POLICY BRIEF

April 2014
Number 29

The Feasibility of Pricing of Carbon Emissions in Three Northeast Asian Countries: Japan, China and the Republic of Korea

Key messages:

- The progress of carbon pricing policies in Northeast Asia has lagged, but recently there has been emerging interest and some measures have begun to be introduced.
- Resistance from industry has been the most significant barrier to the introduction of carbon pricing policies in Northeast Asia.
- Nevertheless, IGES survey research indicates that energy-intensive businesses in this region can afford modest carbon prices. A carbon price of USD5-12 per t-CO_2 would be affordable for companies in China and Japan, while this scale is lower at USD2.3-3.5 per t-CO_2 for companies in the Republic of Korea.
- Affordability is related to the fact that energy-saving investments reduce the operating costs of companies and enhance their competitiveness. Carbon pricing shortens the payback period of these investments, inducing companies to invest sooner.
- Carbon pricing is more economically feasible than generally understood, and therefore is also more politically feasible. China and the Republic of Korea are suggested to establish carbon taxes with low rates while current carbon taxes implemented in Japan could be increased further.
- The pricing of carbon emissions should be a gradual process. Governments in Northeast Asia should continue to promote greater understanding by businesses.
- Appropriate tax relief measures and effective use of carbon tax revenues will help to gain support from industry in the three countries.

Xianbing Liu
Task Manager & Senior Policy Researcher,
IGES Kansai Research Centre
liu@iges.or.jp

Sunhee Suk
Policy Researcher,
IGES Kansai Research Centre
sunhee@iges.or.jp

Ryuichi Yamamoto
Senior Policy Researcher,
IGES Kansai Research Centre
r-yamamoto@iges.or.jp

I Introduction

This policy brief reviews the current status of carbon pricing measures in three Northeast Asian countries, Japan, China and the Republic of Korea (Hereinafter referred to as Korea), and makes the case that it is economically and politically feasible to strengthen these measures in all three countries. Most discussions are based on original IGES research surveying the policy preferences of companies in energy-intensive industries in the three countries. The research found that companies in all three countries could afford modestly higher carbon prices, and a rise in carbon prices will accelerate the introduction of energy saving technology, which in turn reduces companies' operating costs. The overall recommendation is that China and Korea could establish low-carbon taxes, while Japan could modestly raise its existing carbon tax without significant negative effects on companies.

There exists a strong rationale for the dramatic mitigation of greenhouse gases (GHG) emissions and adequate policies should be in place for realising the economic mitigation potential (Pachauri, 2012). Among the policy alternatives, command-and-control regulations (CCRs) provide certain certainty in emissions levels and have been widely adopted. However, CCRs are always inferior to market-based instruments (MBIs) in terms of economic efficiency. Governments should correct the externalities of carbon emissions by expanding the use of MBIs. Economic incentives, such as financial subsidies and tax advantages, have often been applied to promote the investment in low-carbon technologies. Due to fiscal constraints, the feasibility of subsidy policies is questionable for achieving sizable mitigations as desired (Jaffe et al., 2002). On the other hand, policies that give sufficient prices to carbon emissions may create incentives for significant reductions of GHG emissions.

The three largest economies in Northeast Asia, China, Japan and Korea, all rank in the top 15 countries of GHG emissions and are critically important for mitigation efforts globally. The three countries accounted for around 30% of the world's energy-related CO_2 emissions in 2010 with China being the world's largest emitter (ADB, 2013). In contrast to their large GHG emissions, the policy progress of carbon pricing in the three countries is generally laggard.

Resistance from industry has been identified as the most significant barrier to the introduction of carbon pricing policies, i.e. carbon taxes and GHG emissions trading schemes (GHG ETS), in Northeast Asia (Liu et al., 2011; 2012). Policymakers in this region have serious concerns about the potential negative impact of carbon pricing on industrial production costs and international competitiveness, and are reluctant to adopt these policies.

However, there is a lack of practical empirical studies at the business level regarding the extent to which carbon pricing policies would actually affect industry. Therefore, the Kansai Research Centre of IGES carried out a research project addressing this question between 2010 and 2012, called 'Market-based Instruments for Improving Company's Carbon Performance in Northeast Asia' (Hereinafter abbreviated as 'the MBIs project'). The MBIs project surveyed a sample of companies in China, Japan and Korea, and clarified to what extent they could actually tolerate the pricing of carbon emissions. This new evidence clarifies how far the concerns of policymakers could be justified. Using the MBIs project results, this policy brief discusses the feasibility of the pricing of carbon emissions, and recommends practical ways to introduce and implement related policies in the three countries.

To be sure, there are many economic and political differences among the three countries. The basic economic regime of Japan and Korea is market economy, while China is a socialist market economy. The share of business activity and profits from state-owned companies is still significant in China. Japan and Korea are mature economies dominated by service sectors, with a share of 71% and 58% of gross domestic product (GDP), respectively, while the manufacturing industry is still the largest sector in China as an emerging economy and accounted for 47% of the country's total output in 2011 (ADB, 2013). Due to the gap in economic development, the three countries hold different positions in international

negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). The situation is quite different from that in Europe, so it is too early to consider a unified climate policy frame for this region. The surveys under the MBIs project were carried out independently in the three countries. In spite of a large similarity in survey formats and analysis methods, the variety in target sectors and samples discourages any comparison between the three countries. Therefore, the discussions in this policy brief are mostly restricted to the individual countries and do not aim for the policy collaboration at the regional level.

Carbon pricing policies in this policy brief specifically refer to carbon taxes and GHG ETS. In reality, energy-related taxes have been levied in Japan and Korea for a long time and add a certain cost to their carbon emissions. However, a tax specifically on the carbon content of fossil fuels is more effective than general energy taxes for reducing emissions since such a tax functions not only through price effects on energy use but also via fuel choices (Zhang and Baranzini, 2004). There are two types of GHG ETS: baseline and credit schemes, or cap and trade schemes. The latter category is discussed in this policy brief. The advantage of GHG ETS is that it sets a specific mitigation target, while the cost of such a guarantee is not clear. In contrast, a carbon tax provides higher certainty about the likely cost of complying with the emissions target, while there is less certainty about actually achieving the target. The debate on whether price or quantity approaches are better will continue as long as the threshold for severe climate damage is unknown. A hybrid mechanism combining carbon taxes with GHG ETS has been suggested (Pizer, 1999).

This policy brief is structured as follows. Section 2 identifies the carbon price levels needed for the realisation of national mitigation targets of the three countries in the mid-term. Section 3 surveys the progress of carbon pricing policies in this region. Section 4 demonstrates the effectiveness of carbon pricing to encourage businesses to make climate mitigation efforts. Section 5 estimates the level of carbon prices that could be afforded by the companies. Section 6 discusses several important issues for the design of a carbon tax. Lastly, section 7 provides policy recommendations.

2 Macro-economic analyses show that high carbon prices are needed for the three countries to achieve their mid-term climate targets

Table 1 lists the mid-term climate pledges of several large emitting countries in Asia and world regions. Japan once pledged to reduce its GHG emissions by 25% below 1990 levels in 2020 based on the premise that aggressive reduction targets would be achieved by all major emitting countries. Recently, the Japanese government withdrew its earlier commitment and announced a much weaker target that aims for a 3.8% emissions reduction compared to 2005, assuming all the nuclear power plants were taken offline. This is a 3.1% increase from the Kyoto baseline of 1990. A firm target would be eventually set in line with the new energy strategy underway in Japan. Korea committed to reduce its 2020 GHG emissions to 30% below business-as-usual (BAU) levels. China offered to reduce GHG emissions per unit of GDP by 40% to 45% below 2005 levels in 2020.

The fundamental economic question for climate change in any regime is whether the carbon price would likely be high or low. This question can be examined by computerised macro-economic models, which have blossomed over the past two decades (Nordhaus, 2007). Modelling analysis at the global level shows that carbon prices should rise to a scale of 20 to 80USD/t-CO_2 by 2030 in order to stabilise the CO_2 concentration at around 550ppm by 2100. The induced technology change may lower the price level to a range of USD5 to 65 per t-CO_2 (Pachauri, 2012).

Macro-economic analyses of the climate policies of Japan, China and Korea indicate that relatively high carbon prices are necessary for these countries to realise their mid-term mitigation targets. Calvin et al. (2012) comprehensively compared the results from 23 different macro-economic analyses, all of which participated in the 'Asia Modeling Exercise (AME)'. A total of 16 studies cover Japan as a target region. Japan's previous 25% reduction commitment requires a carbon price of

Table 1 Copenhagen pledges of major emitting countries/regions

Country/Region	Emissions reduction target		
	Level	Type	Base year
Japan	-25%*	Absolute	1990
China	-40% to -45%	Intensity	2005
Korea	-30%	Absolute	2020 BAU levels
India	-20% to -25%	Intensity	2005
United States	-17%	Absolute	2005
European Union (EU)	-20% to -30%**	Absolute	1990

Note: * The target of Japan was revised due to the change of the country's energy strategy after the accident at the Fukushima Nuclear Power Plant in March, 2011.

** The reduction target of EU would be -30% if other developed countries made similar reductions.

USD30 to 50 per t-CO_2 in almost all of these studies. In about half of the 21 studies relating to China, a carbon price of USD10 per t-CO_2 would be required to meet the country's mid-term target. If the carbon price increased to USD30 per t-CO_2, China's emission intensity could be limited to the lower range of the 40% reduction target according to all of the models, and it could meet the more stringent range 45% reduction target. Of the nine models reporting results for Korea, only two studies show a way to reach the country's 30% reduction pledge and require a carbon price of USD30 to 50 per t-CO_2.

Meanwhile, individual macro-economic analyses reveal that a carbon tax with low rates would only lead to a very slight fall in economic growth (e.g. Cao et al., 2012). The negative impacts of carbon tax policy can be alleviated if relief or subsidies are provided to energy-intensive sectors (Liang et al., 2007). Takeda (2007) even confirmed a strong double dividend (meaning a reduction in emissions and improvements in the efficiency of the tax system simultaneously) for a carbon tax in Japan if the revenues from a new carbon tax were used to reduce the existing, but distortionary capital tax.

3 Progress in the pricing of carbon emissions in Northeast Asia

Although Northeast Asian countries have lagged in the development of carbon pricing policies, the situation is changing. Discussions of carbon pricing policies have occurred in Northeast Asian countries in recent years, and some concrete policies have recently emerged, such as a low carbon tax in Japan. A carbon tax had been considered within the Ministry of the Environment, Japan (MOEJ) since the early 1990s. Due to the lack of civic support and strong resistance from industry, MOEJ's carbon tax proposals featured a low tax rate and earmarked the revenues for climate countermeasures. The 'Package of Tax Revision of FY2012'[1] finally established a roadmap for introducing specific taxes aimed at climate mitigation in Japan. The tax rates are quite low, at an equivalent of JPY289 per t-CO_2. The taxes have been implemented in three steps: the tax has been applied at one third of the designated rate from 1 October 2012; another one third will be added from 1 April 2014 and the tax will be fully imposed from 1 April 2016. In China, experts at research institutes under related ministries have been discussing how to develop a carbon tax in recent years. They agreed that the setting of carbon tax rates should be a gradual process. The tax rate proposed by these experts starts from CNY10 per t-CO_2 for the initial phase and then increases to CNY40 per t-CO_2 some years later. In Korea, the Korea Institute of Public Finance (KIPF) firstly prepared a detailed carbon tax proposal in 2008. The tax rates were calculated based on the carbon price of EU-ETS at EUR25 per t-CO_2. However, the later KIPF report suggested much lower rates at one eighth of those proposed initially (Liu et al., 2011).

[1] Original title of this document in Japanese is「平成24年度税制改正大綱」.

The advantage of GHG ETS has been recognised by the three governments in Northeast Asia. Japan has even tried to develop an integrative carbon market on a trial basis. However, due to concerns about the potential negative impact of this scheme on industrial competitiveness, full implementation of the GHG ETS proposal of Japan has been blocked in practice. Korea is active in this area and recently launched pilot projects to test the country's domestic GHG ETS, which the country formally decided to start from the beginning of 2015. Many environment and energy exchanges have been established in China since 2008 probably due to the huge potential of the county's carbon market. China established GHG ETS pilot systems at seven localities, including two provinces and five metropolitan cities. However, as a developing economy, it will be quite difficult for China to set a ceiling for GHG emissions in the near future. This may hinder the establishment of a domestic carbon market at the national level in China (Liu et al., 2012).

Overall, the pricing of carbon emissions in Northeast Asia is not well advanced. The tax rates of carbon taxes levied in Japan or proposed in China and Korea are very low, so their effectiveness for GHG mitigation would be marginal. MOEJ (2012) estimated that Japan's current carbon tax would reduce the country's 2020 emissions by 0.5% to 2.2% from the 1990 level, equivalent to 6 to 24 Mt-CO_2. In Korea's GHG ETS, which has a clear implementation schedule, the emissions allowances will be fully allocated to the target entities without cost in the initial phase. In this sense, existing carbon pricing policy practices in this region may not impose real economic burdens for carbon emissions in a few years.

4 In spite of currently low policy awareness and acceptability, the pricing of carbon emissions would be effective to motivate climate efforts of businesses

Practically, the understanding and support of the industry is a precondition for the success of theoretically effective but uncomfortable carbon pricing policies. The surveys under the MBIs project indicate that the companies in Northeast Asia are only moderately aware of MBIs in general. They have a better understanding of the economic incentive policies, e.g. subsidies and tax advantages for energy saving, which already have been widely adopted. However, carbon pricing policies, including carbon tax and GHG ETS, are not well understood by the companies so far. Economic incentives are generally preferable for industry, whereas carbon taxes and GHG ETS are strongly resisted by the companies, particularly those in Japan and Korea.

Nevertheless, putting a price on carbon emissions would be effective for climate efforts of the business in Northeast Asia. The surveys of the MBIs project indicate that companies in the three countries highly expect the profitability of energy saving investments. As listed in Table 2, most of the surveyed Chinese companies (around 80%) ticked an expected payback period of less than 3 years for energy saving projects. Nearly 65% of the companies surveyed in Korea would accept a payback time within two years. The results in China and Korea are similar to Swedish energy-intensive companies which apply a payback time of three years or less for energy efficiency investments (Thollander and Ottosson, 2010). Companies in Japan may accept slightly longer payback time similar to UK companies, averaging 3-5 years (Martin et al., 2012).

Table 2 The expected payback time of companies for energy-saving investments

Payback time (Years)	Percentage of the samples (%)							
	< 0.5	0.5 - 1	1 - 2	2 - 3	3 - 5	5 - 10	> 10	In total
China (N=127)	5.5	12.6	30.7	30.7	13.4	4.7	2.4	100.0
Korea (N=62)	3.2	12.9	48.4	33.9		1.6		100.0
Japan (N=220)	0.5	2.3	7.3	22.3	41.4	24.5	1.8	100.0

Carbon pricing policies put prices on carbon emissions and can increase the savings in the operating costs achieved by carbon mitigation projects. This helps shorten the project payback time for meeting the high profitability expectations of companies in this region and remove the barriers to climate-related investments. In addition, carbon pricing policies generate revenues either through the collection of carbon taxes or the auction of emissions allowances under GHG ETS. The policy revenues can be utilised to subsidise carbon mitigation investments of companies, especially for small and medium-sized businesses which usually lack financial resources and are sensitive to the initial project costs.

5 Businesses in Northeast Asia can afford modest levels of carbon prices

Obviously, businesses in Northeast Asia are still resisting the pricing of carbon emissions. However, the MBIs project reveals that companies in the three countries can afford modest levels of carbon prices (Liu et al., 2013). Table 3 lists the average energy cost increases due to carbon pricing policies and the equivalent of carbon prices, which are affordable for the companies in the three countries. The MBIs project surveys in China and Korea purposely targeted the energy-intensive iron & steel, cement and chemical industries. The study in Japan sampled large energy-consuming companies in Hyogo Prefecture, with half from the food-processing, chemical, iron & steel and electronics sectors.

Not surprisingly, companies in Japan and Korea are much more sensitive to the policy-originated energy cost increases than their Chinese counterparts. An average of 2.5% to 2.8% in energy cost increases would be acceptable for Korean companies. Japanese companies could accept an average cost increase of 1.5% to 3.1%. This ratio for Chinese companies ranges from 7.7% to 9.9%. The policy-originated energy cost increases can be converted into carbon prices currently affordable for the companies. The carbon price affordable for Chinese companies is between CNY40.0 to 83.7 per t-CO_2 (About USD6.0 to 12.3 per t-CO_2, USD1 = CNY6.80 in 2010) (Liu et al., 2013). Japanese companies may be able to afford a similar increase in carbon prices, ranging from JPY426 to 1,062 per t-CO_2 (About USD5.3 to 13.1 per t-CO_2, USD1 = JPY80.9 in November 2012). The carbon price affordable for Korean companies is much lower at KRW2,500 to 4,000 per t-CO_2 (About USD2.3 to 3.5 per t-CO_2, USD1 = KRW 1,131 in March 2012).

Table 3 Carbon prices affordable for the companies in Northeast Asia

Country	China (Unit: CNY/t-CO_2)			Korea (Unit: KRW/t-CO_2)		
Sector	Iron & steel	Cement	Chemical	Iron & steel	Cement	Chemical
Number of samples in total	170 companies			62 companies		
Number of samples by sector	34	17	27	11	5	20
Average affordable ratio of energy cost increase	8.8%	7.7%	9.9%	2.5%	2.8%	2.6%
Affordable carbon price	42.7	38.6	83.7	3,770	2,600	3,950
Country	**Japan (Unit: JPY/t-CO_2)**					
Sector	Food processing		Chemical	Iron & steel		Electronics
Number of samples in total	230 companies					
Number of samples by sector	29		26	11		12
Average affordable ratio of energy cost increase	2.0%		3.1%	1.5%		2.6%
Affordable carbon price	683		1,062	426		801

6 Discussions of major issues for the design of carbon tax policy

The MBIs project measured the preferences of Chinese and Korean companies regarding the design options for carbon tax policy and GHG ETS. This section discusses only some of the important issues for the design of a carbon tax since the analysis of GHG ETS could not achieve results with meaningful policy implications, especially for the study of Chinese companies.

One key issue for a carbon tax is the tax rate. The MBIs project confirms that companies strongly prefer lower tax rates in general. Nevertheless, the results of the MBI project showed that companies in the three countries can afford at least somewhat higher carbon prices. For China, as described in section 5, a carbon price up to CNY40 per t-CO_2 would be viable, even for the energy-intensive iron & steel and cement industries. Japan also has room to increase the carbon tax rates it is currently implementing, since the current tax rates are much lower than the industrial price affordability. The tax rates proposed by KIPF are similar to the carbon prices affordable for Korean companies, confirming the feasibility of the recent KIPF proposal from the business viewpoint. In principle, tax rates should increase over time in order to reflect the rising costs of damages from carbon accumulation, and to give the market a policy signal that the cost of carbon emissions will significantly increase eventually.

Although international competitiveness is not necessarily weakened over the long term by higher energy prices, a persistent concern is that the effects of a unilateral carbon tax may be serious in the short term for certain industries (Zhang and Baranzini, 2004). A common way to address these concerns is a proposal to grant energy-intensive industries a lower tax or even to exempt them from the tax coverage. Some European countries, like Denmark, Norway and Sweden, exempt energy-intensive industries from the carbon taxes completely or partially. The MBIs project confirmed that preferential tax treatment does increase the preference of companies to this policy. The preferable options include the reduction of taxes for either energy-intensive industries or energy-efficient companies. However, the exclusion of these industries from tax coverage due to competitiveness concerns reduces the effectiveness of carbon tax in achieving its major policy objective of emissions reduction.

Another important issue for carbon tax policy is the utilisation of tax revenues. A carefully designed carbon tax, with revenue-recycling measures, can address potential impacts on economic competitiveness. Carbon tax revenues may be used to reduce the existing and distorted taxes. The MBIs project confirmed that companies in China and Korea prefer to earmark the tax revenues for climate change. In Japan, revenues of carbon tax were estimated to be JPY39.1 billion in 2012 and JPY262.3 billion for the calendar years from 2016. These revenues have actually been put into the special account for energy countermeasures and used for climate change projects. The focus is on the development of renewable energies, research & development and investments for energy saving. The experience of Japan in the utilisation of carbon tax revenues may be useful to other countries.

In theory, there should be variations in timing of carbon taxes among countries, given that the marginal abatement cost of CO_2 emissions differs across countries and over time (Zhang and Baranzini, 2004). However, the starting time was not statistically significant in influencing the preferences of Chinese companies regarding the timing of carbon tax policy. This implies that it will be feasible to launch this policy as early as possible in China, i.e. during the 13th Five-year Plan period (2016-2020), considering the time needed for policy implementation preparation. The MBIs project indicated that Korean companies expect to postpone the introduction of carbon tax, particularly since Korea has decided to implement GHG ETS from 2015.

7 Conclusions and policy recommendations

Macro-economic analysis has confirmed the need to increase carbon prices up to USD50 per t-CO_2 so that the mid-term climate targets of the three largest economies in Northeast Asia can be achieved. The underdeveloped carbon pricing policies in these countries contrast with their large amount of GHG emissions. Carbon pricing policies would enhance business climate efforts as the companies in the three countries reveal high expectations for profitability of carbon mitigation investments.

Awareness and acceptability of carbon pricing policies are quite low at present among companies in the three countries. Nevertheless, these companies can afford modest carbon prices. China and Korea would therefore be encouraged to establish carbon taxes with low rates, i.e. ranging from USD3 to 5 per t-CO_2. Japan has already adopted a carbon tax, but the tax rates could be increased further. Tax relief measures significantly reduce resistance from industry and should be considered during the policy design of a carbon tax. Carbon taxes with low rates but wide coverage can generate a meaningful amount of revenue. These revenues should be used specifically for climate change, as favoured by industry, to achieve more significant effects for carbon mitigation. To the extent that revenues are limited in practice, they should focus on R&D and early application of low-carbon technologies.

This policy brief could not address the establishment of GHG ETS in the three countries. However, most of the low cost abatement potential in this region is in China. It would be much more cost-effective for Japan and Korea to offset their emissions through mitigation actions in China. A regional carbon market may provide a framework for this, and it should be an important topic for future policy collaboration in Northeast Asia.

• References

ADB (Asian Development Bank), 2013. Economics of Climate Change in East Asia, Asian Development Bank.

Calvin, K., Fawcett, A., Jiang, K.J., 2012. Comparing model results to national climate policy goals: Results from the Asia modeling exercise. Energy Economics 34(2012), S306-S315.

Cao, J., Ho, M.S., Jorgenson, D.W., 2012. An integrated assessment of the economic costs and environmental benefits of pollution and carbon control. In: Masahiko, A., Wu, J.L. (Eds.), The Chinese Economy, pp.274-305.

Jaffe, A.B., Newell, R.G., Stavins, R., 2002. Environmental policy and technology change. Environmental and Resource Economics 22, 41-69.

Liang, Q.M., Fan, Y., Wei, Y.M., 2007. Carbon taxation policy in China: How to protect energy and trade-intensive sectors. Journal of Policy Modeling 29(2007), 311-333.

Liu, X.B., Ogisu, K., Suk, S.H., Shishime, T., 2011. Carbon tax policy progress in north-east Asia. In: Kreiser, L., Sirisom, J., Ashiabor, H., Milne, J.E. (Eds.), Environmental Taxation in China and Asia-Pacific: Achieving Environmental Sustainability Through Fiscal Policy. Edward Elgar Publishing, Inc., Northampton, MA, pp. 103-118.

Liu, X.B., Suk, S.H., Sudo, K., 2012. GHG emissions trading schemes in Northeast Asia: an overview and analysis of current scenarios. In: Kreiser, L., Sterling, A.Y., Herrera, P., Milne, J.E., Ashiabor, H. (Eds.), Carbon Pricing, Growth and the Environment. Edward Elgar Publishing, Inc., Northampton, MA, pp. 149-166.

Liu, X.B., Wang, C., Zhang, W.S., Suk, S.H., Sudo, K., 2013. Company's affordability of increased energy costs due to climate policies: A survey by sector in China. Energy Economics 36 (2013), 419-430.

Martin, R., Muûls, M., De Preus, L.B., Wagner, U.J., 2012. Anatomy of a paradox: management practices, organizational structure and energy efficiency. Journal of Environmental Economics and Management 63, 208-223.

MOEJ (Ministry of the Environment, Japan), 2012. The introduction of countermeasure tax for global warming (In Japanese), available at: http://www.env.go.jp/policy/tax/about.html.

Nordhaus, W.D., 2007. To tax or not to tax: Alternative approaches to slowing global warming. Review of Environmental Economics and Policy 1(1), 26-44.

Pachauri, R.K., 2012. The way forward in climate change mitigation. WIREs Energy Environment 2012(1), 3-8.

Pizer, W.A., 1999. Choosing price or quantity controls for greenhouse gases. Climate Issues Brief No.17, Resources for the Future, Washington, D.C.

Takeda, S., 2007. The double dividend from carbon regulations in Japan. Journal of the Japanese and International Economies 21(2007), 336-364.

Thollander, P., Ottosson, M., 2010. Energy management practices in Swedish energy-intensive industries. Journal of Cleaner Production 18, 1125-1133.

Zhang, Z.X., Baranzini, A., 2004. What do we know about carbon taxes? An inquiry into their impacts on competitiveness and distribution of income. Energy Policy 32 (2004), 507-518.

Institute for Global Environmental Strategies

2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan
TEL : +81-(0)46-855-3700 FAX : +81-(0)46-855-3709 E-mail: iges@iges.or.jp http://www.iges.or.jp