

# **CHINA'S ENVIRONMENT AND THE CHALLENGE OF SUSTAINABLE DEVELOPMENT**

Foreword by N.T. Wang

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## Reviving the Scorched Earth?

### A Snapshot of China's Hazardous Waste Management and Cleaner Production Programs

*Dan Millison*

Industrial solid waste generation in China is estimated to be 0.5 ton per person per year. A total of 650 million tons was generated in 1995. This amount is projected to increase to one billion tons per year by 2005, of which 5 to 10 percent will be hazardous (Bromby 1997, Liu et al. 1999). These figures exclude wastes from township and village enterprises (TVEs), which may comprise an additional 100 million tons per year. Approximately 18 percent of this waste is treated (115 million tons), 3 to 4 percent is discharged without treatment (20 million tons, 2 million tons of which, for example, is coal ash discharged into rivers), and approximately 38 percent is stored for further treatment (247 million tons). At these rates, more than one billion tons of solid wastes will be stockpiled over a five-year period. The amount of hazardous waste is estimated to range from 2.2 to 8.3 million tons per year, of which 1.5 to 3 million tons per year are discharged into the environment without treatment (Liu et al. 1999, Zhuang 2003). Estimates vary due to uncertainties in applying waste definitions and whether TVEs are included.

Successfully managing these waste streams is a monumental challenge, with a potentially large market for waste treatment and disposal, as well as pollution prevention. China's tenth Five-Year Plan (FYP) for National Social and Economic Development (2001–5) calls for an investment in hazardous waste treatment of approximately US\$8 billion of the US\$26 billion allocated for all environmental programs. Investments in cleaner production (CP) are targeted to reach more than US\$10 billion (PA Consulting 2003b). A key goal of the tenth FYP is to maintain hazardous waste generation at year 2000 levels via CP and industrial reform measures. Hazardous waste management

(HWM) and CP are critical elements in China's overall waste control and management strategy, yet neither is at a mature stage there.

The development of China's environmental management programs resembles that of most other countries: priority is given to immediate public-health-oriented problems, namely, air and water pollution and urban sanitation. After some progress with these initial challenges, HWM and CP programs have begun to develop in earnest, albeit with delays and limitations. Experience in developed and developing countries indicates that, to support successful programs, a variety of conditions must be present. Legislative, technical, institutional, and financial vectors must converge to create an enabling framework. Typically, ten to fifteen years elapse from the time that environmental problems are identified and a program is defined to the point that a functional regulatory program and infrastructure are put in place (Probst and Beirle 1999). While China's experience is consistent with that of most other countries, in some aspects it has lagged behind other East Asian countries, especially with respect to HWM infrastructure and financing CP. The slower pace is due in part to the perception that environmental issues have technological, rather than managerial, solutions (Clarke et al. 1997, Evans and Hamner 2003).

### **Linking Hazardous Waste Management and Cleaner**

#### **Production: The CP Equation**

Cleaner production can be defined as an industrial management process of maximizing resource and production efficiency and minimizing waste outputs. Industrial CP comprises principles of reformulation, replacement, reduction, and reuse (for background, see, for example, Luken and Freij 1994). In the Chinese context, CP can be defined more broadly to include:

- Eco-efficiency
- Pollution prevention
- Waste minimization, reuse, and recycling ("comprehensive utilization")
- Green productivity
- Industrial ecology/industrial metabolism ("eco-industrial partnerships").

In China, CP and HWM sometimes are thought of as distinctly different things, but the following equation clearly illustrates the link:

$$\text{Energy} + \text{Raw Materials} + \text{Water} = \text{Products} + \text{Wastes}$$

In the simplest terms, CP is an effort to make hazardous waste and other environmental pollution problems disappear through better management of inputs and production processes.

As China's economic development accelerated with the onset of economic reforms in the late 1970s, its environmental management programs emphasized end-of-pipe controls rather than CP. By the mid-1990s, China had become a net energy importer (requiring payment in foreign exchange), causing the economic benefits of CP in the form of energy efficiency to become painfully obvious. High energy costs, combined with pervasive ecological degradation due mainly to air and water pollution, have led to giving CP a prominent role in environmental management policy. HWM, the infrastructure development which might be seen as the epitome of Chinese "gradualism," also is maturing, in terms of the PRC implementing a more complete regulatory framework and a national program for safe treatment and disposal capacity.

### **Hazardous Waste Management and Cleaner Production in the Chinese Context**

Since the onset of economic reforms, China has received substantial foreign technical and financial assistance to support its development objectives, including environmental programs. China's CP and HWM programs have enjoyed donor-funded support, foreign-sourced training and overseas study tours, technology transfer, and institutional strengthening. The pattern of donor-supported assistance has shifted from direct intervention—that is, sector-specific or one-off project investments to develop waste treatment capacity or fund prototype CP projects—to a more strategic, staged approach of policy support followed by targeted investment (Evans and Hamner 2003). China's capacity to absorb foreign assistance and investment appears finite. Yet, its development pattern is mixed:

- Economic growth has raced ahead in the coastal provinces and lagged significantly in the western regions.
- Environmental management was not a serious factor in national government planning until the 1990s (Clarke et al. 1997).
- By the standards of developing countries, China is heavily polluted (Newfarmer and Johnson 1997).

Like many other developing countries, China has emphasized the need for technology transfer and financial assistance rather than management and human resource development. Bilateral donor support has promoted primarily technology transfer via hardware exports. Multilateral donors have emphasized policy intervention for management and institutional strengthening, with mixed success.

Some key external legislative developments that have affected China's CP and HWM programs are: (1) two key U.S. legislative developments in the 1980s,<sup>1</sup> and (2) the Basel Convention for the Control of Transboundary Shipments of Hazardous and Dangerous Wastes. China adapted many aspects of the U.S. HWM system, a policy reinforced by China's accession to the Basel Convention.

In the United States, the CP-HWM link became pronounced throughout the late 1980s as regulatory and market forces prompted industrial enterprises to reduce the amount of hazardous and toxic wastes generated and disposed off-site and to shift their emphasis to reducing the amount of such materials used in production processes. Two major legislative developments created the U.S. regulatory framework: the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA, passed in 1984), and the Superfund Amendments and Reauthorization Act (SARA, passed in 1987), which included community-right-to-know provisions, especially those provisions for public disclosure of hazardous and toxic materials use included in the Toxic Release Inventory (TRI) program.

The 1984 RCRA amendments imposed the current regulatory requirements for HWM, including operating regulations for treatment, storage, and disposal facilities (TSDFs). The technical requirements specified in RCRA are de facto the world standards for TSDFs. The TRI program was designed to incorporate greater public awareness concerning hazardous and toxic materials use, with the expectation that public pressure would cause industries to clean up their production processes. While extensive literature exists on the role of public participation in environmental management, TRI and similar programs have caused industries to systematically review their operations, resulting in widespread waste minimization efforts and a general shift to CP processes and technologies.<sup>2</sup>

Roughly coincident with the phased implementation of the RCRA amendments (1984-88) was the adoption of the Basel Convention in 1988, developed in response to several cases of transnational dumping of hazardous wastes. The Basel Convention defined waste classifications in a manner not unlike RCRA and other developed-country systems, established a protocol and limitations for transboundary waste transfers, and specified technical guidelines for appropriate waste management facilities. While the convention afforded some protection from illegal waste exports to developing countries, it also obligated signatories to build the necessary infrastructure to control hazardous wastes within their own borders. Thus, the Basel Convention effectively provided an enabling policy framework for international environmental technology transfer. Within this framework, various bilateral

and multilateral agencies funded a variety of HWM projects in Asia from the late 1980s through the mid-1990s.

As a signatory to the Basel Convention, China began its HWM program in the late 1980s, yet did not approve national definitions of hazardous waste until 1998, did not have a modern TSDF operating until the late 1990s, and did not publish national standards for key TSDF operations until 2001. Basel signatories face the practical necessity of harmonizing their national laws with Basel Convention definitions and stipulations, and this requirement has been a significant factor retarding China's HWM programs.

### **Historical Development of Treatment, Storage, and Disposal Facilities in East Asia**

Beginning in the 1970s and 1980s, countries in East Asia began systematically developing environmental control programs, including solid and hazardous waste management. Various factors affected the outcomes of HWM programs, particularly regarding developing centralized treatment capacity. These programs followed a typical pattern, with major development issues summarized in Box 8.1.<sup>3</sup>

By the late 1980s, legislation and regulatory programs were fairly well developed, preliminary waste surveys and siting studies had been conducted, and extensive multilateral and bilateral donor support had been mobilized to support national environmental program development. The TSDF development programs were to some extent "kick-started" by donor-funded technical assistance for feasibility studies. The U.S. Trade Development Agency (USTDA) and other donor agencies, World Bank and Asian Development Bank (ADB), provided a series of grants for feasibility studies in China, Indonesia, and Malaysia. World Bank and ADB assistance included proposed project loans to finance a handful of TSDFs. During the 1990s, several TSDFs opened in the region. Table 8.1 summarizes the chronology of HWM program and TSDF project development in East Asia.

In the late 1980s, these initial USTDA-funded feasibility studies generally concluded that a potentially large market existed (for example, in most cases, well over 100,000 metric tons per year (T/Y)) and that a commercially viable TSDF would require a minimum of 10,000 T/Y delivered to a centralized facility from a 200-kilometer (km) market radius. At these throughputs, the cost of processing and disposal was estimated to range from US\$100 to \$200/ton for secure landfill (in late 1980s dollars), with much higher treatment costs for dedicated incineration. The feasibility studies paid some attention to facility financing, ownership, and operations, but were not intended to fully resolve those issues. However, fur-

## Box 8.1

### Hazardous Waste Management Program and Treatment, Storage, and Disposal Facilities Project Development Issues

#### HWM Program Development Issues

- Define problems and develop legislative approaches
- Designate a lead agency
- Promulgate implementing regulations, rules, and operating guidelines
- Develop treatment and disposal infrastructure
- Create a mature enforcement and compliance regime

#### TSDF Project Development Issues

*Regulatory requirements and operating guidance.* What are the facility siting criteria? How will permits be defined and issued? What companies and government agencies will be subject to the regulations? What criteria will apply to facility operations? What requirements will be imposed on waste transportation? What level of enforcement will be exercised that in effect creates the market for commercial TSDFs?

*Waste definitions and prediction of waste volumes.* What wastes will be regulated? Will small generators be exempted from management requirements?

*Management strategies, disposal options, and treatment technologies.* What management options will be allowed? What treatment technologies will be permitted? What are the waste acceptance procedures? Will codisposal of municipal and industrial wastes be allowed? \*Dedicated incineration? Deep-well disposal?

*Ownership, financing, and economics.* Who will own and operate the facilities? How will construction be financed? How will tariffs and fees be calculated or regulated? What parameters will be used to determine whether centralized facilities are economically beneficial?

*Operations and human resource management.* Who will actually manage and operate the facilities? What worker training and

certifications will be required? Waste manifest system? Disposal documentation? Emergency response plans?

*Note:* \*In the United States, several landfill sites that allowed codisposal of industrial and municipal wastes prior to the 1984 RCRA regulations have been included in the Superfund cleanup program. Biodegradation of chlorinated solvents resulted in generation of vinyl chloride gas (an intermediate degradation product), a compound more toxic than the original substance. Thus, while codisposal may appear to be an attractive management option, without careful operating controls, the cure will be worse than the disease.

ther progress in TSDF development depended largely on which business model was adopted for specific projects. In the early and mid-1990s, the ADB and World Bank funded more detailed development and design studies, which included resolution of ownership and other operational issues. Outside of China, public-private partnerships with majority private financing emerged as the most common model of TSDF ownership and operations. In China, World Bank loans financed the first commercial-scale TSDF at Shenyang. More recent projects, however, are adopting public-private partnership arrangements.

Technology transfer has been a minor issue. Most Chinese facilities have a combination of stabilization/solidification, secure landfill, and incineration in cement kilns or dedicated incinerators. The Hong Kong Chemical Waste Treatment Center (CWTC) is a notable exception because it was required to accept all hazardous wastes collected in the territory. Waste-specific technologies generally have been limited to on-site treatment. Despite its attractiveness as a "permanent destruction" solution, incineration is limited to high-heating-value wastes (for example, in the United States, only approximately 2 percent of hazardous waste is incinerated).

#### TSDF Status in China

China's path to modern TSDF development began in earnest with the USTDA-funded feasibility study beginning in 1988 for a facility near Shenyang, Liaoning Province. In addition, the World Bank provided a series of loans for environmental protection and waste treatment projects in Liaoning Province, including design and construction of a modern TSDF that began operating in 1999. The landfill is reported to be experiencing operational difficulties, due in part to lack of revenue. At the time of this writing, run-on water, possibly contaminated by contact with waste, was not being pumped and treated (Van

Table 8.1

**East Asia Hazardous Waste Management Chronology**

Year	Country	Milestone
1974	Malaysia	Environmental Quality Act passed
1975	Malaysia	Department of Environment formed
1980	Hong Kong (SAR)	Waste Disposal Ordinance passed
1981	Hong Kong (SAR)	Environmental Protection Administration formed
	Malaysia	Twelve candidate TSDf sites identified
1982	Hong Kong (SAR)	Preliminary TSDf siting efforts
	Indonesia	Basic Environment Law passed; Ministry of Environment (KLH) formed
1983	Indonesia	Initial surveys and siting studies for 10 TSDf's
1984	Malaysia	Draft HWM regulations
1986	Hong Kong (SAR)	Department of Environment formed
	Indonesia	USTDA FS for Cileungsi site TSDf
1987	Hong Kong (SAR)	FS for Tsing Yi Island Chemical Waste Treatment Center
	Malaysia	USTDA FS for Kuala Alam TSDf
1988	China	USTDA FS for Shenyang TSDf
	Thailand	Ministry of Industry industrial waste regulations developed and promulgated
1989	Malaysia	HWM regulations promulgated; fifteen proposals submitted for TSDf development
1991	Indonesia	Environmental Impact Management Agency ("BAPEDAL") formed
1992	China	WB FS for Beijing TSDf
1992	Hong Kong (SAR)	HWM regulations promulgated
	Indonesia	WB FS for Cileungsi site TSDf; USTDA FS for East Java TSDf
	Malaysia	MOU for Kuala Alam operations
	Thailand	Hazardous Substance Act passed; Pollution Control Department formed; Samae Dam TSDf opens
1993	China	WB-loan-funded development of Shenyang TSDf
	Hong Kong (SAR)	Tsing Yi Island Chemical Waste Treatment Center opens
	Indonesia	MOU for Cileungsi TSDf operations
	Thailand	Ratchaburi landfill opens
1994	China	Private sector FS for Tianjin TSDf; ADB FS for Beijing TSDf (proposed loan)
	Indonesia	HWM regulations become effective; Cileungsi TSDf opens
	Thailand	TSDf operating company created
1995	China	WB FS for Shanghai TSDf; Solid Waste Law amended
	Indonesia	HWM regulations amended; MOU for East Java TSDf; ADB FS for Aceh and E. Kalimantan (proposed loan)
1996	China	Shenzhen secure landfill pilot project
1997	China	Suzhou-Singapore Industrial Park FS
	Indonesia	Basic Environment Law amended
	Thailand	Rayong TSDf opens
1998	China	SEPA hazardous wastes catalogue
	Hong Kong (SAR)	Subsidies removed on HWM collection and treatment
	Malaysia	Kuala Alam opens

(continued)

1999	China	Shenyang TSDf (secure landfill) opens
	Indonesia	HWM regulations amended
2000	China	Shanghai TSDf operational
2001	China	TSDf operational standards published; tenth FYP identifies eight TSDf projects for priority development
2003	China	Tianjin TSDf opened; new HWM program guidelines and regulations published

Sources: Authors' notes, Wong and Lai (2002, 2003), Zhuang (2002, 2003), Probst and Beirle (1999).

Notes: Acronyms: ADB = Asian Development Bank; FS = feasibility study; HWM = hazardous waste management; MOU = memorandum of understanding; SAR = Special Administrative Region; SEPA = State Environmental Protection Administration; TSDf = treatment, storage, and disposal facility; USTDA = United States Trade Development Agency; WB = World Bank.

Epp 2003). Two rotary kiln incinerators are under construction, and there is adequate space for additional treatment units at the kiln site. New treatment units may use plasma arc technology.

While progress was slow and sure in Liaoning, the relatively early commissioning of the Hong Kong CWTC set high design and operational standards for TSDf's in China. The technology-intensive approach in Hong Kong is unique to the region, if not the world, but was necessary to accommodate the local conditions and waste characteristics associated with a very large number of small and diverse waste generators. The early operations of the Hong Kong facility were successful and may have fed mainland perceptions that technology was "the answer" and that management and institutional aspects of TSDf development were unimportant.

Development of several other facilities began in the early 1990s, targeting primarily the large urban/industrial areas of Beijing, Tianjin, Shanghai, and Shenzhen. Beijing and Shanghai received World Bank support for feasibility studies in the early and mid-1990s, respectively. A homegrown pilot project facility was developed in Shenzhen with technical support from Qinghua University; the pilot later was scaled up to commercial operations. The facility currently has extensive liquids treatment capacity and uses solidification prior to landfill. Planned expansion includes a third secure landfill cell, rotary kiln incinerator, and recycling unit. In 1997 the Suzhou Singapore Industrial Park commissioned a feasibility study focusing on incineration technology. A comprehensive TSDf is being planned that will include secure landfill and incinerators using rotary kiln and possible plasma arc technologies (Van Epp 2003).

Shanghai's strategy was to construct a new hazardous waste disposal cell at an existing solid waste landfill and retrofit cement kilns for certain organic wastes. The Shanghai landfill site was not consistent with the

regional and international standards already set in Hong Kong and Indonesia, due primarily to high flood risk, but was selected as an acceptable option for early development. In Beijing, after the initial feasibility study funded by the World Bank, the ADB provided project preparation technical assistance in anticipation of financing facility construction and start-up. Ultimately, the original Beijing TSDf project was scrapped due to changes in the potential market and possibly unrealistic business expectations of the local government. New initiatives are underway to develop facilities for the Beijing and Tianjin areas.

Development of a TSDf for the Tianjin municipality began in 1994, following China's aggressive adoption in 1992 of its Agenda 21 program for sustainable development, which included a national hazardous waste strategy. A U.S.-based consulting firm conducted a pro bono feasibility study for Tianjin from 1994-96. The firm also proposed a prepayment financing scheme that enabled calculation of a lower unit treatment cost than that for any other proposed facility in the region (approximately RMB 600, or US\$75, per ton).<sup>4</sup> Although there was considerable private-sector interest in the TSDf project in 1996, it took several years to resolve the issues of risk guarantees and treatment cost versus treatment tariffs (Tianjin 1998; Zorn 1998, 1999). A new facility with 40,000 T/y treatment capacity was to be commissioned in 2003 (Wong and Lai 2002, 2003).

In Zhejiang Province, the Dadi Environmental Protection Co., Ltd. (Dadi) was established in 1998 to provide industrial waste management services. The Hangzhou Industry Solid Waste Disposal Facility, owned by Dadi, was the first demonstration project authorized by the State Environmental Protection Agency (SEPA) for provincial hazardous waste disposal. The service area covers most of Zhejiang Province and they are allowed to accept special wastes from outside the province. The facility reportedly is in early operational status as of mid-2004, with liquids treatment capabilities and a rotary kiln incinerator undergoing test operations. Facility plans include rotary kiln and possibly plasma arc technology; secure landfill; and recycling units for tires, electronics, and fluorescent lights (Van Epp 2003, Zhuang 2003). As of mid-2004, USTDA is providing a grant through SEPA for further facility development. Dadi has submitted a proposal for funding to ADB's Private Sector Operations Department, which is considering possible financial support, pending the participation of additional investors.

Table 8.2 summarizes TSDf status in China.

### Why Has China Lagged on TSDf Development?

Despite the apparent availability of technology and financing, the PRC has

Table 8.2  
Current Treatment, Storage, and Disposal Facilities' Status in China

Facility location	Facility type	Treatment capacity	Operational status*	Ownership structure	Approximate investment
Shenyang	L	20,000 T/y**	1999	GOGO	\$15 million
Shanghai	L, CK	25,000 T/y (Phase 1) 25,000 T/y (Phase 2)	1997 (Phase 1) 2003 (Phase 2)	GOCO	> \$10 million
Tianjin	L, DI	12,000 T/y (initial)	2003	JV	\$16 million
Shenzhen	L	5,000 T/y pilot 20,000 T/y commercial	1995	GOGO	\$18 million
Beijing	L, DI	10,000 T/y	—	GOGO	—
Fuzhou	L, DI	20,000 T/y (Phase 1) 40,000 T/y (Phase 2)	2003 (under construction)	?	\$14 million \$6 million
Nanchang	DI	5,500 T/y (medical waste)	2003	?	RMB 11 million
Nanning	DI	7,000 T/y (medical waste)	2002	?	RMB 6.3 million
Hubei	L, DI, CK	20,000 T/y	2004	GOCO	\$15 million
Hangzhou	L, DI, CK	100,000 T/y	2003	JV	\$18.8 million

Sources: Authors' notes, SEPA tenth FYP, Wong and Lai (2002, 2003), Zhuang (2002, 2003).

Notes: The order corresponds to approximate date of original feasibility studies, but for simplicity those dates were not included. Several other projects are in the planning and feasibility study stages and are not listed here.

Acronyms: CK = cement kiln; DI = dedicated incinerator; GOCO = government owned, contractor operated transfer; GOGO = government owned, government operated transfer; JV = joint venture; L = landfill.

\*Operational status = year of commercial operations.

\*\*T/y = metric tons per year.

lagged in developing a centralized TSDF infrastructure relative to Southeast Asia. Many factors explain China's lag in development, although seven reasons stand out:

1. Low priority for environmental programs in general, and hazardous waste in particular
2. Inadequate funding of environmental programs and limited development of commercial markets for centralized waste treatment operations
3. Lack of appropriate legislation and regulations to implement an effective program
4. Weak enforcement of environmental regulations and standards, and minimal culture of compliance
5. Emphasis on technological solutions vs. management controls
6. Limited business models and markets for waste treatment services
7. Lack of an integrated approach to environmental management.

#### *Development Priorities*

In the scheme of overall infrastructure development, hazardous waste treatment has received a lower priority than electric power, water supply, municipal wastewater treatment, urban sanitation, and solid waste management.<sup>5</sup> This low status is not surprising, as it is similar to regulatory priorities that have been established in other countries.

#### *Lack of Early Financial Commitment*

As noted above, the right combination of legal, institutional, social, financial, and technological factors all must be present for a successful program. This necessity, not emphasized in earlier five-year plans, is well recognized in the tenth FYP (2001–5), which calls for overall environmental investments of 1.5 percent of GDP and identifies eight national-scale TSDFs to be developed and more than 100 additional facilities for HWM.

#### *Regulatory Framework*

Despite an early endorsement of the Basel Convention and external funding for various pilot projects, national legislation for HWM programs—especially regulatory waste definitions—has been slow to appear. TSDF development has not been aggressively coordinated by SEPA. The PRC and Indonesia have both enjoyed extensive, donor-funded technical assistance; yet, China is fully five years behind Indonesia in promulgating waste definitions.<sup>6</sup> With

little history of a rule of law to support a modern regulatory program, this is not surprising (for a more in-depth analysis of legal and regulatory compliance issues see Alford and Shen 1998).

#### *Enforcement and Compliance Regime*

Enforcement of environmental regulations in China has been weak. Although there are several well-defined regulatory instruments, most “enforcement” occurs through the Pollution Levy System (PLS), generally in the form of opaque negotiations between regulators and the regulated. Without including hazardous waste in the PLS operating equation (due to a lack of national standards and definitions to be followed), basic waste control regulations cannot be enforced by local environmental protection bureaus (EPBs). At the national level, political leaders of different stripes have argued over the need for large investments in environmental protection. One of the most serious enforcement actions initiated from the highest levels of government was not issued until fifteen years into the development of modern-day regulatory programs.<sup>7</sup> Attention to transboundary waste shipments has also stretched regulatory resources (Box 8.2).

#### *Technological Solutions Versus Practical Management*

When regulatory programs bring pressure on government and enterprises alike, the natural response is to find the easiest apparent solution. With respect to HWM, high-technology solutions often appear attractive (and such solutions have been actively promoted by vendors and some bilateral programs). Technology options are often seized upon as “The Solution” without recognition of the practical limitations.

For example, incineration always appears attractive at first glance, especially in densely populated regions with intense land pressure, since it holds the promise of total waste destruction. However, as noted above, incineration is limited to high heating-value wastes; dedicated incinerators require substantial operator training and expertise; and incinerators capable of destroying a wide variety of wastes are expensive to build, operate, and maintain. As noted above, incineration accounts for only approximately 2 percent of total hazardous waste treatment in the United States, despite being prescribed in federal regulations as the best available technology to handle many wastes. If treatment technologies were the answer, export credit agencies quickly could have underwritten the sale of several large incinerators and other treatment systems and the problem would have been solved in short order. In effect, *technologies* have been available, but *applications* have not been viable. Essentially,

Box 8.2

**“Basel and the Beast”: Protecting the Environment  
or Distracting the Public?**

The Basel Convention is a worthy piece of international law. However, pursuing well-publicized transboundary cases can strain the limited human resources of regulatory agencies at the expense of domestic enforcement and compliance obligations. Assigning several regulatory staff to police a single case involving one or two containers of alleged hazardous waste legitimately may be questioned when there may only be a handful of people assigned to the national program. On the other hand, from the public relations perspective, it is impossible to ignore such cases. A widely publicized incident in Guangdong Province in 2002 highlights this management quandary.

That year several media reports documented improper disposal of waste electronics and computers in Guangdong Province. Much of this waste—perhaps as much as ten million pieces of electronics scrap per year—was alleged to originate from the United States (e.g., see Pontoniere 2002). Earlier in 2002, the National Peoples’ Congress had urged more stringent legislation to control electronic waste management, including imports. The Congress noted that 150 million pieces of electronics scrap per year were being generated in China (“NPC Representatives” 2002), suggesting that most of the waste at the Guangdong site had originated in China. Whatever the origin, the pictures of the “reclamation” operation in Guangdong showed appalling conditions.

Several questions arise: (1) How much of the waste is originating in China and how much from overseas? (2) Would supplier take-back regulations prevent such exports from developed countries? (3) What is the extent of public health and environmental damage caused by this improper waste management? (4) What is the most cost-effective method of controlling improper disposal as observed in Guangdong (e.g., developing a modern demanufacturing and recovery system)? (5) Would a stricter enforcement regime have prevented the illegal import and disposal activity?

The broader context of imports to China from the United States appears less alarming. For example, approximately 99 percent of hazardous waste exports from the United States go to Canada and Mexico. In 1995, the United States generated 276 million tons of hazardous waste, of which approximately 266,000 tons

(less than 1/10 of 1 percent) were legally exported, while 60 percent was intended for reclamation or recovery ([www.epa.gov/wastes/international/trade/](http://www.epa.gov/wastes/international/trade/) 2003). Although China currently has about 80,000 tons/year of treatment capacity available, as much as two million tons are inadequately treated or disposed of illegally (CERNET 2000). If all U.S. hazardous waste exports were dumped directly into China—which is most certainly not the case—they would represent less than 15 percent of the total waste stream being generated from domestic sources. Some multinational corporations in China actually ship waste back to the United States for proper treatment (Bromby 1997).

*Bottom line.* The Basel Convention obligates its signatories to (1) develop the management capacity to handle their own wastes plus wastes imported legally for reclamation, and (2) prevent import of illegal waste shipments. China is struggling to meet its treaty obligations.

*China Environmental Review* 4, Issue 13, 2002. “NPC Representatives Call for Legislation on Household Electronics Recycling.” Information attributed to Richard Ferris and Zhang Hongjun.

HWM is an extension of and advancement over urban waste collection and processing, and not rocket science.<sup>8</sup>

*Limited Business Models and Markets for Commercial Waste Treatment*

Ostensibly, HWM has been a government-led initiative, with significant donor support but a limited role for private-sector participation. World Bank and ADB-funded assistance was intended in part to eliminate policy barriers, strengthen the regulatory system, build human resource capacity to build and operate facilities, and finance a small number of prototype TSDF projects. By helping create an enabling framework, the initial capital infusions were expected to have some leverage and accelerate broader HWM infrastructure development. Compared to the pace of TSDF development in other Asian countries, the high-priority projects in Liaoning, Beijing, and Shanghai did not engender immediate, rapid growth in HWM facilities beyond the pilot project in Shenzhen and some private-sector-led feasibility studies in Tianjin and Suzhou. By the late 1990s, this situation had begun to change, as evidenced by the Hangzhou Dadi example noted above.

Lack of enforcement and limited government funding translated into lack of facility development and weak markets for environmental services and commercial waste management services. Without direct government funding, treatment capacity theoretically was to be developed with substantial private-sector participation; however, there has been no clear legal framework for private participation.

Private-sector firms have been marketing products and services in China since the 1980s, and many have been willing to finance large-scale infrastructure projects. Despite this availability of financing, lack of a predictable legal framework and government unwillingness to provide risk guarantees prevented or delayed new business models from flourishing in all sectors of the infrastructure.

### *Compartmentalization Versus Integrated Environmental Management*

China has not taken an integrated, holistic approach to pollution control and waste management. The country has had a tendency to compartmentalize environmental problems according to medium (air, water, solid waste), and to deal with them in a sequence roughly proportional to infrastructure development priorities. In other words, cleaner air will come with modernization and expansion of heavy industries and the power sector, cleaner water will come with renewed investment in water supply systems and wastewater control, and hazardous waste will be dealt with after those problems have been brought under control.

In addition, cultural and intellectual factors have had some effect. A common intellectual barrier in China and other developing countries is stated succinctly as "all we need is money and technology," without acknowledging the need for management skills.<sup>9</sup> A "culture of compliance" is still evolving as the rule of law takes hold. Polluting enterprises in China are maturing and are moving toward the point at which they take proactive responsibility for pollution control and waste management.

### **Cleaner Production in China: Beyond Industrial Modernization**

The industrial response to environmental management has been characterized in four phases:

1. Environmental consciousness and pollution control
2. Pollution prevention and productivity

3. Environmental performance and competitive advantage
4. Sustainable development (SD) (Rao 2000).

Broadly considered, China began tackling the first phase in the 1980s; the second phase in the 1990s; and, with accession to the WTO at the turn of the twenty-first century, entered the third phase. The fourth phase also was addressed beginning in the 1990s, with the quick adoption of SD principles and preparation of the Agenda 21 sustainable development program. Nevertheless, China's industrial development cannot yet be classified as sustainable.

If the waste volumes noted earlier are correct, then hazardous waste is the proverbial tip of the iceberg and, compared to the considerable effort already devoted to HWM, a much larger effort is called for in the context of CP.<sup>10</sup>

Recalling the CP equation . . .

$$\text{Energy} + \text{Raw Materials} + \text{Water} = \text{Products} + \text{Wastes}$$

. . . the potential scope of CP activities is quite broad, comprising energy efficiency, water conservation, raw-materials management and substitution, industrial process efficiency and process changes, product quality, and waste minimization (Box 8.3). CP now is being defined broadly and applied to the enterprise level and the public utility level, and as a concept in urban planning and city management.<sup>11</sup>

### *Key Drivers of Cleaner Production*

When driven by purely financial and economic considerations, industrial CP is just another name for industrial modernization. A successful CP program requires both a market pull and a regulatory push. Experience indicates that the regulatory push creates an enabling environment that forces new CP-oriented thinking onto enterprise management. An effective regulatory push causes pollution control costs to increase from zero to a range that impacts profitability. Making the cost of compliance cheaper than the cost of non-compliance is the job of both regulators and enterprise managers. Making noncompliance unattractive by other means (for example, legal penalties, such as revocation of operating licenses) is the job of regulators, consumers, and civil society. This combination of factors created the CP market in the United States and is emerging now in China.

"Creating the market" for CP sounds like a simple prescription, but it is not easy in practice. Government awareness and support are required to create the appropriate policy framework to foster market evolution. A comparison of wind power development in China and India illustrates this point.

## Box 8.3

## Typical Cleaner Production Applications

**Energy + Raw Materials + Water = Products + Wastes***Energy efficiency*

- Replace coal-fired power generating units with natural-gas-fired units to improve thermal efficiencies from 30 percent to well over 80 percent.
- Use inside-the-fence cogeneration (combined heat/steam and power) to replace dedicated boilers and power generation units.

*Raw-material changes*

- Reformulate production process to use environmentally benign materials, e.g., use citric acid-based cleaners instead of chlorinated solvents in electronics manufacturing.

*Water conservation*

- Recycle up to 80 to 90 percent of cooling water in power generation and other industry sectors.
- Reuse secondary sewage treatment effluent as industrial process cooling water to reduce total water consumption and water pollution loads.

*Solid waste minimization and reuse*

- Use calcium sulfate residue from power plant desulfurization as an input for gypsum wallboard production.
- Reuse power plant ash as additive in cement manufacturing and as construction fill supplement.
- Reuse shredded tires as an additive in road surfacing.
- Cocompost municipal sewage treatment sludge and biodegradable solid wastes.

*Comprehensive redesign of major production processes*

- Replace obsolete process technologies with more efficient and environmentally friendly technologies, e.g., replace mercury cells with ion-exchange or diaphragm technology to manufacture caustic soda.
- Replace traditional steelmaking technologies, e.g., blast furnaces, with granular coal injection, minimills, or the direct reduced-iron process.

Both are developing economies, but neither would be considered an advanced market economy, due to trade barriers, protection of state-owned enterprises, and immature capital markets. However, since the early 1990s, while the world watched in awe at the economic growth of China, India has developed three times as much installed wind power capacity. The relative mix of policy incentives, financing options, and regulatory frameworks accounts for the difference (Lew 2001).

At the enterprise or production facility level, it is useful to think of CP in terms of two factories: the visible factory that manufactures products, employs people, and contributes to economic development; and the other factory—not always visible to management—that causes pollution, creates public health problems, and detracts from economic progress. The manager's aim should be to improve efficiency, minimize operating costs, maximize profits, and not pollute the environment. The typical cycle of CP implementation begins with no-cost/low-cost changes (mainly housekeeping), then medium-cost modifications (equipment improvements), progressing to capital-intensive process modification or replacement. The financial return on investment is inversely related to the cost of the CP effort, i.e., the no-cost and low-cost CP options typically yield the highest relative returns. Table 8.3 presents examples of CP efforts in China.

China's CP programs have been largely donor-driven, with substantial support from the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Bank, ADB, and various bilateral agencies. Typical donor-funded projects have targeted specific industry sectors (for example, construction materials or chemical manufacturing), provided audits and assessment, prepared feasibility studies, and proposed specific implementation projects. Donor support in the 1980s and 1990s was primarily in the form of prototype projects: one-off, sector-specific (for example, construction materials or chemical manufacturing) or project investments (covering selected enterprises from a few sectors) intended to demonstrate practical, commercial aspects of CP. The CP knowledge base now is extensive, with CP centers having been established in several cities. Applying a broad definition of CP, donor support, including grant-funded technical assistance and loan-funded projects, is well over US\$1 billion (for example, see Evans and Hamner 2003 for a summary of ADB assistance).

In the context of industrial CP, the situation in China might be described as "long on audits and assessment, short on implementation." There is little documentation of projects that have been self-financed or supported solely by government funding (for a notable exception of CP technology transfer in the electronics sector, see Bersin et al. 2001). The leverage sought by donors

Table 8.3

**Examples of Cleaner Production Measures in Chinese Enterprises**

Cost category	Target	Type	Industrial sector	Outline of CP measures
Low-cost measures (high ROI)	Operation	Good house-keeping	Fertilizer plant	Cover fertilizer bags to prevent rainfall from washing out ammonia and contaminating surface runoff.
		Waste segregation	Fertilizer plant	Recover spent lubricants before they get to sewer.
		Simple recycling	PVC plant	Reuse noncontact cooling water/water conservation.
Medium-cost measures (medium ROI)	Equipment	Equipment modification	Pulp and paper mill	Install screw press to improve black liquor extraction, thus reducing BOD discharge.
		Equipment modification	Pulp and paper mill	Install nozzles to increase water pressure for washing pulp, thus reducing water consumption.
		Source treatment	Fertilizer plant	Treat excess scrubbing liquor ["liquor" is industry terminology for specific wastewater stream] at gas desulfurization area in order to recover sulfur.
		Source pretreatment and recycling	PVC plant	Pretreat and recycle liquid stream at the acetylene reactor.
High-cost measures (low ROI)	Process	Process change	Chlor-alkali plant	Replace diaphragm electrolysis technology by membrane electrolysis technology/energy conservation.
		Complex recycling	Fertilizer plant	Install distillation unit to purify and recycle spent lubricants/reduce pollution by oily waters.

Source: PA Consulting Co. 2002.

Notes: Acronyms: BOD = biochemical oxygen demand, ROI = return on investment, PVC = polyvinyl chloride.

on externally funded projects has not yet been realized (as is the case with the HWM program). Obviously, the market for CP is still developing in the PRC. Unlike the United States, where the increasing cost of hazardous waste disposal and ever-tightening regulatory pressure forced industries to minimize wastes, similar compliance pressures are virtually nonexistent in China. Despite the limited regulatory pressure and weak economic drivers for waste minimization, from the enterprise viewpoint, CP is becoming a more obvious option for achieving compliance with environmental discharge and emissions standards (PA Consulting Co. 2003a).

While the PRC was developing stronger legislation and more stringent standards in the 1990s, regulated industries complained that they could not afford to comply with the standards. Their reaction contrasted with that in other developing countries, in which typical environmental compliance costs have been 3 to 5 percent of total capital and operating costs (Ecology and Environment 1998). The conclusion is that the Chinese enterprises that cannot afford to comply with discharge standards are operating with very slim profit margins or are inherently unprofitable. At the same time, various barriers have prevented the enterprises' making the capital investments to upgrade process efficiency, become profitable, and achieve compliance. "Clean and green" was not a centerpiece of official Chinese industrial policy until recently (PA Consulting Co. 2003a, b). China's accession to the WTO is expected to rapidly increase market pressures that will drive enterprise reforms, including CP.

#### *Barriers to CP Implementation*

Why do CP implementation and investment appear to be so slow relative to the level of donor support? As is the case with HWM, a learning curve must be surmounted, and a similar set of several factors must converge to support CP implementation. At least six barriers to widespread CP implementation are discussed briefly below (PA Consulting Co. 2002, 2003a, b).

#### *Policy and Intellectual Framework*

Although several ministries have been involved in CP activities, national leadership has come primarily from the erstwhile State Economic Trade Commission (SETC) and SEPA.<sup>12</sup> CP has been a component of the eighth and ninth environmental five-year plans but was not incorporated in the overall national plan until the current tenth FYP (2001–5) was prepared. SETC and SEPA both have had limited influence over enterprise behavior. There is a latent tendency for policymakers and enterprise managers to view any "environmentally beneficial" expenses as dead-load cost with no possible economic or financial benefits.

#### *Lack of Information and Knowledge About Cleaner Production*

Most planners and managers do not have any working knowledge of CP concepts and options. Internet access, electronic communications, and e-business, which can facilitate the exchange of CP knowledge, are in early stages of evolution and have not been widely adopted, especially in small- and medium-scale enterprises (SMEs).

*Management Leadership and Market Incentives*

Without working knowledge of CP concepts, managers cannot effectively lead CP audits or promote implementation of recommended CP options. High transaction costs also inhibit CP adoption at the enterprise level: while the payback for specific CP alternatives may be fast, as short as six months, the initial capital costs may be high and the overall savings may represent a very small percentage of total operating costs. The economic incentives that have driven CP in other countries are just beginning to emerge in China. Immature market conditions, including cross-subsidies and continued policy lending (directed credits and soft loans based on government directives rather than financial credit-worthiness), do not generate sufficient market forces to promote CP adoption.

*Technology Transfer*

Some CP options may require foreign-sourced technology; the availability of which is limited by intellectual property concerns. There is a tendency for Chinese managers to pursue high technology rather than "appropriate technology" solutions.

*Legislative Framework and Regulatory Pressure*

The environmental regulatory framework does not provide adequate incentives or disincentives to clean up pollution. A culture of compliance is just beginning to emerge.

*Financing*

Ongoing banking-sector problems, continued policy lending practices, limited credit made available to market-oriented enterprises, and the generally poor credit history of enterprises have resulted in limited capital for CP projects. Typically, enterprises that have ready access to financing have no real incentive to clean up, while enterprises with sound CP proposals but limited political influence are not able to obtain needed capital.

Under today's market conditions, an enterprise or facility manager who recognizes the benefits of CP may not have a clear understanding of management options, knowledge of hardware sources, or the capability to prepare a detailed investment proposal, much less the access to financing. Clearly, greater access to information for planners and managers, improved financial management capability at the government and enterprise levels, facilitation

of technology transfer, and expanded financing options all are necessary to expand CP project implementation.

Despite these significant barriers, progress is being made on all fronts:

- CP was formally included in the national tenth FYP (2001-5).
- New laws that provide a legal framework for SME and CP development went into effect in 2002 and 2003 respectively. The SME Promotion Law includes a provision for special development funds that could support CP technology investments. The CP Law includes a provision for enterprises not in compliance with relevant discharge standards to conduct CP assessments.
- Theoretically, technology transfer is becoming easier with China's accession to the WTO.
- Information and knowledge transfer is becoming easier with the establishment of CP centers in several cities and rapidly increasing access to the Internet.
- Management acumen is improving as the market economy matures and competitive pressures resulting from WTO membership increase.
- Strengthening the regulatory framework, in particular modifications to the Pollution Levy System, bode well for adopting CP as an environmental compliance tool.
- In the energy sector, large power plants have been converting to low-sulfur coal (an economically attractive alternative to flue-gas desulfurization), and natural gas is being adopted as a primary fuel for power generation and industrial applications. [See Chapter 7 for additional discussion on this topic.]
- Public awareness concerning environmental issues is rising, and consumers are becoming more knowledgeable regarding corporate environmental behavior.
- Reforms in the financial sector continue, albeit slowly.
- Local governments are promoting enterprise development zones (EDZs), which have inherently more efficient power, water, and waste management systems. SMEs and TVEs are actively encouraged to relocate to the EDZs, which potentially expands the scope of CP initiatives to a citywide basis.

Recognizing that the implementation barriers noted earlier still exist, alternative approaches to CP are being designed to achieve greater leverage on initial project investments. For example, the World Bank has funded the start-up of energy management companies (EMCs) modeled on the energy service company (ESCO) business model (Taylor 2002).<sup>13</sup> The EMCs operate with performance contracts, providing turnkey-type survey/assessment and

engineering services, and earn profit based on actual client energy savings. The U.S. Department of Commerce is promoting the creation of energy and environmental service companies (EESCOs), also using a performance contract model (Ballard 2003). ADB has evaluated a broader CP service company model, similar to the EESCO concept, but emphasizing financial assistance and corporate restructuring supported by engineering and environmental services (Millison 2002; PA Consulting Co. 2003b). The markets for renewable energy and energy efficiency are growing as the Kyoto Protocol's Clean Development Mechanism (CDM) has been embraced by the national government and restructuring of the power sector proceeds. Positive experience in the energy sector should provide a foundation for broader CP activities.

### *CP: Great Leap Redux or Green Leap Forward?*

Superimposed on a decade of consistent policy statements embracing SD, the past twenty years of China's industrial growth have occurred to a great extent by cloning inefficient, highly polluting process technologies rather than via wholesale technological improvement. Although intellectual property concerns have inhibited or prevented technology transfer, all of the barriers noted above, as well as immense social and political pressure to maintain full employment, have played a role in the development trajectory. "Get rich first, clean up later" was the *modus operandi* in response to Deng Xiaoping's statement that "socialism is not poverty." However, as in many countries, economic growth has come at the expense of the environment: estimates of economic losses caused by pollution range from 3 to 5 percent of GDP per year to as high as 13 percent of GDP per year (Smil and Mao 1998). The industrialization of the PRC, from the Great Leap Forward (1958–60) into the 1990s, charitably characterized as a "scorched earth" development approach, is just beginning to show signs of recovery.<sup>14</sup>

China's SME sector, especially TVEs, was the key to growth in the early to mid-1990s, spurred to a great extent by investment from overseas Chinese. TVEs typically used obsolete, highly polluting technology. The resulting environmental problems, combined with other factors, led the State Council to issue a decree in 1996 outlawing various outdated process technologies and requiring enterprises to comply with discharge standards or be closed, merge with larger production units, or modify production processes (see reports in *China Daily* 1996a, 1996b). By the mid-1990s, the SME/TVE sector posed an economic threat to larger state-owned enterprises (SOEs), credit from state-owned commercial banks was tightened, and the SME/TVE sector had to compete for financial support to remain afloat (Becker 2000).

This sector currently is experiencing extensive restructuring, promoted by widespread development of enterprise development zones and "rural urbanization" (PA Consulting Co. 2003b).

With respect to market forces, China's dynamic economic development is still in an early stage. CP adoption appears to be lagging, but is it really or is it just lagging relative to economic growth? Perhaps both phenomena are occurring. CP has been donor driven rather than market driven, although market forces are beginning to pull CP into the mainstream.

With respect to energy efficiency, market forces certainly are influencing policy. Since the mid-1990s, several events have signaled a new national energy policy oriented toward cleaner energy:

- China became a net energy importer, with substantial foreign exchange implications.
- In 1998, a moratorium was imposed on new coal-fired power plant construction in urban areas, which effectively halted new power plant construction for about three years.
- Natural gas development finally was accepted as an economically viable energy alternative, as well as a source for power generation.
- In 2000, the Air Pollution Control Law was revised, with provisions for expanded use of natural gas for power generation; use of low-sulfur coal in large generating plants; and closure of small, obsolete power plants.

Enterprise reforms and financial-sector reforms significantly influence CP adoption, and wider adoption of CP is linked to progress on both fronts. A "green leap" is possible, but it is not yet obvious from recent trends. For example, in 2001 the government announced that by the year 2005, at least 5.5 percent of primary energy production would be from renewable sources. By 2002 the government had signaled that this percentage was just a target that would not be supported by legislation and central government funding. Despite being a signatory to the Kyoto Protocol and having significant potential for CDM project implementation, as of mid-2003 China had no clear renewable energy strategy, at least with respect to projects funded by loans from the ADB and World Bank. As of mid-2004, the National People's Congress was working on draft legislation and had requested technical assistance from the donor community to support further development of a renewable energy law.

### **Factors for Change and Signs of Hope**

"Is your stomach too full?" This was the question posed to one writer when he arrived in China on his worldwide search for environmental consciousness

(Hertsgaard 1998). Not unlike the case in most other countries, China's environmental progress has become serious only after the country has reached a threshold of affluence. There appears to be a paradigm shift occurring, from an earlier belief that environmental investment detracted from economic growth to a greater recognition that environmental investments pay off. Likewise, enterprise managers have a growing appreciation for the difference between pollution control as a management exercise rather than a technology application (Evans and Hamner 2003). Culturally, there is also a broader consensus for restoring balance between human development and environmental protection. In the richer coastal provinces, environmental protection now is perceived as "affordable." In some interior provinces, natural and cultural resource protection is becoming a worthwhile investment in its own right.

China became polluted because it was poor, and it remains statistically poor because it is polluted. Lack of investment in modern industrial technology created huge environmental problems with extensive social costs (for a comprehensive review, see Nehru et al. 1997). Social unrest has also resulted from extensive pollution problems (see, for example, Economy 1997). Yet, few of China's political leaders really believed that environmental problems could hinder economic development until the mid-1990s, when air and water pollution had become so serious that the State Council intervened directly. Beginning at approximately the same time, the foreign exchange outflow for energy imports provided some shock therapy to drive home the idea that inefficient use of resources has real hard-currency implications. The ninth and tenth FYPs reflected this paradigm shift, with much more detailed environmental programs and spending commitments. The tenth FYP (2001–5) includes a goal of investing 1.5 percent of GDP in environmental programs. The plan thus acknowledges the experience of Organization for Economic Cooperation and Development (OECD) countries, in which approximately 2 percent of GDP and twenty to thirty years have been devoted to achieve successful environmental programs (Ecology and Environment 1998). In China, actual investments in environmental protection are estimated to have been 1 percent (or less) of GDP per year during the ninth FYP (1996–2000).

As noted earlier, China's stockpile of solid wastes could soon be well over one billion tons nationwide. Managing these wastes in an environmentally acceptable fashion is a formidable task, but it can be done and, in China's case, must be done, before another billion tons is added to double this stockpile. An appropriate regulatory framework now exists to support the technical aspects of HWM. WTO membership is generating new market forces that support CP as a means of achieving environmental compliance

and increasing profits. The specific case of HWM is exemplary of China's environmental challenges in general: uncontrolled disposal can be prevented only if a combination of legal, technical, and financial measures are implemented over a number of years (not months). CP is an example of how such problems can be prevented in the first place and—by simultaneously reducing air, water, and solid wastes—provide direct economic benefits. The amendments to the Air Pollution Control Law that took effect in 2000 signaled a realization that cleaner energy production was possible without sacrificing macroeconomic benefits. The SME Promotion Law and the Cleaner Production Promotion Law, effective in 2002 and 2003 respectively, signaled government support for broader application of CP in the small- and medium-scale industrial sectors. This national legislation has been a necessary complement to China's membership in the WTO and is intended to create additional market pressure to drive sorely needed enterprise reforms.

Environmental management is not glamorous, but, occasionally, it has a very high profile, as in the case of the pending 2008 "Green Olympics" in Beijing. In anticipation of unprecedented media coverage, billions of public dollars are being invested to clean up the city's air and water. However, can this exercise be extended to the country as a whole?

The current generation of political leaders appears to be supporting accelerated industrial and financial reforms, but the government's willingness to tackle environmental and social problems head-on is subject to doubt.<sup>15</sup> The old school of politically based reporting and information control was alive and well in early 2003 as exemplified by the government's failure to control an outbreak of severe acute respiratory syndrome (SARS). The government admitted that a problem existed only after scathing criticism by the World Health Organization (WHO) and foreign governments, and then only because the official truth was challenged by Chinese health care professionals (Becker 2003, Jakes 2003). Some critics compared the SARS episode to the Chernobyl incident, which heralded the break-up of the former Soviet Union (Wei 2003), while others interpreted the PRC government's interventions to control the epidemic as a positive transformational event (Cheow 2003). The SARS crisis may have been instrumental in accelerating the issuance, in 2003, of new regulations and guidelines for hazardous and medical waste management (Van Epp 2003).

China's development progress is often summed up as "two steps forward, one step back." The current environmental situation in large part resulted from central control of industrial development and pollution control, favoring the former at the expense of the latter. Massaged statistics and political slogans did not solve China's problems in the past, nor will they help now. The SARS case is a recent example of that "one step back."

Nevertheless, we can see at least two steps forward. The legal framework for business operations is improving, and widespread enterprise reform is proceeding. Capital markets, perhaps the biggest obstacle to CP adoption, are expanding, albeit slowly. Public awareness is increasing, although civil society remains weak. Social pressures are being channeled into policies that reflect environmental protection as an achievable goal. Generational change is being accompanied by a push for accountable political leadership, modern industrial development, and effective environmental management. This new "long march" is just beginning. Let us hope that it keeps heading in the right direction.

## Notes

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1. The U.S. experience is referenced because many HWM and CP programs have adapted the U.S. management approach to local conditions.

2. For analyses of public-information-based programs, see, for example, Afsah, Laplante, and Makarim (1995); Afsah, Laplante, and Wheeler (1996); and Afsah, Blackman, and Rattunanda (2000).

3. See Probst and Beterle (1999) for a more comprehensive comparative discussion of Asian, European, and U.S. HWM program development.

4. This financing calculation was, in essence, an accounting trick, in that interest earned on the prepayment would be subsidizing or reducing the nominal unit cost to the generator.

5. A widely referenced World Bank report (Newfarmer and Johnson 1997) suggests that, in terms of economic impact relative to national gross domestic product (GDP), hazardous waste's impact on development is not as great as that of urban air pollution, acid rain, or water pollution (PA Consulting Co. 2003a).

6. The Government of Indonesia has also coordinated the construction of a large-scale TSDF with the promulgation of its national hazardous waste regulation. At the same time, the PRC has been much more advanced in developing its Pollution Levy System.

7. State Council Decree No. 31 (1996) stated that national industrial enterprises must comply with national discharge and emissions standards by the year 2000, or be closed, modified, or merged with larger production units. This decree also mandated the closure of fifteen sectors of highly polluting small-scale enterprises.

8. Referring again to the U.S. situation, despite extensive treatment technology development, most off-site hazardous waste treatment is by secure land disposal rather than some form of destructive treatment.

9. In China, other more complex intellectual and cultural issues are at play, as

eloquently discussed by Judith Shapiro (2001). See also Backman (1999) for a comparative discussion of business practices in East Asia.

10. For a comprehensive analysis of China's environmental challenges, see McElroy, Nielsen, and Lydon (1998), and other chapters of this volume.

11. An extensive and detailed discussion of the broader application of CP and related concepts can be found in "Natural Capitalism" (Hawken et al. 1999).

12. In March 2003 the SETC was dissolved, with many of its functions transferred to the National Development and Reform Commission.

13. World Bank Project Identification Number CN-PE-3606, US\$63 million loan, GEF grant US\$22 million.

14. See Shapiro (2001) and Hertsgaard (1998) for a historical and a more modern perspective, respectively. Unfortunately, the gradual environmental recovery noted in the late 1990s has not been sustained: SEPA reported (in 2004) that nationwide sulfur dioxide emissions increased by about 11 percent from 2002 to 2003, vs. a tenth FYF goal of a 10 percent reduction.

15. For example, see Economy 2002 for a critique of environmental implications of the Western Development Strategy; see Chang 2002 for a critique of the "gradualist" economic reform strategy.

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**Useful Web Sites**

Asian Development Bank: [www.adb.org](http://www.adb.org)  
Burton Hammer, independent consultant: [www.cleanerproduction.com](http://www.cleanerproduction.com)  
Chemical and Pesticides Results Measures (CAPRM): [www.pepps.fsu.edu/CAPRM](http://www.pepps.fsu.edu/CAPRM)  
[Via the tab "Draft Indicators" you will find "Design Indicator: Volume of U.S. Imports of Hazardous Waste, by Treatment Method and Country of Origin (7/13/01)."]  
PRC State Environmental Protection Agency: [www.zhb.gov.cn/english/](http://www.zhb.gov.cn/english/)  
Sino-Canadian Cleaner Production Cooperation: [www.chinacp.org.cn](http://www.chinacp.org.cn) and [www.chinacp.com](http://www.chinacp.com)  
United Nations Environment Programme (UNEP): [www.unepitc.org/pc/cp/](http://www.unepitc.org/pc/cp/)  
United Nations Industrial Development Organization (UNIDO): [www.unido.org](http://www.unido.org)  
United States Department of Energy (U.S. DOE): [www.fe.doe.gov/coal\\_power/ccv/](http://www.fe.doe.gov/coal_power/ccv/)  
United States Environmental Protection Agency (U.S. EPA, hazardous waste): [www.epa.gov/epaoswer/osw/hazwaste.htm](http://www.epa.gov/epaoswer/osw/hazwaste.htm)  
World Bank: [www.worldbank.org](http://www.worldbank.org)