of EP firms are small in size, difficult to finance, unable to keep up in management and quality controls. They lack a skilled work force and face a series of problems in product development and obtaining credit. All of these factors directly influence competitiveness and growth. Any company needs good management, advertising, and public support in order to thrive.

Enhance support to large-sized enterprises. It is planned to select 15-20
companies from the current 43 large-sized firms and some well-managed SMEs and give them overall support in many forms so as to promote their development, upgrade their quality and their ‘brand image’ and their capacity to compete in international markets. With sales exceeding 100 million Yuan, and steady growth rates, within 1-2 years such firms could become listed on the stock exchange.

Enhance support for SMEs. The small and medium-sized enterprises accounting for 96% of the total EPI firms in Shanghai are small and find it difficult to finance the construction of new plants. Internal management, technical development, and market distribution are influenced and restricted to a certain degree. But among these SMEs, some really have the technical superiority and energy to exploit the market, which enables them to survive and expand their share, even under difficult economic conditions. Helping such enterprises overcome their difficulties and grow, with help from the government, is important and should not be ignored in the future development of Shanghai’s EPI.

- Encourage the SMEs to examine the benefits of merging forces to benefit from their strengths and pool their financial resources, develop a commercial network and improve their access to credit. Scientific research institutions, associations, professional commissions and related experts should be contacted to enhance technical support to the SMEs in product development and market exploitation. An EPI development park, combining research and production, trade links and services should be established.

Appendix IV: Analysis of Jiangsu Province’s EPI

1. Basic Status of Jiangsu’s EPI

Jiangsu’s EPI has the following characteristics:

- The EPI is on a large scale.

By the end of 2000, there were 1,711 exclusive or sideline enterprises and institutions involved in the EPI, including 1,498 companies and 213 institutions, of which 1,324 were exclusive and 387 sideline, accounting for 77.38% and 22.62% of production, respectively. There was 163,900 staff employed in the EPI, among whom persons with senior professional titles and middle professional titles account for 2.86% and 7.99% of the total respectively. The EPI fixed assets in 2000 exceeded 20 billion Yuan. EPI investment the same year was 2.23 billion Yuan, of which firms and institutions accounted for 88.51% and 11.49% respectively. Investment in the three
major areas, new EP products, recycling and Clean/Green production accounted for 28.09%, 31.58% and 13.93% respectively. The EPI gross product of the whole province in 2000 amounted to 23.933 billion Yuan, accounting for 12.71% of the whole country’s EPI gross product and 2.9% of the province’s GDP. The value of EP products, recycling, and EP services was 28.42%, 15.66% and 23.39% respectively of the province’s EPI that year. The annual total profits of the whole province’s EPI amounted to 2.346 billion Yuan, with the business and institutions accounting for 94.25% and 5.75% respectively. The EPI contract value in 2000 amounted to 28.249 million USD. The environmental protection products were exported to 27 countries and regions, the total value of export contracts amounted to 191.312 million USD. In the period of the 9th Five-Year Plan, the provincial EPI saw an average growth rate of 25%, higher than the growth rate of the national economy in the same period. A large number of EP products with annual output value over 100 million Yuan and 34 key EP firms, with an annual sales value of over 100 million Yuan developed.

- A complete EPI system has taken shape

  Over a 20 year period, Jiangsu’s EPI evolved from production and operation of single EP products in the starting phase to comprehensive utilization of resources and EP services. An EPI system composed of five major parts, EP products, Clean/Green products, recycling, EP services and natural ecological conservation, has taken shape.

  To manufacture EP products, an industrial system has formed with air pollution control equipment as the backbone along with solid waste treatment and disposal equipment, noise control equipment, EP chemicals, monitoring instruments, that can be divided into 200-plus types and 2,000-plus models. There are 986 EPI companies involved in water treatment. Jiangsu Province has the largest number of functional water treatment systems in the country.

  In recycling sector, comprehensive use of “three wastes” generated by industries such as building materials, chemicals, power, light industry, metallurgy has seen rapid development. Comprehensive use of industrial solid wastes reached 25.984 million tons and the rate of use of recycled materials reached 85.52%. Recycled waste materials such as plastics, paper, non-ferrous metal and steel exceeded 2 million tons. EP technical and consultation services; emerging service industries like general contracting of environmental projects, and special pollution control operations developed rapidly. According to statistics in 2000, there were 647 EP firms including 69 control operation facilities, providing for wastewater treatment of 114 effluent
units.

- Technical level has been upgraded

In recent years, Jiangsu Province has started to carry out the sci-tech advanced strategy, adhering to the principle of giving equal emphasis to the development of technology depending on domestic strength and the introduction of foreign funds and technical joint ventures. In 2000, the number of EP sci-tech projects reached 917, accounting for 53.59% of all EPI enterprises and institutions. Almost 22% or 374 units achieved ISO9000 certification. And new investments in EP sci-tech development are increasing year by year. By 2000, investment in EP technologies in the whole province had reached 307 million Yuan. There were 1,009 locally developed projects and 519 joint ventures.

At present, Jiangsu Province has established joint ventures with over 20 countries, speeding up the pace of EP transformation. Technologies like abattoir wastewater treatment, printing and dyeing wastewater treatment, small incinerators and solid and liquid wastes separating equipment are ‘cutting edge’ developments.

- EPI based construction has seen greater progress

Yixing City is an area of Jiangsu Province where the EPI took root early, developed quickly and with a high concentration of facilities it has earned the title, “the home of EPI”. In 2000, there were 330 EP enterprises in the city with output value amounting to 3.808 billion Yuan, accounting for 21.31% of the whole province. Through 20-plus years of development, Yixing’s EPI has created its own superior character.

Production of EP products and comprehensive recycling make up the main body of the industry, accounting for 61.55% and 38.45% respectively of gross value of the EPI in 2000. In the production of EP products, wastewater pollution control facilities accounted for 81.32% of the total.

Intensification and scale are comparatively higher. Among 330 EPI enterprises, there are 48 enterprises with gross output value over 20 million Yuan, accounting for 14.55%; 18 over 50 million Yuan, accounting for 5.45% and 9 over 100 million Yuan, accounting for 2.73%. The technology development capacity and sci-tech content of these enterprises are comparatively higher.

With a stated preference for ‘sci-tech and joint venture driven projects’ in recent years, the industrial park has enjoyed rapid growth in pollution control technologies and related products, i.e., clean/green products, recycling technologies and products,
design, construction and management of environmentally friendly projects, research and development of EP technologies, consultation service, training and education, ecological engineering and microelectronic technologies. In 2000, there were 90 EP enterprises in the park and total income of EPI enterprises amounted to 1.48 billion Yuan. In 2001, national EPI parks were established in the cities of Changzhou and Suzhou, marking a new phase of development in Jiangsu’s EPI.

2. Characteristics of Jiangsu’s EPI

The development of Jiangsu’s EPI has following characteristics:

- **Rapid Development**

In 20 years, Jiangsu’s EPI has become a pillar industry of the province. In 1985, there were 274 units involved in EPI, in 1993, there were 1,180 and by 1997 there were 1,404. Now, the total number is 1,711. Their value was 400 million Yuan in 1985, 5.535 billion Yuan in 1993, and 7.965 billion Yuan in 1997 and it is 23.933 billion Yuan today.

With rapid growth in the number of EPI enterprises and institutions, investment in fixed assets, sales value, and taxable income from the industry has changed greatly. It has shifted from reliance on simple machinery and operations in its initial phase to encompass all aspects of design and construction of environmental projects, technical consultation, recycling, natural ecological conservation and environmental protection services, thus forming a complete industrial system.

- **The economic structure has evolved from simple to complex.** Initially, the EPI was mainly composed of a few state-owned and township enterprises. With the development of the economy, the opening up to the outside world, and the heating up of the EP market, the economic structure of EPI now has dozens of economic elements including state owned, collectives, joint stock companies, privately owned, the Sino-foreign joint ventures, and those wholly funded by overseas firms.

- **Operations are market driven.** The production and operation of Jiangsu’s EPI was market driven from the very beginning, laying a firm foundation for all future development. Instead of clinging to government departments, companies and institutions formed the main body of the industrial market, promoting expansion, driving technological progress, upgrading the quality of products and services and increasing the social and economic benefits of the EPI. The per capita annual income
of the whole province from EPI amounted to 12.21 million Yuan and the per capita profit amounted to 14,300 Yuan in 2000, 3.35 and 2.86 times higher than 1997 respectively. The year-by-year growth has provided the basic development strength for production and operations as well as a continuous investment cycle.

3. Problems in the Development of Jiangsu’s EPI

The major problems in the development of Jiangsu’s EPI at present include:

- **Irrational structure.** Although the aggregate economic volume of Jiangsu EPI tops the whole country at present, an irrational organizational structure still obtains.

  Although the industry has changed through primary adjustments, there are too many small firms and a shortage of large companies because of the historical evolution from township enterprises in the primary phase to the development of private firms in recent years. In 2000, there were 232 units with fixed assets over 15 million Yuan, accounting for 13.56% of the total and 374 units with industrial output value over 10 million Yuan, accounting for 20.28% of the total. The number of EPI enterprises with fixed assets and industrial output value over 100 million Yuan are respectively 43 and 34, accounting for 2.51% and 1.99% of the total respectively. The numbers of EPI enterprises with fixed assets less than 15 million Yuan and output value less than 10 million Yuan accounting for 83.93% and 77.73% of the total number respectively. With outdated equipment and low specialization levels, this large, motley collection of small units cannot profit from economies of scale.

- **Irrational production rates.** Production rates, standards, and new technological development levels are generally rather low. There are too many firms turning out the same type of basic product but only about 30 that have real superiority in quality control, branding, and marketing.

  - **Weak capacity of technological development and low technical content of products.** With a large proportion of small-sized enterprises basically unchanged, most firms are weak in scientific research and design capacity and short of technical development funds. Technical innovations have not taken shape; the enterprises do not have the technical capacity to manufacture the pollution control equipment that the market urgently needs, such as for coal-fired power plants flue gas desulfurization, city garbage treatment, large and medium-sized domestic sewage collective treatment, highly concentrated organic wastewater treatment and so on.
The EP consultation service sector is imperfect. Institutions involved in technical research and development and project design and construction are large in number, small in size, weak in distribution networks and lacking the capacity to offer a complete range of services. Many pollution control facilities are in the early stages of specialization, and market orientation. The natural ecological conservation industry and EP services are comparatively backward and have not adjusted to the demands of the market. The operation of many pollution control facilities and treatment rate of pollutant discharge is poor and investment in new EP technology remains low.

The EPI management system needs effective leadership. Jiangsu’s EP enterprises are subordinate to about 20 departments in charge of different sectors such as machinery, electronics, shipbuilding, aeronautics and astrophysics, chemical industry, light industry, and military industry. For a long time, industrial management has been too widely dispersed, without effective macro guidance and control of overall planning and specialization needed to encourage and support EP policies and measures.

The EPI lacks sound management techniques. A standard management system has not yet been established so most EP firms do not have effective quality controls.

4. Development Prospects of Jiangsu’s EPI and Policy Support Measures

With powerful policy support, the development prospects of Jiangsu’s EPI will be outstanding.

Development Prospect

During the “Tenth Five Year Plan”, investment of EP in China is estimated to reach 700 billion Yuan, out of which 115 billion Yuan comes from Jiangsu. Increase in EP investment brought about the expansion of EP market. By the end of the “Tenth Five Year Plan”, total annual production of Jiangsu’s EPI should have achieved 50 billion Yuan, with annual increase of over 15%. Moreover, acceleration of strategy adjustment in economic structure, introduction of new technology, review of traditional industries, reduction in consumption and promotion of clean and green products have explored great market for Jiangsu Province in technology of manufacturing green products and EP services.

Policy support measures should include.

Adjust the structure and foster a new pattern for optimizing and upgrading the
Based on current marked demand and future development trends, enterprises should be guided to develop EP equipment that is in high demand such as sewage treatment, garbage treatment and automobile gas exhaust purifying equipment, increase investment in technologies and initiate many important EPI technical reform projects.

Bring regional superiority into play and optimize industrial distribution networks. Give special assistance to the construction of the key EPI bases - the three EPI parks, Yixing, Changzhou and Suzhou, develop new technologies to enhance their capacity to lead the industry, prevent duplication, and form a highly competitive EPI structure.

Devote major efforts to developing an EPI services system. Encourage service providers to optimize their organizational structures, with fund raising, project construction, facilities operation, technical consultation, information service and personnel training as the main elements.

Optimize the allocation of resources. Support leadership by large-sized enterprises or groups that oversee general contracting of environmental projects that integrate technological development. Encourage scientific research institutions, universities, colleges and investment companies with superior technology by helping them to find the funds to become shareholders in self-directed IPOs. Identify outstanding key companies with ‘deep pockets’ to establish SMEs involved in EPI to become “small, precise, and specialized”, so as to provide specialized supplementary services to the large firms and general contractors.

- Formulate and implement EPI technological policies. The government should adopt policies and measures for financial subsidies, interest payment assistance, and EP technology funds, to improve the development and spread of innovations in sci-tech achievements.

Guide and support the development of technical innovation systems. Further promote collaboration among companies and research institutes and encourage them to establish joint technical centers for pre-production tests. By working together they can spread the risks and benefit from cooperation in multiple projects that can accelerate sci-tech achievements.

Enhance the introduction and utilization of new technologies through joint ventures or other channels to speed up public acceptance of key EPI technologies and equipment.
Formulate and implement preferential policies for the transfer of EP sci-tech achievements; enact legislation on EP policies; establish systems for quality standards and technical specifications for EP products.

- Implement economic policies that support the EPI.

Formulate and implement preferential policies on revenue tax and financial credits to promote EPI development; expand the current scale of the EP sci-tech fund, give special assistance to the research, development and popularization of EPI new technologies and products; support the key EPI technical reform projects with high-tech industrialization funds included in the provincial financial budgets; perfect the policies and regulations on tax exemption and/or reduction for comprehensive use of resources.

Explore new ways to establish diversified EPI investment and funding systems that are adapted to market forces. Encourage commercial investment in EPI through stock acquisition. The construction and operation of urban EP infrastructures should be undertaken with a unified plan and under government supervision, in accordance with the needs of the market. Actively adopt the international BOT mode to raise funds by issuing shares that will attract various kinds of public or private funds both overseas and domestic for new joint construction and operations, forming a diversified investment pattern combining government, business, and private sources.

Increase charges for sewage and garbage treatment according to the polluter pays principle and, at the same time, refine the commercial management facility operation, taking into account relative economic and environmental protection obligations.

- Perfect policies, laws and regulations of the EPI market to standardize management practices. Formulate and implement rules and regulations on EPI market management that reflect actual conditions, to regulate product quality standards and tendering procedures to discourage unethical competition.

Devote more efforts to managing, monitoring and inspecting the quality of EP products, investigating and prosecuting illegal production and distribution of counterfeit and shoddy EPI goods. Introduce a certification system on design, construction and supervision of EPI projects; carry out whole process management of the environmental engineering projects from design, construction, parts and equipment to installation, debugging, commissioning and acceptance inspections by government officials and end-users. Remove regional and industrial monopolies and open the market; strictly adhere to the market access system of EP goods and invite a
public bidding system on EP works; with third-party authentication bodies to form a unified, fair and consistent market according to the laws on specific product standards and services.