Report of the Study Group on Economic Instruments in Environmental Policies

Summary

The Study Group on Economic Instruments in Environmental Policies (chairperson: Hiromitsu Ishi, President, Hitotsubashi University) was formed to investigate the use of economic instruments such as ecological taxes in environment policies. This report was put together by the group.

With a focus on the use of taxes for preventing global warming, the report summarizes the progress of environmental policy initiatives undertaken in Japan and overseas. The report also includes trial simulations on the amount of taxes needed to reduce carbon dioxide emissions in Japan and assessments of the effectiveness of a policy mix that combines taxation with other measures such as emissions trading.

The report concludes by stating that, “In addition to existing regulatory measures and voluntary initiatives, we have reached the stage where we can undertake comprehensive and detailed examinations of environmental policy packages that include economic instruments such as taxation and emissions trading.” Thus, the report calls for investigations to be taken one step further.

1. Aim of the study group

An earlier study on the use of economic instruments such as ecological taxes in environmental policy was completed by the Research Panel on Economic Instruments Such as Taxation and Charges in Environmental Policies, a group formed within the Environment Agency. The group’s final report was presented in July 1997. Based on this report, the Planning and Policy Group of the Central Environment Council has held discussions on global warming countermeasures.

The Study Group on Economic Instruments in Environmental Policies was established in March 1998 with the aim of coordinating effective nation-wide debate on environmental policy. As part of this effort, the group is carrying out studies on the use of economic instruments from a broad perspective, making use the findings of the earlier report and taking into consideration the latest trends in Japan and overseas.

2. Members of the study group

To ensure that its study takes a truly broad perspective, the study group was made up of ordinary consumers as well as academics. The chairperson of the study group is Hiromitsu Ishi, president of Hitotsubashi University. For details of members, refer to Appendix 1.

3. Details of the study group’s investigation

To meet its aim of addressing a broad range of concerns, the investigation has solicited opinions from a variety of sources on taxation issues and the use of fossil fuel taxes to reduce carbon dioxide emissions. The study also collects, organizes and evaluates the latest information from Japan and overseas and identifies key discussion points regarding systems currently in use.

4. Organization and main points of the study group’s report

The contents of the report are outlined in Appendix 2. The main points of the report are given in Appnedix 3, Reference 1 and Reference 2.

NOTE: The English version of all the report is not available.

(Appendix 1)

Members of the Study Group on Economic Instruments in Environmental Policies

HIROMITSU ISHI (Chairman)
President of Hitotsubashi University

YASUSHI IINO
Professor of Faculty of Economics, Keio University

TATSUYA ISHIKAWA
Senior Economist of NLI Research Institute

HIROKO KAKUTA
Chairperson of Osaka Housewives' Association

KOUNOSUKE KIMURA
Professor of Faculty of Law and Political Science, Keio University

NORIYUKI GOTO
Professor of Komaba Graduate School of Arts and Sciences, Department of Advanced Social and International Studies, University of Tokyo

HISASHI SHINAGAWA
Executive Director of Japanese Consumer's Co-operative Union

KIICHIRO HAYASHI
Staff Researcher of Mitsubishi Research Institute, Inc.

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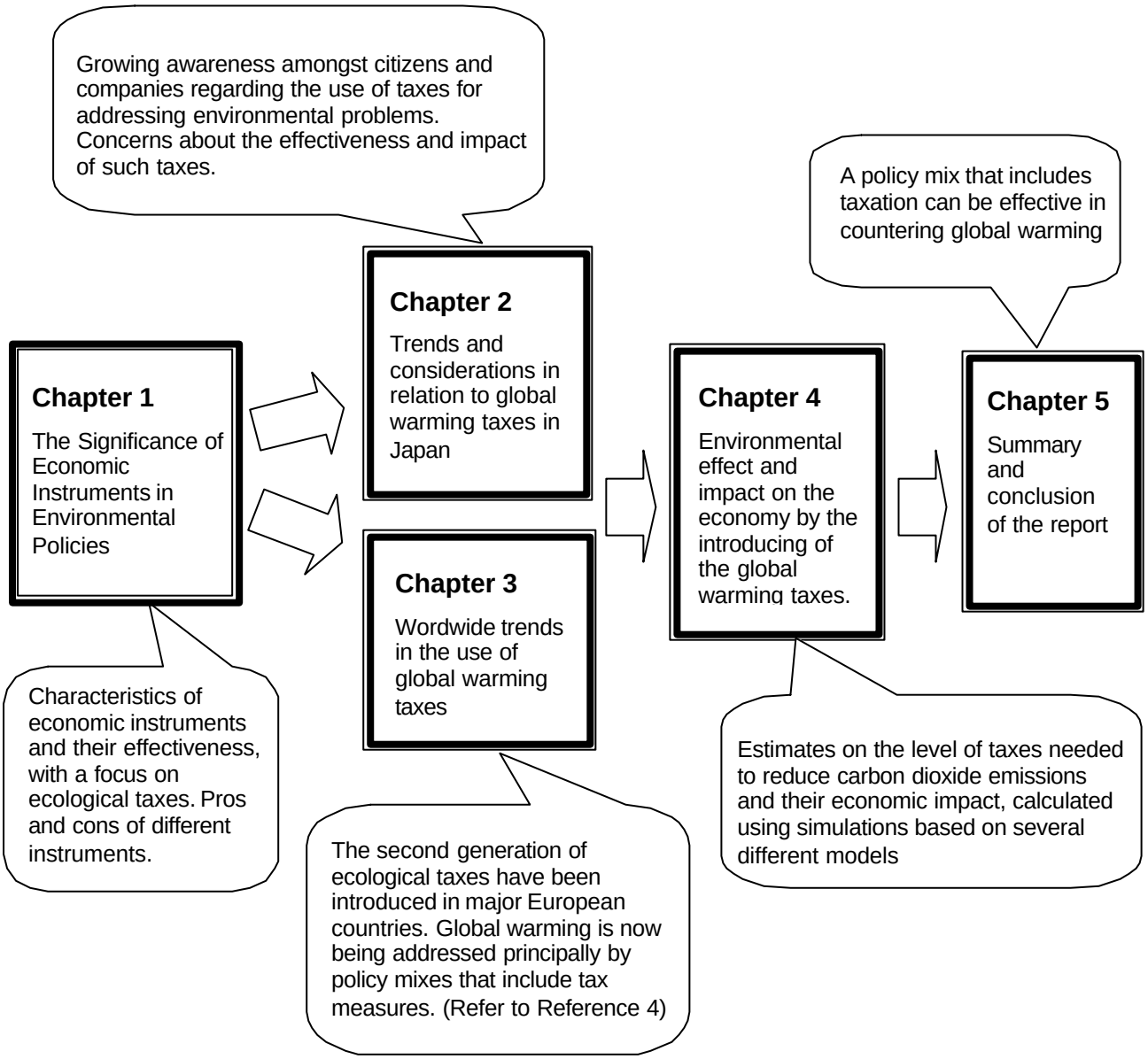
TSUNEYUKI MORITA
Director of Social and Environmental Systems Division, National Institute for Environmental Studies

Secretariat
Office of Policy Planning and Research, Planning and Coordination Division, Planning and Coordination Bureau, Environment Agency

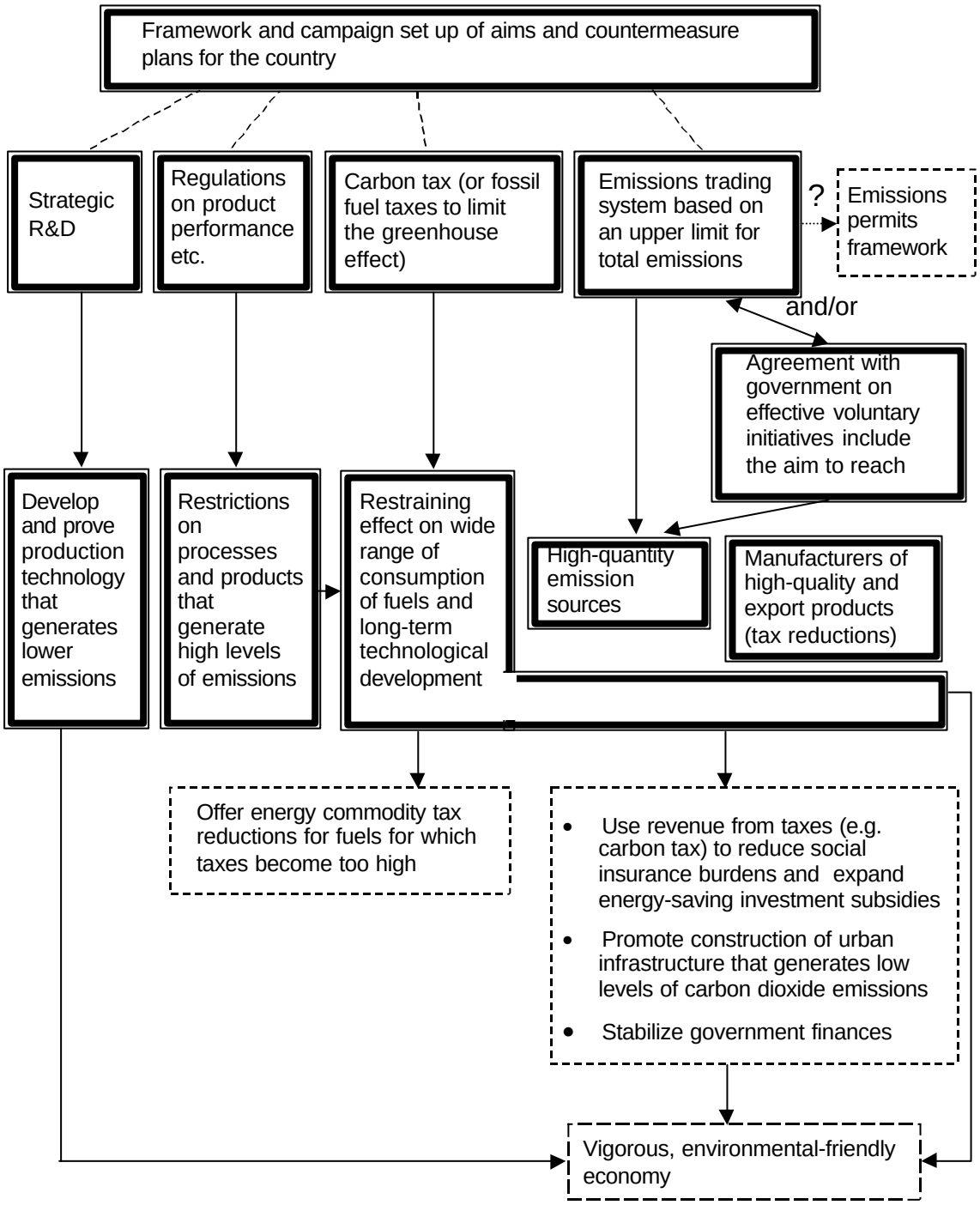
(Appendix 2)

Organization of the Report of the Study Group on Economic Instruments in Environmental Policies



(Appendix 3)

Typical Policy Mix for Addressing Global Warming Based on Cases of Major European Countries



Note: Reproduced from Chapter 3 of the Report of the Study Group on Economic Instruments in Environmental Policies

(Reference 1)

Summary of Simulations and other details of the Report of the Study Group on Economic Instruments in Environmental Policies

1. Policy mix components and their pros and cons

Carbon tax

- Allows revenue to be collected from a broad cross-section of society
- Can reform market mechanisms by financially bearing (by charging for "environment use") polluting parties that lack the technology to reduce emissions or who don't implement countermeasures.
- Charging a tax in proportion to the quantity of carbon is highly rational in terms of economic theory and cost-efficient in terms of government administration.
- If the tax rate is high, some sectors of the economy may be affected severely.
- It is not absolutely certain that the tax will achieve the emissions reduction target, so the tax rate may need to be adjusted.

Emissions trading

- Can be more effective than a carbon tax if emissions trading is practiced widely throughout the economy.
- Expensive to develop the system widely to the point where even parties producing small quantities of emissions are involved.
- At the least, parties generating large quantities of emissions can benefit greatly by participating.
- Further investigation is required to determine details, for example, whether to allocate the emission permits forcibly or allow parties to trade by voluntary initiative.

Subsidies for energy saving facilities and environmental social infrastructure

- Readily acceptable to parties generating emissions.
- Can be made even more effective if combined with a carbon tax. However, this requires financial resources.
- A potential problem is that some types of subsidies may violate the Polluter-Pays Principle (PPP).
- There is a risk that governments fail to implement this type of policy effectively.
- It is difficult to forecast the level of reductions with this approach.

Regulatory measures

- Effective for controlling behavior in limited spheres, such as high-volume emission sources and mass production products. Also, governments are experienced in this area.
- Predictable results but of limited effectiveness. Also, governments must bear the costs of implementing regulations.
- Since CO_2 is generated by a wide variety of economic activities, implementing direct and comprehensive regulatory measures is difficult. In addition, administration costs are high.

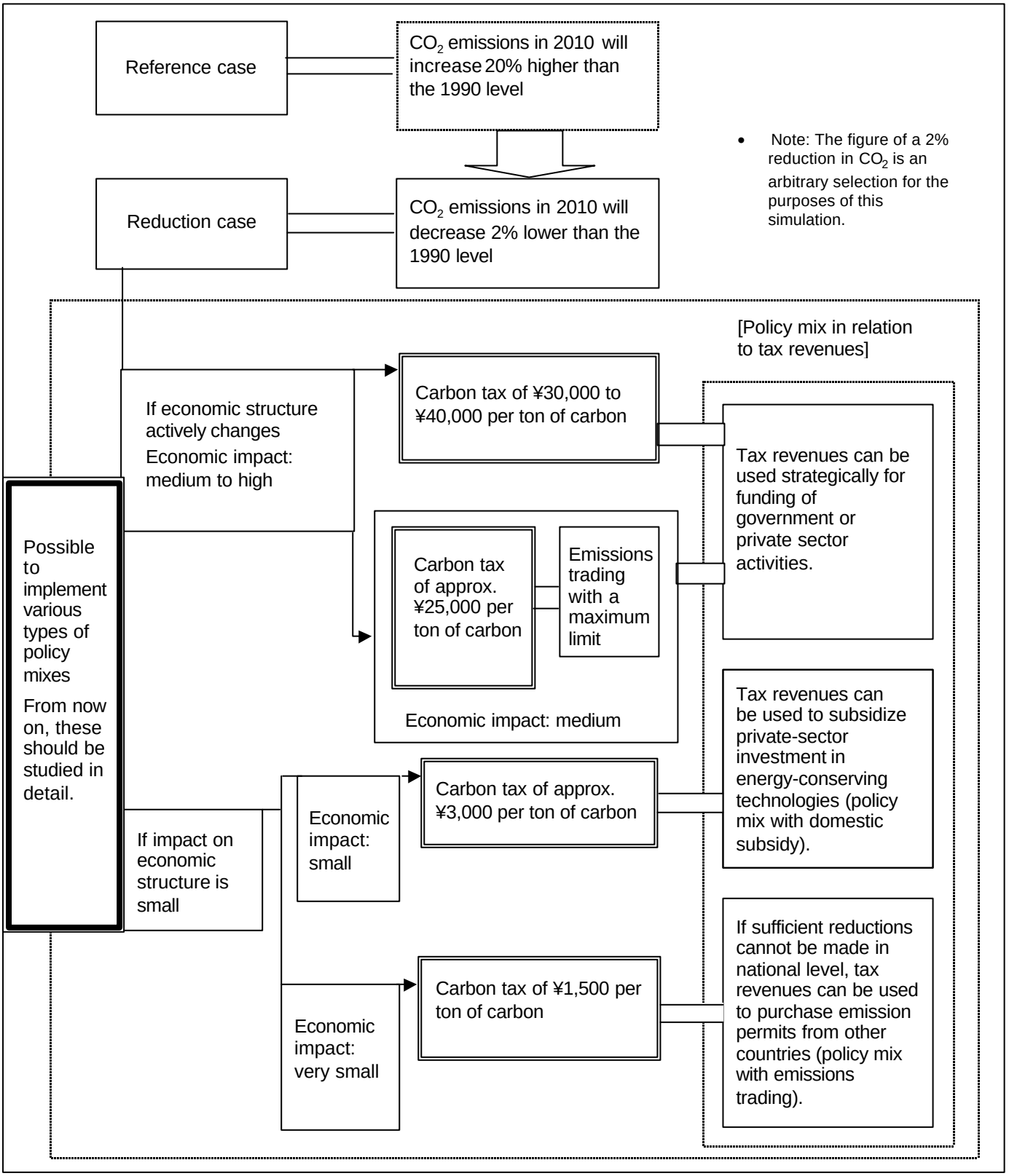
Voluntary initiatives (self-regulation)

- This policy approach places the responsibility of implementation in the hands of the polluting parties, which means public resistance to the issue is not a problem.
- Effectiveness is difficult to forecast because it is uncertain whether countermeasures will be implemented to the desired standard.
- Some polluters will take advantage by "free-riding," which means that companies that are eager to take countermeasures are put at a disadvantage.

Tax reductions (income or investment) and budget deficits reductions for "goods"

- More readily acceptable than policies based only on tax increases
- Powerful impact on economic structure.
- Adverse economic impacts can be minimized, in the other hand, there is risk that CO_2 emissions may actually rise rather than fall.

2. Policy mix examples used in trial calculations for estimating necessary carbon tax rates



- Note: The tax used in this simulation (for reference in future studies) is a typical type of carbon tax, whereby a single uniform tax rate is applied to all economic activities. That is, tax rate is proportional to the quantity of carbon emitted. Note that calculations, especially for lower values of the carbon tax rate, assume various ideal conditions.

3. Summary of Chapter 5 (conclusions) of the Report of the Study Group on Economic Instruments in Environmental Policies

- It is found that by using policy mixes such as a combination of taxes and emissions trading or a combination of taxes and subsidies for investment in large-scale energy-conserving technologies, CO_2 emissions can be cut almost as effectively through low carbon tax rates as high carbon tax rates. Low carbon tax rates have the advantage of making smaller impacts on the overall economy and individual economic sectors.
- It is also found that environmental and economic impacts vary depending on how carbon tax revenue flows back into the economy.
- In short, by strategically combining measures such as taxes, emissions trading, and investments in energy-conserving technologies, and by paying careful attention to how tax revenue is fed back into the economy, in case that the amount of tax revenue is considerable, these policy mixes can be highly effective in shaping a new form of environment-friendly economy.
- The key challenge now for developing global warming countermeasures is to begin investigating different types of policy mixes in detail, including effective mixes that involve low tax rates.
- Most leading European countries, are expected to has introduced global warming taxation measures in 2001. Meanwhile, the U.S.A. and Canada appear set to implement economically efficient policies centered on emissions trading.
- The sooner global warming countermeasures are implemented the less they will ultimately cost. An expected advantage of introducing countermeasures at an early stage is that stimulates the development of energy-saving technology, for which there will be a high demand in the international market. Another advantage is the ability to promptly adapt to international emissions trading regulations if they are introduced.
- There are many options available in developing global warming countermeasures. These range from “low impact” measures that minimize disruption to the existing industrial/economic structure to “high impact” measures that strategically accelerate change towards a more environment-friendly and sustainable industrial/economic structure.
- It is now necessary to explore new forms of economic growth that do not contribute to global warming and to secure the resources and formulate the measures to realize these. Following this, it is necessary to reach a consensus on implementation.
- The issue of economic instruments should not be seen simply as a question of whether or not to introduce new taxes. What’s important is to carry out detailed investigations of complete policy packages that include taxes, which are proved to be more effective than other instruments in achieving the objectives to prevent global warming.

(Reference 2)

Report of the Study Group on Economic Instruments in Environmental Policies (extract of chapter 5)

Looking to the introduction of a global warming tax (summary and conclusion up to chapter 4)

In chapter 1, we assessed the effectiveness of different economic instruments for addressing global warming and discussed these in terms of their expected economic efficiency. In chapter 2, we presented opinions and doubts regarding these measures from various sectors of society. In chapter 3, we presented an overview of international developments and a description of the global warming taxes that European countries have been working to introduce in recent years.

In chapter 4, we reported on the simulations we conducted on the effects and costs of global warming taxes[*1] based on three economic models.

As we outlined in chapter 1, an effective approach to combating environmental problems such as the global warming resulting from a wide range of our economic activities, is a policy mix that strategically combines different measures to maximum advantage. Some overseas countries have already adopted policy mixes, by combining emissions trading and taxes, or subsidies and taxes, to complement their existing regulatory measures. And many other countries are currently investigating the introduction of these measures. In view of this, we set out to conduct simulations to evaluate such policy mixes. In the first stage, we analyzed the effects of a carbon tax for reducing CO_2 emissions and tried to predict its effectiveness and economic impact.

In addition, we analyzed specific policy combinations (carbon tax + international emissions trading, and carbon tax + subsidies), and evaluated them for their effectiveness in cutting carbon emissions and for their effect on the economy. The question of how the revenue generated by a carbon tax is spent is also an important factor in assessing the economic impact of different policies. For this reason we analyzed and compared different ways of utilizing this tax revenue. The results of these investigations along with comments are given below.

1) Evaluating the benefits of policy mixes

The potential for reduction in the use of an economic resource (known as "marginal cost of reduction" in economic theory) varies from one sector of society to another. A key characteristic of a global warming tax is that it promotes its objective by making use of this potential in an economically rational way. This means such a tax should work efficiently. To begin with, we estimated the carbon tax rate that would be required to reduce CO_2 emissions to 2 percent[*2] below the 1990 level by the year 2010, assuming a policy based solely on this tax. From this simulation, which made use of three types of economic models, we found that this reduction would require a carbon tax rate of approx. ￥30,000 to ￥40,000($273 to $364*) per ton of carbon. This corresponds to about ￥20 to ￥26($0.18 to $0.24) per liter of gasoline, ￥22 to ￥29($0.2 to $0.26) per liter of crude petroleum, and ￥20 to ￥27($0.18 to $0.25) per kilogram of coal.[*3]

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*1: In this report, taxes for addressing global warming are collectively called "global warming taxes." However, in our simulations, we assumed the use of a "carbon tax," levied according to the quantity of carbon in fossil fuels. These simulations assume that a carbon tax is levied on all fossil fuel used in any sector of the economy.

*2: The Kyoto Protocol sets Japan the goal of cutting greenhouse gas emissions by 6% (relative to the 1990 level) by the period 2008 to 2012. In our simulations, gases other than CO_2 and CO_2 sinks are not taken into account. In view of this we have assumed a lower target of a reduction 2% simply for the purposes of assessing the effects of different policy measures.

*3: Quantities of typical fossil fuels equivalent to 1 ton of carbon: 1,555 liters of gasoline; 1,380 liters of crude petroleum; and 1,487 kilograms of coal (anthracite)

*4:exchange rate 1$=￥110

Now let's consider the economic impact of this case. The simulations (based on the different economic models) show that the overall effect on the economy is a reduction in GDP, due to the rise in energy prices. They also predict reductions in production output (or production value) for specific sectors of the economy. The estimates for the drop in GDP by 2010 range from 0.7 percent to 0.24 percent comparing to the reference case. The lowest estimate for annual GDP growth is below -0.1 percent, that is, a drop in GDP. Thus, these results show a definite but relatively small impact on the overall economy.

However, analyzing the impact on specific sectors of the economy, we find that energy-intensive industries will be significantly affected. The greatest impacts predicted by our simulations were an 11.2 percent drop in output for the steel industry and a 7.5 percent drop in output for the paper manufacturing industry (relative to the reference case). On the other hand, the estimated impacts in the machinery, construction and service industries are all below 0.5 percent.

The simple case we analyzed was a policy of addressing global warming through a carbon tax only. For comparison, we then performed further simulations on different policy mixes—a combination of carbon tax and emissions trading, and a combination of carbon tax and energy-saving subsidies. From the results we concluded that a policy mix using a low carbon tax rate can achieve about the same reduction in CO_2 emissions as a tax-only approach with a high carbon tax rate. Furthermore, a policy mix offers an added advantage since a low carbon tax rate has a less severe impact on the overall economy and individual industries.

In addition, for the case when a carbon tax is the main instrument of addressing global warming, we explored different ways in which carbon tax revenue can be strategically returned to the economy and assessed the resulting degree of structural change in the economy ("green tax reform," through raising taxes on "bads" and reducing taxes on "goods," or consolidation of private funds through sound finance). Our conclusion about how to use tax revenue was that the environmental and economic impact of policy measures depends strongly on how carbon tax revenue is utilized.

The results of our simulation-based estimates are outlined below.

(1) Combination of carbon tax + emissions trading

As yet, there is no emissions trading system in place either in Japan or internationally, so the prices and trading volumes used in the simulations are based only on our assumptions. In addition, it is unknown whether or not a national trading system would involve an upper limit on allowable emissions purchases. Our simulation, which was performed under relatively strict parameters (Goto Model[*1]), showed that combining international emissions trading with taxation measures offers substantial flexibility, expands the range of low-cost policy options and minimizes adverse economic effects.

The simulation assumed a CO_2 reduction target in line with the emissions target set for Japan in the Kyoto Protocol (2% drop in CO_2 emissions by 2010 relative to the 1990 level). In addition, we assumed an upper limit for international emissions purchases corresponding to 25 percent of the total needed reduction (15 million tons C/year) and an emissions purchase price of ￥10,000($90.9) per ton of carbon. Based on this, the carbon tax rate required to meet the target is approximately ￥26,500($240.9), substantially lower than the rate required for a carbon tax-only policy (approx. ¥34,900/ton($317.3)). The economic impact of this mix was estimated to be as little as a 0.1% drop in GDP in 2010.

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*1: Goto Model (GDMEEM: Goto's Dynamic Macro-Energy Equilibrium Model)

Dynamic market equilibrium model describing the operation of the macroeconomy and energy market and their interaction

As an extreme case, we also ran a simulation assuming that the difference between the emission cuts produced by the carbon tax component of the mix and the reduction target is made up by government purchase of emission permits, paid for by carbon tax revenue. In this case, even though we set the international emissions trading price to the relatively high value of ￥10,000($90.9) per ton of carbon, we found that the target can be met at a tax rate of ￥1,500 to ￥2,000($13.6 to $18.2) per ton of carbon (¥0.6 to ¥1.3($0.0054 to $0.012)/liter of gasoline, ¥1 to ¥1.4($0.009 to $0.0127)/liter of crude petroleum, or ¥1 to ¥1.3($0.009 to $0.012)/kilogram of coal). In this case, the economic impact (drop in GDP) would be less than half of that in the case where the target is met entirely by means of a carbon tax. As mentioned, in the case of a carbon tax-only policy, the hardest hit sector of the economy is the steel industry, which was estimated to suffer an 11.2 percent drop in its value-added output for 2010 relative to the reference case. However, we found that a policy of levying a ￥1,500($13.6) per-liter carbon tax and using the revenue from this for emissions purchases would result in only a 4.2 percent drop in output for the steel industry (relative to the reference case)—just one third of the carbon tax-only case.

It should be mentioned that all other circumstances being equal, lowering the carbon tax rate by increasing purchases of emission permits on the international market would lead to an outflow of money overseas. This would have a slightly adverse affect on economic growth in Japan. These effects are stated in the report (as GDP differences in policy cases 4-1 and 4-2) to point out this potential disadvantage of purchasing emissions internationally. (Conversely, national reduction measures have potential economic benefits.) Further analysis is required on this point. Also, it's important to remember that it still unclear how international emissions trading will work, so there is a risk in reading too much into these estimates. So, we need to be careful to consider this policy option beyond its obvious advantage of allowing lower carbon tax rates.

Table 5-1: Simulation results for carbon tax + emissions trading combination

*Figures in brackets are percentage changes relative to the reference case. (comparison for the year 2010)

	Reference case	Case 1	Case 2-1	Case 2-2	Case 3	Case 4-1	Case 4-2
GDP (billion yen/year)	599,543	595,466 (–0.68)	596,078 (–0.58)	595,618 (–0.65)	596,645 (–0.48)	597,691 (–0.31)	597,618 (–0.32)
Energy demand (10^{12} kcal/year)	4,068	3,402 (–16.36)	3,527 (–13.31)	3,475	3,643 (–10.44)	3,704 (–8.94)	3,783 (–7.00)
CO_2 emissions (10^6 tons C/year)	346	285 (–17.65)	300 (–13.32)	295 (–14.74)	310 (–10.29)	314 (–9.30)	321 (–7.23)
Emission permits purchases (10^6 tons C/year)			15	10	25	29	36

*Simulation based on Goto model

**Case 1: Carbon tax only (¥34,900)

**Case 2-1: Carbon tax (¥26,500) + emissions purchases (up to 15 million t C/year)

**Case 2-2: Carbon tax (¥31,700) + emissions purchases (up to 10 million t C/year)

**Case 3: Carbon tax (¥10,000) + emissions purchases using carbon tax revenue

**Case 4-1: Low carbon tax (¥3,000/t C) + emissions purchases using carbon tax revenue
Assumes that tax revenue not used for emissions purchases is returned to the economy

**Case 4-2: Low carbon tax (¥1,500/t C) + emissions purchases using carbon tax revenue
Assumes that tax revenue not used for emissions purchases is returned to the economy

(#Emission permits price = ¥10,000/t C for all cases)

(2) Combination of carbon tax + energy-conserving investment subsidies

To explore the policy option of using carbon tax revenue to promote installation of energy-efficient facilities, we conducted a simulation (based on the AIM Model[*1]) of a combination of carbon tax and government subsidies for investment in energy-conserving technology, funded by the carbon tax revenue. In this case, both the subsidies and carbon tax act as incentives for undertaking energy-saving measures. An earlier simulation revealed that with a carbon tax-only policy, the tax rate needed to cut CO_2 emissions to at least 2 percent below the 1990 level by 2010 is ¥30,000($272.7) per ton. (In this model, this rate cuts emissions by 3 percent). However, in this simulation we found that if all carbon tax revenue is used to subsidize investment in energy-conserving technology, the reduction target of 2 percent can be achieved at a tax rate of just ¥3,000($27.3) per ton of carbon.

These figures assume that tax revenue is used exclusively for energy saving technology and that emission reductions generated by this technology do not affect the economic output in any sector of the economy. (That is, the overall size of the economy is not influenced by this investment in energy-conserving technology.) However, in reality, we can expect energy-conserving investments to lead to production increases in some sectors of the economy. (In view of this, the increase in CO_2 emissions caused by this economic growth should be taken into account.)

It should be noted that in this simulation, subsidies are not awarded according to reductions in pollutant emissions—they are given upon installation of energy-efficient facilities to stimulate investment in these. (For the sake of simplification, the simulation assumes that tax revenue is spent as subsidies. However, there are different ways of spending tax revenue to achieve the same effect as subsidies. One example is offering tax concessions for investment in energy-saving projects, which would work similarly to subsidies.)

Subsidy schemes are generally considered to have several pitfalls. One of these is the difficulty of distributing funds efficiently. So a prerequisite for this policy approach is to devise an effective and efficient subsidy system. The AIM model (used in this simulation) uses information about the kinds of technology and systems that qualify for subsidies. However, if such information is not continuously revised to keep pace with advances in technology, the subsidy scheme would gradually become inefficient. In view of this, it should be noted that a carbon tax rate of ¥3,000($27.3) per ton is about the lower limit for trying to cut CO_2 emissions through national measures. Another point to mention is that since the subsidies proposed in this simulation are entirely funded by carbon tax revenues rather than general public finances, there is less potential for objections and disputes arising from the fact that subsidies do not work according to the Polluter-Pays Principle.

Another issue with a subsidy scheme is the transfer of capital between different sectors of the economy. Our simulation shows that carbon tax revenue collected from households and businesses goes back into these sectors in the form of subsidies (This means that within the sectors, capital is transferred from parties that don't or can't take energy-saving measures to those parties that do invest in such measures.) However, due to a shortfall in the revenue from the transport sector, some tax revenue from the industrial sector must be used to pay for subsidies to the transport sector. This result occurred because our simulation worked to maximize reductions over the entire economy. Even so, from the point of view of the industrial sector, it is preferable to pay a carbon tax than to face the expense of conforming to CO_2 emission restrictions, at least for relatively low carbon tax rates.

Nonetheless, this issue of capital transfer between different sectors of the economy should be noted.

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*1: AIM (Asia-Pacific Integrated Model: AIM/end-use model)
This model was developed for the purpose of analyzing greenhouse gas emissions, emission reduction measures and the impact of these measures on climate change-affected environments. This simulation employed the "end-use" AIM model, which focuses on the final consumption of energy.

Table 5-2: Simulation results for carbon tax + investment subsidies combination

*Figures in brackets are percentage changes relative to the reference case.

(comparison for 2010) (10^6 tons C)

	Reference case	Market choice (no carbon tax)	Carbon tax (¥30,000/t C)	Carbon tax (¥3,000) + investment subsidies
Total CO_2 emissions	360.7	318.4 (–6.5)	278.9 (–18.1)	282.0 (–17.1)
Industrial sector	147.3	136.7 (–7.2)	125.5 (–14.8)	127.6 (–13.4)
Households	49.5	44.1 (–11.0)	32.6 (–34.1)	33.3 (–32.8)
Business sector	43.4	39.5 (–9.0)	33.5 (–22.9)	33.9 (–22.0)
Transport sector	80.4	79.6 (–1.0)	71.1 (–11.5)	71.1 (–11.5)
Energy conversion sector	19.8	18.6 (–6.3)	16.1 (–18.6)	16.1 (–18.6)

*Simulation based on AIM model

**Market choice case: This assumes that all parties operating in the various sectors of the economy invest in energy-conserving technology out of free, rational market choice. The results of this simulation show that even without a carbon tax emissions can be reduced to well below the levels of the reference case. This proves that there is great potential for "soft" environmental policy measures such as education and providing information to promote environmentally positive economic choices.

**Carbon tax (¥30,000): This case assumes a tax-only measure with a carbon tax rate of ¥30,000/ton.

**Carbon tax (¥3,000) + investment subsidies: This assumes a carbon tax rate of ¥3,000/ton with all tax revenue used to provide subsidies for energy-conserving investment.

(3) Environmental and economic effects of how tax revenue is spent

In this simulation we consider three different options for spending tax revenue, all assuming that the emissions reduction target is met solely through a carbon tax. In the first option, tax revenue is used to increase government expenditure and boost public capital reserves. In the second option, carbon tax revenue is used to reduce public debt through redemption of government bonds. (The model assumes the government buys back previously issued bonds.) In the third option, carbon tax revenue is used to fund income tax cuts. Generally speaking, the higher the carbon tax rate the more effective the policy will be in meeting its environmental objectives and the more likely it will be that tax revenue can be used for non-environmental purposes.

In this simulation (based on the SGM Model[*1]), we can see how environmental effectiveness and economic impact varies according to how carbon tax revenues are spent.

*1: SGM (Second Generation Model)
This is a classic Computable General Equilibrium (CGE) model based on national income accounts. With this model it is possible to analyze different patterns of carbon tax revenue spending and their economic effects.

The simulation shows that regardless of how tax revenue is spent, the impact of a carbon tax is to stimulate greater economic demand. Using carbon tax revenue to minimize the rate of devaluation of capital stock prevents the decline in the productivity and production capacity of the entire economy over the long-term, thereby preventing a decline in real GDP. In other words, the policy mix that has the least adverse impact on the economy is the one that results in the lowest decline in capital stock.

From the three cases examined in this simulation, we found that using tax revenue to reduce public debt through redemption of national bonds and funding interest rate drops, which has the effect of injecting funds into the private sector, has the least impact on the economy. However, since reducing public debt results in a smaller drop in real GDP than the other spending options, it also results in the highest rate of energy consumption. Therefore, to ensure that energy consumption is kept below the level needed to meet the CO_2 reduction target, the carbon tax rate must be adjust slightly upward.

As this shows, the way tax revenue is spent affects both the level of CO_2 emissions and economic impact. So to formulate a policy, these points must be taken into account in a strategic investigation.

Other options not included in our simulation this time include stimulating private investment and economic growth by spending tax revenue exclusively on energy-efficient facilities, as discussed in (2) above. This approach has been adopted in various overseas countries. Another approach to spending tax revenue that is worth examining is to subsidize the labor costs of employers. This strategy, which places more importance on stimulating employment than promoting economic growth, has also been adopted in various countries.

Table 5-3: Simulation results for differences in tax revenue spending patterns

*Figures in brackets are percentage changes relative to the reference case. (comparison for 2010)

	Reference case	Increase Public Spending	Reduce Public debt	Cut Income tax
Real GDP (billions of yen)	599,878	596,913 (–0.49)	598,468 (–0.24)	596,750 (–0.52)
Capital stock (billions of yen)	2,282,756	2,276,891 (–0.26)	2,288,486 (0.25)	2,275,505 (–0.32)
CO_2 emissions (10^6 tons of carbon)	344	285 (–17.1)	285 (–17.1)	285 (–17.1)
Carbon tax rate (yen/carbon ton)		38,700	41,500	41,500

*Simulation based on SGM Model

**Increase public spending: Carbon tax revenues are used for public expenditure and government capital reserves.

**Reduce public debt: Carbon tax revenues are used to redeem government bonds.

**Cut income tax: Carbon tax revenues are used to finance income tax cuts for households.

2) Conclusion

As outlined in parts (1), (2), and (3) of section 1) above, combining carbon taxes with emissions trading, energy-conserving investment subsidies or other measures, is an effective way to cut emissions while minimizing the adverse economic impacts. In fact, by formulating policy mixes that strategically combine taxes, emissions trading, energy-conserving investment and other available measures, and by carefully planning how collected tax revenue is spent (when revenue is high), it is possible to achieve major reductions in CO_2 emissions at relatively low carbon tax rates. Furthermore, such a policy mix can actively reshape the economy into a more environment-friendly structure. A low carbon tax rate cannot be expected to reduce energy consumption by virtue of a "price effect," i.e. by dampening energy demand by raising energy costs. However, it is equitable, because it makes everyone in the economy contribute to combating global warming, and it is flexible, because it can be combined with other measures to create policy mixes suited to specific objectives. Furthermore, although difficult to quantify in simulations, there is an "announcement effect," in which the mere introduction of such a tax is likely to help reduce emissions. (The publicity generated by the announcement of a tax will stimulate awareness and interest in energy-conserving investment and behavior.) If a suitable policy mix is implemented it is quite possible to minimize the impact on existing industries while accelerating growth in certain economic sectors.

It should be remembered that the simulations we have reported here are based on various theoretical assumptions. For example, the lower limit of carbon tax rate in the simulation was several tens of thousands of yen per ton of carbon. It is important to carefully investigate several types of policy mix, including one that features a low tax rate like this, and to start developing a program to implement these types of policy mix over an extended period. Note also that there is an advantage in policy mixes that do not depart too far from current tax systems.

Examinations are currently in progress in Japan to try and establish an international system of emissions trading, as proposed in the Kyoto Protocol. In some overseas countries, private industry groups, as well as governments, are working to develop national emissions trading systems. Through our simulations, we found that a combination of carbon tax and emissions trading can be very effective in cutting emissions without adversely affecting the economy. This basic finding is applicable to all countries. We believe that a carbon tax can also work to inspire the introduction of an emissions trading system in Japan. Over time, we expect that international prices of emissions permits will tend to rise. To prepare itself to join an international emissions trading system at an early stage Japan must urgently develop a package of national policies that makes use of the benefits of a carbon tax. It goes without saying that the formulation of a policy mix that allows for international purchases of emission permits depends on having a solid foundation of domestic measures, as stated in the Basic Guidelines on Measures to Tackle Global Warming, which in turn is based on the Law Concerning the Promotion of the Measures to Cope with Global Warming.

Now we turn to the controversial question of when, exactly, we should introduce a carbon tax. Our simulations all assumed that carbon tax went into full effect immediately it was introduced. This made it possible for the simulations to achieve the required CO_2 emission reduction targets by 2010, even if the tax was assumed to go into effect in that same year. In reality, however, an adjustment period is necessary. If the adoption of the new tax could be managed very smoothly, it is possible to introduce a carbon tax quite close to the target year and still meet the target. Realistically, though, we can predict that it will take a long time for the country to adjust to the new tax. Thus, if we leave the introduction of a carbon tax too close to the "deadline" year, there is a danger that its expected effect won't be seen. This point needs serious consideration.

The concept of using indirect methods such as taxes and levies for environmental protection is quite new in Japan. However, as outlined in this report, a growing number of countries in Europe are now either introducing or planning to introduce a global warming tax. It is expected that by 2001, most of the major European countries, all of which are our economic competitors, will have adopted such a tax. In addition, the U.S.A. and Canada appear set to introduce economically efficient global warming policies based on emissions trading. For the sake of remaining economically competitive with these countries, Japan must urgently implement policies that can reshape the economy into a new, more efficient structure. Fortunately, there is now a growing awareness and understanding in Japan regarding the use of economic instruments in global warming countermeasures, both amongst consumers and within the industrial sector.

The problem of global warming is closely bound up with the structure of our economic and social systems. So the only way to address this problem seriously is to ensure that the social costs we have regarded as external up to now are seen as internal. This process unavoidably involves a restructuring of our economy. And we should not forget that it is no longer possible to remain passive about this issue. We must face this change.

Clearly, there are major benefits to actively implementing global warming countermeasures sooner rather than later. Here are some examples: The longer we wait to address global warming, the more expensive it will be to implement countermeasures and adapt to the resulting changes; International demand for global warming-related products and services, such as energy-saving technology, is expected to grow fast, so tackling this issue quickly will give Japan the chance to become a leader in meeting this demand on the world market; If Japan is prepared to take part in new international frameworks and regulations, such as emissions trading markets as soon as they come into effect, it will be able to secure emission permits at a lower cost.

In view of these examples, it is important that we consider the advantages of implementing global warming countermeasures at the earliest opportunity, that we create a vision for the "new economy" that we need to create to combat global warming and formulate the measures to make this a reality, and that we secure the necessary resources to put this plan into action. After this we need to forge a consensus on the plan.

As we have pointed out, there is a range of countermeasures available. To implement effective measures to counter the threat of global warming, it is necessary to create a mixed policy package. A mixed package offers a wide range of options, ranging from "low impact" measures that favor minimizing the impact on existing economic structures, to "high impact" measures that strategically accelerate the transition to a more environment-friendly and sustainable economy.

As for economic instruments, we should not regard them—as we have up to now—in terms of whether or not to adopt them (e.g. should we introduce this tax?). Rather, we should ask ourselves how we can use them effectively in combination with other instruments and measures in order to expand our policy options. This approach will allow us to develop finely tuned global warming strategies that are highly effective, equitable, and which minimize the adverse effects to Japan's economy. We are now at the stage of examining complete policy packages including tax,which highly effective instrument offers benefits no other measure can provide. We will then perform comparisons of these different packages.

We hope that this report will help take us to the next stage in this work.