

Hong Kong Innovation Project

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Environmental Technology:

Hong Kong's Innovation System

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Introduction

Hong Kong is going through the era of its rapid transformation as it tries to remain as one of leading metropolitan centers of Asia at least for the next several decades. While China's economy expands rapidly, Hong Kong has served the role of the gateway for channeling foreign investment to Mainland China. As Hong Kong compete with the major cities in the coastal area of the mainland, it needs to transform itself from a global financial service center as well as a trade support center for Asia to an important access point in the global innovation network. In today's global network for knowledge creation, Hong Kong can play an important role of trading and importing technology and jointly developing technology for the local Chinese market. Especially, the collaboration with Guangzhou and Shenzhen will be the essential aspect of Hong Kong's future economic development.

Currently, China is searching for a new strategy of sustainable economic development. The Chinese leadership considers the development of "green technology" is essential for transforming its current mode of economic development to a more energy efficient and environmentally friendly socio-economic system.¹ In the past decade, many Hong Kong manufactures have relocated their factories to

¹ For China's Mid and Long Term Plan for "green tech" development strategy, please see, <http://www.ndrc.gov.cn/fzgh/ghwb/115zxgh/PO20070930491947302047.pdf>

Guangzhou and the Pearl River Delta region. There are over 56,000 Hong Kong factories currently located in the region. Consequently, these factories are seeking to adopt better and more affordable technology for cleaning up their waste water and air to meet their environmental standard. In Mainland China, the number of new and also amended environmental laws and regulations were passed last year. Among them, the laws targeting energy conservation, water pollution, environmental information disclosure, and the ban on plastic bag are well recognized even outside China. As China pushes for tougher environmental regulations, the heart of China's manufacturing base in the south creates a potentially huge market for environmental technology. All the technology needs to be modified or redevelop to meet the local needs before they are adopted. Moreover, even after it has been successfully adopted, the system needs to be monitored regularly and readjusted to a constantly changing environment. Here, Hong Kong can potentially be a significant player in developing the technology to be adopted more easily to the local factories using more advanced technology in the US, Europe and Japan. There are two other but important reasons why Hong Kong should help China, especially Guangdong, to clean up the environment. One is the deterioration of Hong Kong's air quality primarily caused by the air pollution from the PRD. The other is the possible rise of sea level due to the global warming. Both

would threaten the future welfare of Hong Kong's living conditions.

Environmental technology is a very broad area of technology ranging from a simple energy saving device to a complicated system of water purification and recycling. Environmental technology can be conveniently divided into four areas based on their application. They are technologies related to the area of (1) global warming, (2) environmental pollution, (3) resource recycling, and (4) ecological management. The main users of the technology are both business and public sectors. Therefore, it is fair to say that the environmental technology developed by Hong Kong is mainly used by the local governments and local businesses of Hong Kong and the Pearl River Delta region. Although there is no definite boundary for the components of environmental technology, it is fair to say that it encompasses all technology areas which are used to maintain the sustainability of our mankind. It means the technology which helps to improve our environment, the technology which measures and evaluates the current environmental condition and potential risks. It also means the technology which leads to the alternative sources of energy, and the technology which resolves or improves already deteriorated environment. However, this chapter will mainly focus on the technology area relating to environmental pollution. Hong Kong can take this system of technology not only to the local market but also for the application in Mainland

China.²

There are four basic suggestions for policy action one could consider in looking at the future of environmental technology in Hong Kong. (1) Hong Kong government's role for creating the demand for environmental technology can have a significant demand-pull effect on the development of the technology. (2) The collaboration with Mainland China, especially Guangdong local government, is a necessary condition for bringing Hong Kong's environmental technology to the PRD region. (3) China and Hong Kong's commitment to solving Climate Change creates a great opportunity for Hong Kong's environmental technology development. (4) In order to sustain the development of innovative capabilities, Hong Kong should implement the innovation strategy based on creating a system utilizing the capability of universities through designing the channels of technology transfer to the local industries in particular. Hong Kong's innovation capabilities have been well recognized. According to Global Innovation Index compiled by CII and INSEAD, Hong Kong ranked 12th in the GII 2008/9 overall rankings following Singapore, Korea and Japan among Asian countries.³ In addition, Hong Kong universities maintain quite strong

² Japan Science Agency, *Kagakugijyutsu Kenyukaihatsu no Kokusaihihaku*, 2008. JST Report.

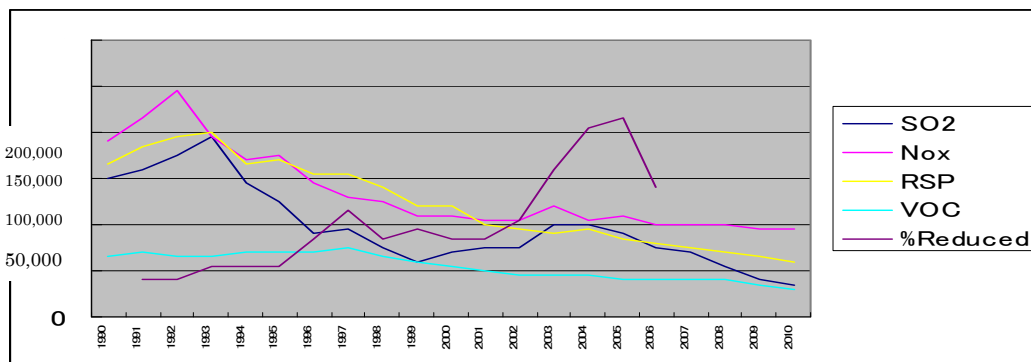
³ INSEAD and CII, *Global Innovation Index*, 2008.

performance in scientific research while continuing to attract good students from Mainland.

I. Hong Kong's Environmental Problem

The deterioration of Hong Kong's air quality has become one of the city's main policy concerns in recent years. Although emissions of key air pollutants in Hong Kong have dropped substantially since 1990's, the visibility has deteriorated significantly, reflecting worsening of the regional smog originating from the Pearl River Delta in China.

Air Pollutants Emitted and Visibility Trend from 1990 to 2010⁴



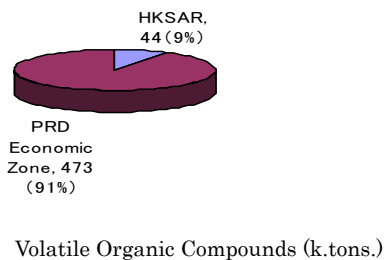
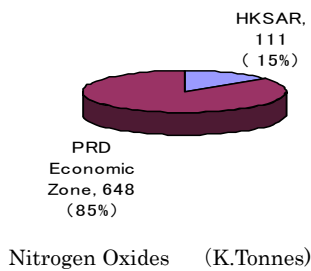
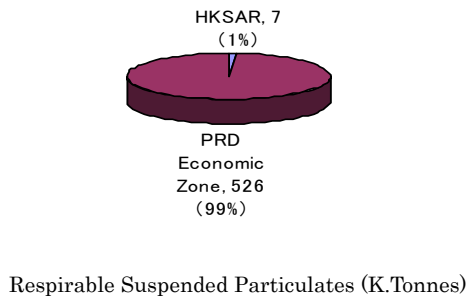
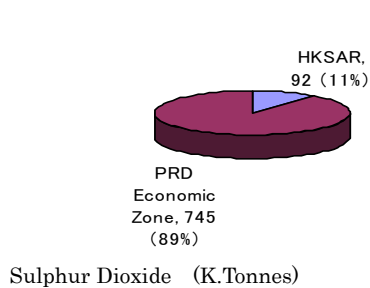
(HK Environmental Protection Department)

Two distinct pollution sources are local pollution sources and regional pollution sources coming from the Pearl River Delta region. The following pie charts clearly

⁴ The rate of reduced visibility refers to the percentage of time in a year which has the visibility less than 8 km with relative humidity not exceeding 80%. The emission figures after 2006 are projected data.

show that the main source of pollution comes from the Pearl River Delta region.

Emission in the PRD Region in 2003



Local Pollution Sources

<p>Electricity generation Largest source of SO₂, NO_x and RSP emissions.</p>	<p>Road transport Second largest source of NO_x, RSP and VOC emissions.</p>
<p>Navigation Second largest source of SO₂ emissions.</p>	<p>Civil aviation A relatively minor source of emissions.</p>
<p>Other fuel combustion A relatively large source of RSP emissions. (from fuels consumed in industrial, commercial and residential sectors, off-road transport, construction industry, etc.)</p>	<p>Non-combustion sources Largest source of VOC emissions. (from consumer products, printing, paints, etc.)</p>

(HK Environmental Protection Department)

Hong Kong can become one of the important hubs of global innovation network for the development of environmental technology, transforming from the gateway of China for FDI. By examining the current activities relating to environmental technology especially for wastewater management and air pollution control in Hong Kong and in the Pearl River Delta region, it will show that already there is a basic trend towards Hong Kong becoming an active and important player in bridging the world technology to the local market. Furthermore, it will shed light on the fact that if the public sector and a series of adequate public policies create a demand-pull effect for the development of pollution control and alternative energy technology, Hong Kong can make use of its full potential to be once again the gateway and a leading metropolitan center in Asia for global network of innovation in “green technology.”

Hong Kong has several institutions actively engaged in the development of environmental technology already. On the one hand, most of basic and fundamental research has been carried out by universities. On the other hand, a government-affiliated institution such as Hong Kong Productivity Council is actively developing the technology through prototype and diffusing that technology with local businesses in the region. First, Hong Kong Productivity Council’s environmental technology program will be discussed followed by other institutions engaged in the

development and the diffusion of “green tech” in the region namely, Hong Kong R&D Centers, Hong Kong Science Park, and universities.

II. Institutions

1 Hong Kong Productivity Council’s “Green Productivity” Program

Hong Kong Productivity Council (the Productivity Council or HKPC) has been established to provide services supporting local business in various aspects with focus on manufacturing almost 40 years ago in Hong Kong. It was a part of the “productivity movement” in the whole Asian region driven by the Japanese business community in their effort to help economic development in Asia through promoting efficiency in the manufacturing and improving productivity. Currently, Asia Productivity Organization, an international organization located in Japan, is continuing the effort through its extensive network of Asian productivity organizations spread across all over Asia. The range of technology services they provide covers from manufacturing technologies, information technologies, business management and training as well as environmental technologies more recently. The Productivity Council has developed the extensive network among Hong Kong manufacturing industry over the years. The network is the strength for the Council especially in the

diffusion of environmental technology among the PRD factories in particular.

Hong Kong Productivity Council has launched the first environmental support service for the business community in Hong Kong as early as in 1981 by opening its laboratory testing activity. In fact, the “green productivity” concept was first presented by the Productivity Council in Hong Kong. Since then, the Productivity Council has pushed the “green productivity” movement for this region as part of the Asia Productivity Organization’s regional-wide effort to help the development of the environment technology industry. In particular, the need for environmental support services both in technology development as well in the application and implementation is prominent in Pearl River Delta where many Hong Kong’s manufacturing firms either located or contracted with the factories in the region.

Today, the Pearl River Delta region is known not only as the manufacturing center of South China, but also for the rapid deterioration of environment. Over the years, serious pollution caused by these factories deteriorated the quality of air and water. As China pushes hard for cleaning up the environment based on the current 11th Five-year Plan among other central government programs, the PRD’s need for any effective environmental support services will increase even more significantly in coming years.⁵

⁵ The Chinese government’s commitment for technological development leading to its

Under the HKSAR government's "Action Blue Sky Campaign," HKPC's push for "green productivity" is carried out in accordance with the policy of both HK and Beijing governments. Furthermore, it tries to take a leadership in meeting various international environmental standards including the EU's, one of the toughest regulations, such as WEEE, RoHS, and EuP.⁶

Roadmap of the "Green Productivity" movement:

1981 – Launch of laboratory services

1983 – Launch of services in pollution control for tanning and leather dressing industry as well as electroplating industry

1984 – Building of the first flue gas desulphurization system in HK

1985 – Launch of technical support services for SMEs in pollution control

1986 – Establishment of Center of Environmental Technology for Industry, design of locally fabricated cost-effective pollution control systems

1988 – Launch of Indoor Air Quality services

sustainable development can also be found in the Mid & Long Term S&T Development Plan, 2007.

⁶ WEEE stands for "Waste Electrical and Electronic Equipment." RoHS stands for "Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment." And EuP stands for "Framework for the setting of Eco-design Requirements for Energy-using Products."

1989 – Launch of supporting services for infrastructure development projects

1992 – Launch of environmental compliance supporting services for HK-linked factories

1993 – Development of cleaner production technology

1994 – Introduction of ISO 14000 series Environmental Management Standard

1997 – Introduction of “Energy Performance Contracting” services

2005 – Launch of Green Manufacturing Supporting Services: Design for Environment, EU RoHS/WEEE compliance, EuP compliance, China RoHS

(From HKPC’s brochure on Green Productivity)

Some examples of the commercialization of environmental technology developed through the support provided by HKPC are following: Handy Toilet Waste Disinfection System, Wastewater Treatment System for Construction Site, Automatic Wheel Tire Washing System, STS treatment system for temporary offices on construction sites.

The top priority for the Productivity Council’s green tech projects is the waste-water treatment in the Pearl River Delta region. Almost 70 to 80% of the Hong Kong’s industry’s operations are taking place in the region. Moreover, well up to

70,000 Hong Kong owned enterprises have relocated to the mainland. Therefore, water-treatment, water recycle technology is much needed in the region especially as the Chinese authority tighten the environmental regulation in last few years.⁷

Productivity Council has set up the one-stop service for the local factories from R&D, design and the system implementation. Since the most of the Pearl River Delta region's projects are small, individual factory-based demand, the time line is usually very short which requires more quick and cost-efficient solutions to the problem. Overseas technologies are usually more advanced than the locally available ones.⁸ However, they tend to be too expensive for the local market. The Productivity Council's strategy is to import the core technology from Germany or Japan and to modify and assemble them through OEM in the region. In short, the role of the Productivity Council is to act as a bridge between the more advanced overseas technologies and the local needs by helping to localize the technology. This is exactly the strategy Hong Kong should adopt for the development of environmental technology in the initial phase. HKPC has successfully led many projects in the region. For air quality improvement, it has developed and installed air filtering and control system for

⁷ Based on the interview with Mr. Anthony Ma, HKPC

⁸ Japan Science Technology Agency, (2008).

metal product industry, food industry, and automobile repair workshops. In the area of wastewater treatment system, HKPC has helped the companies in the region in electronics industry, toy manufacturing and chemical industry to food industry including MNCs. Recently, a Japanese company in the region has used HKPC's wastewater treatment system to meet the regulatory requirement instead of more advanced Japanese technology, because of its high cost and the need for further modifications of technology to fit the local environment. The technology which HKPC introduced for wastewater treatment combines both biological submerged aerated filter (SAF) and rotating biological contactor (RBC) for food industry at relatively reasonable cost.

However, the challenge for the operations in the Pearl River Delta region is that the environmental regulations are often not so clear when they are implemented and change very often. It includes various standards or quotas for different organic pollutants. Therefore, the collaboration with both the central as well as regional governments is crucial. This is also an advantage for Hong Kong as it has a good working relationship with the local governments in the region comparing with MNCs operating in China. In fact, there are several MNCs who partnered with the Productivity Council to bring in the technology to the region.

2 Hong Kong Research and Development Centers: NAMI – HKUST

The R&D Center Program of Hong Kong has been set up by the HKSAR government to facilitate the collaborative R&D between the research organizations and industry. Under this program, there are six R&D centers established so far. However, many of these centers suffer for an inadequate financial support from the government while operating under the constant pressure for short term results for evaluation. Therefore, the scale of the activities of these R&D centers is comparatively small in order to compete at the world level or even with the most of R&D centers in Mainland China.⁹ Among these R&D centers, there are two institutes both directly and indirectly involved with the development of environmental technology.

The R&D Center for Nanotechnology and Advanced Materials is located in the Hong Kong University of Science and Technology. The center's research focus is in the following five key areas: nanomaterials, nano opto-electronics, nano-structred/textured material applications, advanced materials for interconnection and packaging, and development of advanced materials.¹⁰ However, the lack of

⁹ Based on the hearing at HKSAR in 2008.

¹⁰ Based on the hearing at NAMI in 2008.

adequate funding and support from the government as well as the university, the center operates in these areas quite unevenly. The limited resources forced the center to abandon some research areas and focus on more near-sighted research topics with clear industrial support. Here, the center is working on the technology applicable to the needs of the Pearl River Delta region's manufactures meeting environmental regulations rather than focusing on basic and more fundamental research. In particular, the center is pushing hard for the project on water waste management with photo-catalytic and new materials technology. The director who has a long time experience working with the top chemical companies is regularly visiting the factories in the Pearl River Delta region to oversee the project. Since, these projects are still in the initial stage, there is no clear successful case observable. Furthermore, the center's network with the Pearl River Delta manufactures is still at personal level and not fully institutionalized. Moreover, the director recognizes the presence of several MNCs in Pearl River Delta already which will inevitably become a tough competitor to the center in providing the environmental technology.

At any case, it is essential for NAMI to establish the role in developing the technology for Pearl River Delta quickly as many MNCs are seeking for an opportunity to scale up their activities in the region. Furthermore, in order to compensate the

limited resources (less than ten PI level R&D staff), NAMI must find the way to expand its collaborative R&D network with the advanced R&D centers outside of Hong Kong. Consequently, the center has began looking for partners in the US, EU and Japan recently.

3. Hong Kong Science and Technology Park : Incu-Tech

Hong Kong Science and Technology Park (HKSTP) has been operating an incubation program called Incu-Tech. The incubation program provides the services necessary for the startups varying from consultancy services, entrepreneurship training, and networking with local universities and the other research centers both in Hong Kong and the outside. All tenants are eligible for the first year rent-free space followed by the two-year term of reduced rent scheme. The main areas of technology are IT, electronics, biotech, and precision engineering. Although, it is still not at all significant by any means, there are two or three startups based on environmental technology already graduated from the program, however. The HKSTP is not currently interested in pushing for the development of environmental technology as they are focusing on IT and precision technology for at least next few years. One of the companies in the HKSP is AKOS (Advanced Technology Ltd.). Their main area of products is air purifier using the basic technology from Germany. AKOS is trying to

market their products mainly in the local Hong Kong household needs. Other companies that are either the spin of from the local universities or using the technology developed by the university are Environmental Care (CU) and Altenano (HKUST). All of these companies are manufacturing the prototypes by contracting out to the Pearl River Delta factories. Both Environmental Care and Altenano are looking for the local and the Pearl River Delta region as well as the global market.

4. Universities and U-I Linkages

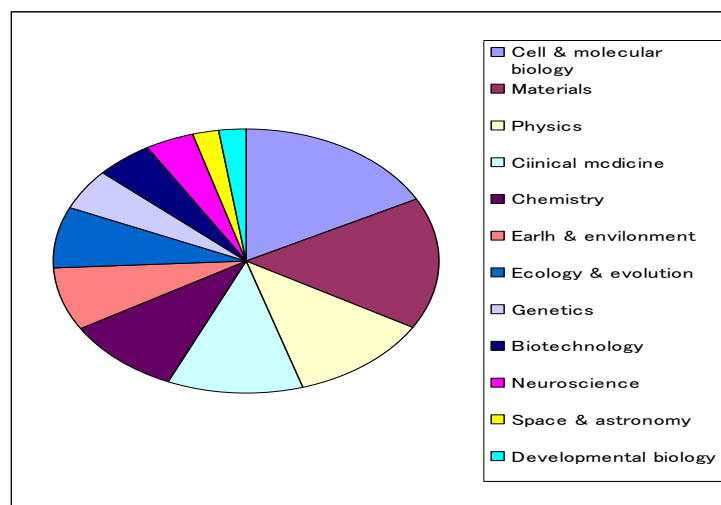
Hong Kong's strength in developing environmental technology has some component of basic research. They are located in the local university labs. In particular, chemistry is comparatively strong area of fundamental research in the Hong Kong academics. For example, by measuring the research output by scientific papers, the rating by Thompson is quite high for Hong Kong in the area of chemistry. Based on the data provided by Nature China, Hong Kong is clearly one of the top research centers in China. In particular, University of Hong Kong and HKUST are both ranked in the top ten institutions producing high quality research papers accepted by Nature China.

City	Number of Papers	% of Total
Beijing	153	30%
Shanghai	99	19%
Hong Kong	60	12%
Nanjing	26	5%
Hefei	25	5%
Guangzhou	18	4%
Wuhan	13	3%
Hangzhou	11	2%
Lanzhou	11	2%
Xiamen	11	2%

(Data provided by Nature China)

Lead Institute	# of Papers	% of Total
Chinese Academy of Sciences, Beijing, China	60	13%
Chinese Academy of Sciences, Shanghai, China	50	10%
University of Hong Kong, Hong Kong, China	36	8%
Peking University, Beijing, China	29	6%
Tsinghua University, Beijing, China	21	4%
Fudan University, Shanghai, China	16	3%
Hong Kong University of Science and Technology, Hong Kong, China	16	3%
University of science and Technology of China, Hefei, China	16	3%
Shanghai Jiao Tong University, Shanghai, China	11	2%
Zhejiang University, Hangzhou, China	10	2%

(Data provided by Nature China)



(Data provided by Nature China)

A good example to illustrate how Hong Kong has a great potential to excel in several areas of science utilizing the right resources available is Prof. Jimmy Yu at the Chinese University of Hong Kong. His research in Advanced Photo-catalyst and Nano Coating has received Hong Kong's Innovation Technology Funding in 2001, collaborating with the local company, Environmental Care, Ltd.¹¹ As in the other great cases of University-Industry collaboration, he met the people from Environmental Care at an academic conference few years ago almost by accident. He did have some interest in bringing his research to the market by partnering with industry to develop some products using his technology. However, it was the people from Environmental Care who approached him at the conference without knowing his interest.

¹¹ Hearing at Innovation and Technology commission.

Environmental Care used to be a ship building company diversifying its business into environmental technology. It is no coincidence that the two shared their mutual interest in taking Prof. Jimmy Yu's research into the market. The factories for their technology are in Shen Zheng. They are producing salt water purifier, currently installed at a famous seafood restaurant in Hong Kong.

Hong Kong's strength in environmental technology lies in (1) information by tapping into its global network, (2) Intellectual Property, (3) International Collaboration. In addition, the availability of human resources in S&T from Mainland China is a new addition to the list. For example, Professor Yu's students are mostly from the mainland. The strength of China's science recently lies in Chemistry, Math and Physics. For Hong Kong universities, English is working language; however, Chinese can be used outside of campus which is quite helpful especially for the mainland students.

On the other side, the problem of research funding is still a significant constraint for Hong Kong's innovation system. To remedy the problem, the Research Grant Council is funding 18 million HK dollars. However, the R&D projects have been constantly under pressure for review and evaluation by the government every so often. This creates a diversion in research and favors more short term research targets than a seamless research and development efforts necessary for the technological development.

As for Hong Kong as a potential market for green technology, environmental friendly building or other energy saving for consumer sector can be considered in the future. However, local power company is very slow in adopting Renewable Energy or new efficient technology. Moreover, private sector's attitude is still a short term looking.

Technology transfer from university to the industry is rather difficult and not working well in Hong Kong as in other major advanced economies such as Japan. Thus, the problem of Hong Kong's environmental technology is how to get the technology out to the market. The process of technology transfer and more applied research by industry are the critical issues facing Hong Kong's innovation system in general.¹² In order to strengthen the role of industrial sector for promoting environmental technology, Hong Kong Environmental Industry Association has been formed led by several leading companies in Hong Kong such as Dunwell Enviro-Tech Ltd. The activities of the association should be recognized as an important step in transforming Hong Kong's industry and supported by the government through Private Public Partnership.

¹² Based on the interview with Professor Jimmy Yu at the Chinese University of Hong Kong.

III. Evaluating the Hong Kong's Innovative Capabilities in Environmental Technology

It is quite difficult to say exactly how well Hong Kong's innovative capability compete with the rest of the world especially US, Europe and Japan in the area of environmental technology.

As it has been indicated earlier, environmental technology covers a very broad area of technology. For a matter of convenience, environmental technology can be divided into four areas based on their application. They are technologies related to (1) global warming, (2) environmental pollution, (3) resource recycling, and (4) ecological management. In the earlier section of this chapter, technology related to cleaning up environmental pollution both air and water has been extensively discussed as Hong Kong hope to sell this technology first to Mainland China's factories.¹³ Japan Science and Technology Agency's Center for Research and Development Strategy has conducted a detailed survey of the environmental technology in the US, Europe, China, Korea and Japan in 2008. This comparative study of five countries has used the above four categories to cover the whole field of environmental technology. Then, it has

¹³ Japan Science Agency, Kagakugijyutsu Kenkyukaihatsu no Kokusaihikaku, 2008. JST Report.

introduced ten subfields of technology within the all four categories to break down further. The study looked at these subfields of environmental technology in the US, Europe, Korea, China and Japan from three perspectives: (1) the level of basic research, (2) the level of technological development, and (3) the level of commercialization. According to the study, in almost all fields of technology, the US, Europe and Japan excel in the levels of basic research, development and commercialization of these technologies. In short, it is clear that the advanced industrial economies are still the leader of environmental technology.

Environmental technology is the product of multi-disciplinary research cutting across several areas of traditional research disciplines. Thus, research collaboration among different disciplines and institutions become a key to the success of the development of the technology. Several studies of *centers of excellence* such as the reports by Science Policy Research Unit of Sussex University and National Institute of Science and Technology Policy of Japan show the existence of global network of research activities among the leading research centers of environmental technology in the world.¹⁴ This JST Study also shows a dramatic increase of the level of research in the area of biodiversity in China due to the effect of Brain Circulation. The number of

¹⁴ NISTEP, *Study of the World's Top Class Research Centers in Europe*, NISTEP Report #112, March, 2008.

Chinese researchers in the field who returned to China is continuing the research with the leading scientists in the US and the Europe. This has helped to bring up the level of research in China in those fields.

However, it is also true that the level of technological advance is not at all important as a choice of technology as long as it delivers the required results. In other words, the advancement of environmental technology depends not only on innovative capability but also on how much the technology is in fact used. For example, Japan's recycling technology for building materials is leading the world according to the JST study because of Japan's strict law and its enforcement of building recycling code. Therefore, it is very important to see the technology as user-driven as much as its innovation capability when considering the strategy to develop environmental technology for Hong Kong.

IV. Suggestions for Policy Action

1. Hong Kong Government's Policy for Creating the Demand for Environmental Technology: A Demand-Pull Strategy

It is now become quite clear that the development of Hong Kong's environmental technology industry is closely related to its presence in the Pearl River Delta region.

Thus, it is very important to investigate the effectiveness of Hong Kong's role as both the mediator and modification development center for the introduction of environmental technology in the Pearl River Delta. In fact, there is always a possibility that the Pearl River Delta can develop its own environmental technology industry without Hong Kong directly working with Beijing and MNCs.

The other possibility is the environmental technology applied in the local Hong Kong market. One example is the area of construction industry. However, many Hong Kong's real estate developers are known for very cost conscious and short term looking so far. Tougher building regulations and the change of consumer taste might create an opportunity for the development for environmental technology in the areas such as energy efficiency and building materials recycling. It might be useful to discuss this possibility with the people in the construction sector and real estate developing as well as the government in charge of environmental regulation in this area. Thus, for Hong Kong, the challenges are (1) separation of waste water and lack of self discipline, (2) separating the most polluting group from the others, (3) separating liability for pre-treatment or control as the government lacks resources for preventive measures.

Hong Kong has a very few local environmental technology available. The main reason is the lack of demand in the market. The Environment Bureau was set up in

July 2007 as part of the re-organization of the Government Secretariat with the commencement of the Third Team of the Hong Kong SAR Government. The policy objectives of Environmental Bureau are Environmental protection, Energy, Sustainable development.

In 2007, Donald Tsang announced his commitment for improving environment in his New Direction for HK address. This potentially shows that the market for green tech will expand in Hong Kong as well in few years. The current measures for controlling air pollution are (1) new coal-fired power plant banned since 1997 and (2) tighten emission caps. New measures introduced recently are (1) legislative amendments to stipulate the emission caps for 2010 and beyond and to enable power plants to conduct emissions trading, and (2) link power companies' rate of return to achievement of the emission caps, (3) provide higher return to renewable energy facilities. As for electricity Generation and Demand Side Management, existing measures include (1) promote energy efficiency and conservation, (2) enhance building efficiency. New measures under public consultation are (1) mandatory compliance with the Building Energy Codes, and (2) mandatory Energy Efficiency Labeling Scheme.

The existing measures for environmental regulations regarding transportation are (1) a world-class public transportation system consists of LPG taxis and Light buses, (2) tightened emission standard to Euro IV, (3) to require for pre-Euro diesel vehicles to install emission reduction devices, (4) to provide \$3.2 billion to expedite replacement of *pre-Euro* and *Euro I* commercial diesel vehicles with *Euro IV models*, and (5) to provide incentive through tax break for vehicles with low emissions and high fuel efficiency. The new measures are (1) to ask public on banning idling with running engines, (2) to provide tax incentive to encourage the use of Euro V diesel, (3) to strengthen the control of emissions from petrol and LPG vehicles by remote sensing equipment and advanced emission test.

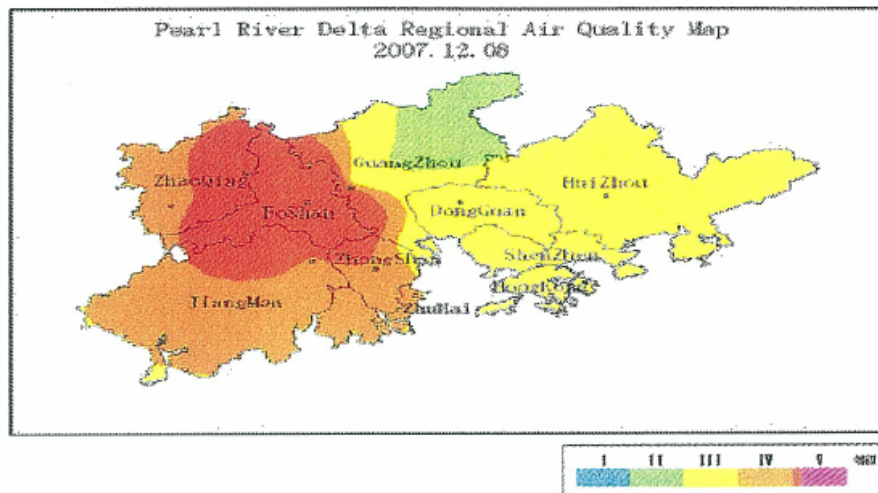
As for the policy concerning the area of navigation, the existing measure is to require the usage of ultra low sulphur diesel in government vessels since 2001. The new measures are (1) to study the feasibility of requiring all vessels plying the harbor to use high-quality fuel, (2) to explore with GD on more stringent measures to control emissions from vessels in PRD for inclusion in the Regional Air Quality Management Plan, and (3) to participate in International Maritime Organization and support development of emission control measures for ports and ocean liners.

Other major measures existing are (1) to require vapor recovery system for vehicle refueling to be installed in all petrol stations, (2) to impose mandatory emission limits for volatile organic compounds in architectural paints, printing ink and selected consumer products. The new measures are (1) to mandate the use of ultra low sulphur diesel in all industrial and commercial processes, (2) to enhance public awareness and education, e.g. encourage the business sector to internalize core environmental values in investment decisions/policies, (3) to require appropriate environmental performance in procurement and merchandising activities, (4) to promote clean production, (5) to launch a \$93 million project to provide support for Hong Kong-owned operations in the Pearl River Delta for cleaner technologies and practices. The government must provide a firm political leadership and commitment in implementing these already existing measures as well as following up with various new initiatives to improve the environment of air and water as well as recycling/reusing resources for Hong Kong.

2. Collaborating with Guangdong Government

The governments of Hong Kong and Guangdong have agreed to reduce the emission of the following sources of air pollution by 2010 (compared to 1997) in April 2002.: (1) Sulphur dioxide (SO₂) by 40%, (2) Nitrogen oxides (NO_x) by 20%, (3) Respirable suspended particulates (RSP) by 55%, (4) Volatile organic compounds

(VOC) by 55%. The two sides are developing the Joint Air Quality Monitoring Network to oversee the regulation.



(Data given by HK Environmental Protection Department)

The environmental regulations and the measures currently existing in the Pearl River Delta are (1) to reduce emissions from power generation, (2) to continue to reduce energy intensity (i.e. energy consumed for each CNY 10,000 GDP): Guangdong Province: -16% by 2010 & PRD Economic Zone: -1 8% by 2010, (3) to install gas de-sulphurization facilities in coal-fired power plants, (4) to phase out highly polluting small thermal power units, small-scale cement factories and iron-and-steel mills, and (5) to develop new large-scale gas-fired power plants. Moreover, major regulations for transportation are (1) to reduce vehicle emissions, (2) to adopt the National *III* (on a par with *Euro III*) motor vehicle emission standards and motor fuels, (3) to reduce emissions

from the industrial sector, (4) to phase out highly polluting industrial processes and compulsory adoption of cleaner production practices for some industries, and (5) to control emissions of VOC from oil depots, tanker trucks and petrol filling stations.

Furthermore, Guangdong introduced measures to meet the 2010 emission reduction target. They are (1) new coal-fired power plants to install de-NOx equipment, (2) more stringent emission standards for boilers, (3) to tighten emission control on local vessels, (4) cleaner production requirements for paint production, (5) green industrial standards for printing industry, (6) labeling schemes for VOC-containing products, and (7) public awareness program to promote the use of products with a low VOC content. The challenge is effectively to implement all of these measures and monitor the progress correctly. This requires the collaboration between the two governments to build up the effecting governing mechanism for environmental regulation in the region such as the Joint Air Quality Monitoring Network. The two governments must continue to work together to address the common problem and should introduce a joint government program to build the PRD region as a regional platform for innovation ecosystem targeting the development of environmental technology for the region.

Projected Emissions in 2010 After the implementation of Additional Control Measures by Guangdong

Pollutant	2010 Emission Reduction (using 1997 as base year)		
	HKSAR	PRD Economic zone	Reduction Target
SO₂	-54%	-41%	-40%
NO_x	-25%	-20%	-20%
PM₁₀	-58%	-60%	-55%
VOC	-55%	-56%	-55%

(HK Environmental Protection Department)

3. Climate Change

The situation of Hong Kong with respect to the problem of Climate Change is the following. The local greenhouse gas emissions is relatively low at some 45 million tons CO₂ equivalent per annum. The per capita emission is 6.5 tons CO₂ equivalent; and the carbon intensity is 27.6kg CO₂ equivalent per HKD1,000 GDP (2005). The main emission sources in Hong Kong for the greenhouse gas are energy sector (63%), transport sector (16%), and waste/landfills (12%) according to the regulatory agency of Hong Kong government. The greenhouse gas reduction measures mainly adopted are (1) electricity generation, (2) renewable energy, (3) efficient public transport, (4)

landfill gas utilization, (5) energy efficiency and conservation, and (6) publicity and education. Furthermore, other additional measures considered are to consult the public on the mandatory implementation of Building Energy Codes, to launch the mandatory Energy Efficiency Labeling Scheme, to conduct a Carbon Audit and implement an emissions reduction campaign in the new Central Government Complex at Tamar, to incorporate environmental measures under the New Scheme of Control Agreements, to encourage the use of bio-fuel in vehicle, and to conduct a climate change consultancy study.

As for the efficiency in the production of energy and the development of alternative energy, the Energy Division of the Environment Bureau is responsible for formulating the energy policy and overseeing the economic regulation of the energy sector. Safety regulation is overseen by the Electrical and Mechanical Services Department. Environmental regulation is enforced by the Environmental Protection Department.

The objectives of energy policy are to ensure reliable, safe and efficient energy supplies at reasonable prices, and to minimize the environmental impact caused by the production and use of energy. The main measures are to achieve the energy policy objectives via legislation, “agreements” guidelines and public education, etc. The

monitoring mechanism is the following: supply is by the private sector, with no subsidy from the Government, setting up safety and environmental standards via legislation and guidelines, consumer protection. For town gas, the policy instrument is based on Information and Consultation Agreement. For fuel oil market, free market economic principles are used as the main policy tool to encourage competition and to enhance transparency. Consequently, if most of these policy measures are effectively implemented with a strong political leadership, Hong Kong can create enough local market for environmental technology to be developed even further again as a part of its demand-pull strategy.

4. Innovation Strategy

The innovation policy particularly for environmental technology in most countries shares several common features. They are funding, the institutions supporting networks of technology, IP/Standard, public procurement, human resource development and global network of talents. The above diagram illustrates the concept of innovation eco-system put forth by the Japan Science and Technology Agency for the last year's G8 Summit in Japan. Hong Kong does have some advantage in creating the global networks for technologies as well as human capital to be a regional platform.

The success for the HKPC's initiative in developing innovative environmental technology industry in Hong Kong and the Pearl River Delta lies in several factors. The coordination with the regulatory agencies responsible for implementing environmental policy to guide the direction of technology development as well as identifying the adequate levels and forms of green technology for the region. Second, the role of the local government not only as a regulatory agent but also as an important user of environmental technology should be recognized. In short, how effective Hong Kong as a mediator in adopting and implementing environmental technology in the region will be the key for the development of the new industry. Third, given the role of Hong Kong as the gate for the Pearl River Delta region, it can collaborate with the advanced economies such as US, Japan, EU in R&D for any environmental technology used in the region. In particular, air pollution control, water waste management, and energy & material recycling/reuse (waste chemicals) systems are the main areas of environmental technology. The source of fundamental technology can come from the advanced economies; and Hong Kong can provide necessary modification to meet the local needs and be cost-effective.

The international collaboration of their R&D is very limited so far. To compensate or augment their limited R&D capability (less than 50 R&D in house staff –

mostly for development work) particularly for the absorption of the fundamental key technology, it is necessary to pursue the collaboration with the foreign R&D centers will be crucial. Furthermore, the establishment of university-industry linkages or basic-applied research collaboration is absolutely crucial for the development of environmental technology. It is not only for encouraging technology transfer from university labs to industry but also for supporting the dynamic interaction between basic research and more applied research which has been shown to be a key for the successful development of several environmental technologies in Japan such as nano-materials, photo-catalyst coating, membranes and filters for waste water treatment. Hong Kong should create both funding and evaluation schemes to encourage the interaction between university-industry and basic-applied research which is a more dynamic and continuous long-term process. Hong Kong also has been working hard to meet the world standard for IPR, in addition. However, it should also recognize the danger of IPR regime becoming overly excessive in the implementation which may discourage technological learning as well as cumulative and interdisciplinary research necessary for the development of environmental technology. In addition, incentive measures for R&D in Private Sector are needed. A recent study on the Japanese experience conducted by RIETI-METI illustrates that tax break for Green Tech R&D can be more effective than

R&D subsidies.¹⁵

For the demand-pull development, the HKPC began to push for environmental compliance to the Hong Kong factories currently operating in the Pearl River Delta region. When one tries to improve the quality of environment, the cost of compliance also goes up accordingly. Especially in the Pearl River Delta, there are over 56,000 factories and more operating. Thus, the key is to address the problems in the region directly both through air pollution control and the improvement of energy efficiency considering the costs for the implementation. HKPC has already introduced tough environmental management standards such as ISO14001 and EU Environmental Directives on electronic and electrical products to the contracted factories in the region. Furthermore, Hong Kong Environmental Industry Association can be a good platform for the industrial sector and the government to work together. Through this Private Public Partnership, pushing for the implementation of tougher environmental standards inevitably leads to the expansion of the market for Hong Kong's environmental technology in coming years.

Finally, the development of human capital is also a key policy initiative. The government of Hong Kong can clearly help to promote the “green productivity”

¹⁵ K. Motohashi, RIETI Discussion Paper, 2008

movement also by supporting various training and educational programs introducing cleaner production technologies to energy saving manufacturing systems to such industries as construction, textile, toy and electronics. Not only supporting Hong Kong's R&D network of global innovation in environmental technology through building up the innovation capabilities through a stable funding system, bring in the top researchers and engineers to the region for consultation and training is also important. For example, HKPC has already started various training programs and study missions for last 25 years. However, in order to introduce environmental technology in the region more effectively, each project must be uniquely tailor made for individual factories. Thus, human resource must be constantly available. Furthermore, it is apparent that a pool of young talents and well qualified students is necessary to maintain and improve the innovation capability of Hong Kong in any areas of technological advance. As in China, Hong Kong should also take an advantage of the effect created by "*Brain Circulation*" to help bring up the level of research. Not only to attract the students from both Hong Kong and Mainland China, but also from the global talent pool beyond East Asia should be one of the first objectives of innovation policy for Hong Kong in today's global knowledge-based economy.

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