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The Cyclical Economy of Japan*

Fumikazu Yoshida

Contents

In 2000 Japan enacted the Basic Law for Establishing a Cyclical Society (Cyclical Society Law), which was followed by several specific waste-and recycling-related laws created within the framework of the Cyclical Society Law. Among them are the Container and Packaging Waste Recycling Law, the Household Appliance Recycling Law, and the Automobile Recycling Law. Additionally, the Wastes Disposal and Public Cleansing Law has been amended a number of times. But investigation of whether waste is being reduced and whether recycling is making progress reveals many problems to be solved including illegal dumping and the export of waste to other countries. This analysis uses the material cycle and regime/actor analysis as the keys to understanding such problems.

With global environmental problems in mind, this investigation therefore attempts to determine the basic conditions and challenges involved in creating a "cyclical society" in modern Japan based on the question of whether it is possible to realize human well-being while lowering our environmental burden.

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Foreword

With the arrival of the 21st century, the concepts of "sustainable society" and "cyclical society" have established themselves. The reason is that environmental limitations and changes in the socio-economic structure have heralded the end of economic growth and expansionist civilization, and we are now forced to consider how we shall greet the new age of population decline and shrinking economies. But this does not mean there is clear agreement on what the new society should be like.

With global environmental problems in mind, this book therefore attempts to determine the basic conditions and challenges involved in creating a "cyclical society" in modern Japan based on the question of whether it is possible to realize human well-being while lowering our environmental burden.

I'll start with a general overview of the book. In 2000 Japan enacted the Basic Law for Establishing a Cyclical Society (Cyclical Society Law), which was followed by several specific waste-and recycling-related laws created within the framework of the Cyclical Society Law. Among them are the Container and Packaging Waste Recycling Law, the Household Appliance Recycling Law, and the Automobile Recycling Law. Additionally, the Wastes Disposal and Public Cleansing Law has been amended a number of times. But investigation of whether waste is being reduced and whether recycling is making progress reveals many problems to be solved including illegal dumping and the export of waste to other countries.

The book uses the material cycle and regime/actor analysis as the keys to understanding such problems. To begin with, the material cycle is discussed on a global scale and examined as a component of global environmental problems with the idea of determining the size of the global cycle in natural history, and discerning human society's impacts—such as carbon and heavy metals—on the cycle. Next, in the modern world energy, raw materials, and products are supplied worldwide, and thus they are moving and cycling across national borders. Governments must formulate "domestic cycle policies" in accordance with this reality. The book examines each step in the progression from extraction of overseas resources to the transport of raw materials and parts, their use and processing, finished products, waste, and finally export to other countries. After an overview of the cyclical society and the waste economy as a whole, I will demonstrate in an easy-to-understand manner the effectiveness of the second analysis key, regime/actor analysis (Chapter 1).

Chapter two will explain the basic laws for the cyclical society, this book's theme, and it examines each stage from waste reduction to reuse, recycling, proper disposal, and use for energy. In particular, this chapter will discuss the nature of waste, the need for material cycle control laws, and the market for used products. In that section I want to emphasize that recycling is a means, while the objective is to decrease the environmental burden. For measuring environmental burden the chapter will discuss and explain MIPS, ecological footprint, hidden flow, and other concepts, and provide the point of view

needed to assess material cycling laws (Box. 2).

Chapter 3 explores the achievements and direction of reform under the Container and Packaging Waste Recycling Law, which became effective in 1997. In particular it discusses matters including why PET bottles are increasing, and the amount of taxes used to run this program, and it shows the problems of giving the highest priority to recycling.

Chapter 4 discusses the Appliance Recycling Law system and the increase in wastes that are hard to dispose of properly, and investigates whether illegal dumping is actually increasing. It also notes that something over 50% of the potential recoverable number of the "four appliance types" designated by the Appliance Recycling Law is actually being recovered, and it discusses the actual situation in the used appliance market and the overseas export of junked products.

Chapter 5 discusses the Automobile Recycling Law, scheduled to become effective in 2005, in light of illegal dumping on Teshima Island, automobile shredder residue, the automobile life cycle, and paying recyclers to accept materials, then moves on to a discussion of the problems of the new system.

Chapter 6 discusses construction and demolition waste and food waste, which are the main types of industrial waste, and then deals with the new Building Construction Materials Recycling Law and Food Waste Recycling Law. In particular, there is much biological organic waste because of its high moisture content, making odor-suppressing measures crucial, and there is a close connection with food production and consumption.

Chapter 7 asks whether illegal dumping can be stopped, and in that light considers Japan's biggest illegal dumping incident (on the Aomori-Iwate prefectural border), how to ensure that waste generators take responsibility, the role of waste taxes, and cooperation and the allocations of roles among administrative authorities, businesses, and citizens.

With regard to society's future direction the concluding chapter discusses the sustainable society, things and their functions, human well-being, and the environmental burden as it considers a way to provide well-being and decrease the environmental burden.

As consumers, citizens have surprisingly few opportunities to find out how the products they use are made, and what happens to them after they are consumed. This book will therefore attempt to provide readers with a written "factory tour" so they can see how consumer appliances, automobiles, and other products are actually produced, and how they are managed as waste.

Many of my examples will be from Hokkaido because I live there, but I will also present information on nationwide trends discovered in my investigations. I will also describe some specific environmental initiatives by companies based on their environmental reports.

This book will proceed as follows:

(1) Show a correspondence between reality and principle;
(2) Explain the latest research in an easy-to-understand manner so that it is interesting and useful;
(3) Make policy proposals instead of just pointing out problems; and

(4) Give readers a better understanding with "boxes", definitions of terms, a list of references.

Overall, this books argues that the cyclical society's purpose is to minimize environmental burden while increasing human well-being.

Introduction

What Is the Cyclical Society?

What do you think of when you see the word "cycle"? Some people probably think of the saying "Money comes and goes," which refers to how money cycles through society, while others perhaps think of the hydrological cycle, in which water falls as rain, moistens the earth, flows to the sea, and evaporates.

It was not so long ago when the keyword "cyclical society" started being emphasized in reference to environmental issues. There is little doubt that behind this term's ascendancy are factors such as thinking better of the mass-production, mass-consumption, mass-disposal social system, the growing seriousness of waste problems because of the disposable society, the insufficiency of landfill space, and dioxin from waste incineration.

The cyclical society's purpose is not cycling material and energy or recycling per se, but improving human well-being by doing so. The kind of production and cyclical economy which have a detrimental impact on the lives and livelihoods of people owing to the production and possession of things have their purpose and means in reverse order. Society must minimize the environmental burden through cycling, in other words, decrease the extraction of resources and minimize throughput. In that sense, it is incumbent upon us to look for ways to improve human livelihood through cycling-based dematerialization (using as little material as possible).

The Basic Law for Establishing a Cyclical Society and the Basic Plan for Establishing a Cyclical Society

The Basic Law for Establishing a Cyclical Society (the Cyclical Society Law) defines the cyclical society as one which is brought about by reducing the consumption of natural resources and by keeping the environmental burden as light as possible using these means and methods: (1)keeping products from becoming wastes, (2)encouraging the proper recycling of products when they have become recyclable resources, and (3)assuring the proper disposal of recyclable resources that are not recycled.[1)]

What's important is that this definition says the "cycle" itself isn't the purpose of the cyclical society, but rather using the cycle to reduce consumption of natural resources, and to alleviate the environmental burden to the maximum possible extent. Hence the cyclical society is not the same as a recycling society, a common misunderstanding. Accordingly, the usual English translation for this term, "recycle-based society," is inappropriate. What's more, the focus is not the cycle itself, but rather controlling the cycle so as to lighten the environmental burden through cycling (see Fig. 1.7).

Additionally, the Recycling Society Law specifies an order of priority for discarding and recycling: (1)reducing waste, (2)reuse, (3)recycling, (4)thermal recycling, and (5)proper disposal. But more investigation will be needed to see how these contribute to reducing the overall environmental burden, and an emerging problem will be determining an order of priority and a combination

of means that take into account cutting CO_2 emissions, regulating hazardous substances, mitigating environmental risk, and other considerations.

The Basic Plan for Establishing a Cyclical-Based Society (Cyclical Society Plan), which was adopted by the Cabinet in 2003, establishes an initiative indicator and three material flow indicators (total material input, material flow, and total material emissions, totaled by partitioning physical areas and time periods), and it sets targets for three things in 2010: entrance, cycle, and exit.

The "entrance" indicator is resource productivity, which is obtained by dividing GDP by natural resources and other inputs. Its target is ¥390,000 per ton, which is twice the 1990 level.

The "cycle" indicator is materials recycled or reused, which is obtained by dividing the cyclical use amount by the total material input. It is set at 14%, which is an 80% increase over 1990.

The "exit" indicator is the final disposal amount, whose target is 28 million tons, a 75% reduction from 1990. A problem is that the specific indicators for environmental burden reduction and the measures to be taken for attaining targets are not clear. Further, when incinerating wastes to substantially reduce the landfilled amount, thermal recycling and other ways of using the heat energy might increase CO_2 emissions.[2] And the fact that residue remains even after incineration points to the need to have targets for reduction, reuse, and recycling.

As this shows, although the concept of the cyclical society developed directly out of the waste problem, it can be considered a subordinate concept of the sustainable society that describes the material aspect of that society.

The foregoing considerations lead us to the fundamental problem of how to build an "affluent society" (i.e., one with good quality of life) by lowering the environmental burden within the framework of sustainable development and the sustainable society. For example, how do we achieve real happiness with little money and a low environmental burden?[3]

When considering this problem it is important to sufficiently consider changes in international conditions and social conditions (such as fiscal crises, declining birthrate and the aging population, and Asian economic growth), but not necessarily narrow the scope to the material cycle within one country or region because countries and regions bring in material from outside. It is also urgent to find how to incorporate systems into society to reduce the environmental burden.

Box 1 Japanese Indicators of Environmental Sustainability

Every year the World Economic Forum brings world political and economic leaders together for talks. The forum has released the 2005 environmental sustainability indicators for each member country. Japan is ranked low at number 30. Near the top come the Scandinavian countries, and far below them Japan, the US and Britain.

Japan had high scores for "reducing human vulnerability" (64), "global stewardship" (78) and "social and institutional capacity" (89), but it scored low in other components: "environmental systems" (32), and "reducing stresses"

(37). According to standard deviation using zero as the mean, individual indicators were low for "reducing air pollution" (−1.55), "land" (−1.74), "biodiversity" (−0.80), and "reducing waste and consumption pressures" (0.24). High indicators were "private sector responsiveness" (2.04) "science and technology" (1.93), "reducing population growth" (1.14), "water quality" (1.06), and "reducing transboundary environmental pressures" (0.67).

Japan is rated highly regarding human health and science and technology, but it faces serious challenges on the ecosystem, biodiversity, waste and consumption, and environmental pressure on other countries.[4)]

Research on the "well-being" of peoples comparing the quality of life and environment[5)] used "health and population," "wealth," "knowledge and culture," "community," and "degree of equality" as "indicators of human well-being, while "land," "water," "air," "species," and "resource use" served as "indicators of environmental well-being" to compare countries.

In the first category Japan is among the world's developed countries except for degree of equality, while in terms of the environment there is much room for improvement. According to the research, Japan has many improvements to make with respect to river and groundwater contamination, energy consumption, CO^2 emissions, fish consumption, and land use.

Chapter 1 The Material Cycle and the Regime/Actor Analysis

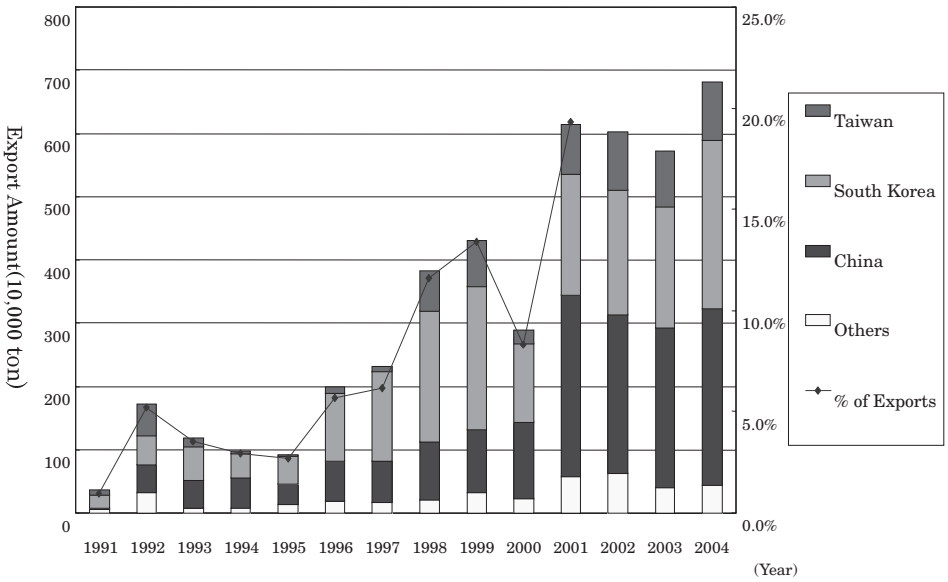
1 The Material Cycle

Cross-Border Resource Cycling

Because of economic globalization, the material cycle has totally transcended national borders. In particular, imports and exports of scrap metal, post-consumer waste paper, waste plastic, and other reclaimed materials are booming due to heavy demand stemming from falling demand in Japan and to Asian economic growth.

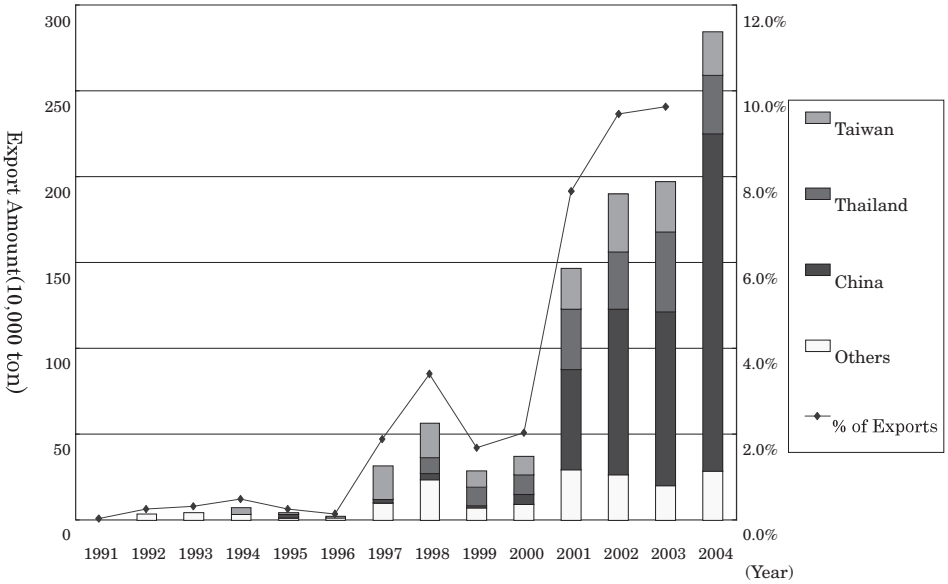
Exports of scrap iron, which exists in immense quantities, began to increase rapidly in 1996, and at present about 20%（about 6.8 million tons） of the scrap iron generated in Japan each year is exported. Ninety percent of this exported scrap iron is imported by South Korea, China, and Taiwan（Fig. 1.1（A））. Exports of waste paper grew quickly beginning in 1997 and currently account for nearly 10% of the waste paper domestically generated, which is one reason for the domestic shortage of waste paper. Importers include South Korea, Thailand, China, and Taiwan（Fig. 1.1（B））. Exports of waste plastic tend to increase in recent years, and in 2003 accounted for about 7% of the amount generated domestically. The major importers are Hong Kong and China（Fig. 1.1（C））.[1)]

From the perspective of importing countries, the wastes and scrap from



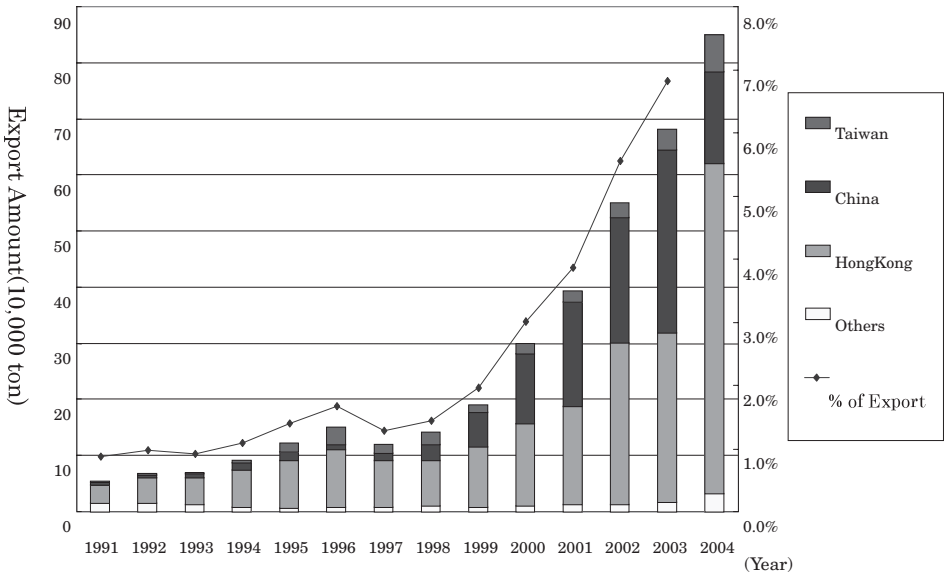
Source: Ministry of Finance, *Trade Statistics*.

Figure 1. 1 (A) Ferrous scrap exports and importing countries



Source: Ministry of Finance, *Trade Statictics*.

Figure 1. 1 (B) Waste paper exports and importing countries



Source: Ministry of Finance, *Trade Statistics*.

Figure 1. 1 (C) Plastic scrap exports and importing countries

abroad come in vast amounts. Fast-growing China in particular accepted 9.38 million tons of waste paper, 9.29 million tons of scrap iron, 3.96 millions tons (in 2000) of electroscrap including motors, electronic equipment, and cables, and 3.2 million tons of plastic in 2003.[2)]

Since the 1990s India has been the biggest importer of lead scrap (mostly from spent lead-acid batteries), and most of its imports are from Japan and

Europe. The next-largest importer is South Korea, which imports most of its lead scrap from Japan. Although Japan's 2001 exports were half of those in the 1990s, South Korea accounted for most of 3,800 tons.[3] Of the specified hazardous waste export applications made in Japan in 2000, the largest proportion was for lead scrap to South Korea, amounting to 8,100 tons.

At the same time, Japan's imports of specified hazardous wastes increased about four fold in five years. The underlying reason is probably the rigorous implementation of Japan's domestic law corresponding to the Basel Convention (the 1992 Law for the Control of Exports and Imports of Specified Hazardous Wastes and Other Wastes), which requires reports on imports and exports. Most of these imports consist of parts, metals, and other industrial waste and construction waste, and the primary sources are Singapore, the Philippines, and Malaysia. Electronic products such as the printed circuit boards of personal computers and cell phones cannot be reclaimed at factories abroad, and are therefore imported by Japan. Since Japan's economy slowed after the boom years, fewer commercial buildings and factories are being rebuilt, which means less electrical cable is being recovered. In some instances the shortfall is made up by imports.[4]

Exports of Scrapped Household Appliances

As Japanese companies establish an increasing presence abroad, Japan has in recent years been importing products made in China and Southeast Asia. In 2003, 97% of televisions sold in Japan were imported, as were 65% of refrigerators, 53% of washing machines, and 14% (2000) of air conditioners.[5] After importation and use in Japan, the appliances are scrapped and exported back to China and Southeast Asia.

The Ministry of Economy, Trade and Industry (METI) estimates that 1999 exports of used TVs were about 3.27 million units, or about 38% of domestic scrapped TVs. For air conditioners the figures are 920,000 units and 33%, and for automobiles they are 1 million units and about 20%.[6] Other estimates indicate that after the Home Electrical Appliance Recycling Law took effect exports of TVs climbed to 4.3 million units and those of air conditioners to 1.2 million units. After this law took effect, more of these used products for export have been obtained through direct takebacks by businesses. Exports of these used products assume three forms:

(1) They are exported as used products and treated as used products at the importing end.
(2) They are exported as used products but cannibalized for parts.
(3) They are exported as electroscrap and used as recycled materials and resources.

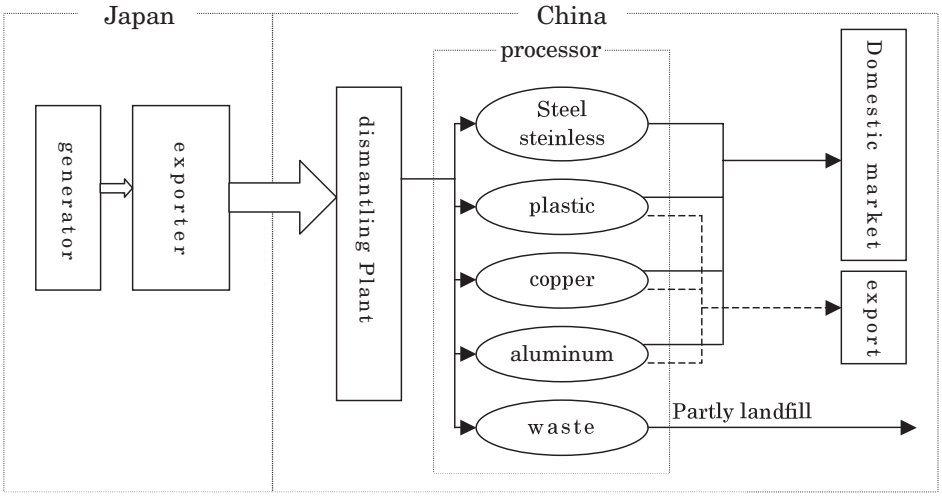
Importers include China (via Hong Kong), Southeast Asia (the Philippines, Vietnam, Cambodia, and others), South Asia (Pakistan, India, and others), the Middle East (Lebanon), North Korea, and Russia. Most exports of consumer appliances go to Southeast Asia.[7] However, recent data show that TV exports

have dropped by half to 1.84 million units, and exported air conditioners down to 40,000 units.[8)]

These statistics indicate that Japan is exporting about one-third of its TVs and air conditioners, which are covered by the Home Electrical Appliance Recycling Law. Thus the cyclical economy is not a closed loop within one country, and cannot become one. Further, air conditioners, refrigerators, and washing machines that are on the domestic market as used products are estimated to account for between 5 and 10% of the total of those used products.[9)]

Hence it is considered necessary to design a regime which assumes used products will appear in both domestic and foreign markets, and which will also guarantee that pollution is prevented in the recycling process, and assure transparency and fairness in the distribution of merchandise.

Although Japan's Home Electrical Appliance Recycling Law and the Container and Packaging Waste Recycling Law share the ideal of fostering a domestic recycling industry, the large wage differential between Japan and China and strong demand in China has spawned a new phenomenon in which used products are exported to other Asian countries, especially China.[10)]



Source: Kojima and Yoshida, 2003.[6)]

Figure 1. 2 Japanese waste exports and recycling in China

Box 2 Methods of Measuring the Material Cycle

(1) Life cycle assessment is a method that comprehensively assesses the environmental impact of a product through its entire life cycle from resource extraction to material manufacturing, product manufacturing, product use, and disposal. It can assess tradeoffs between environmental problems by taking into account all such problems including global warming, acid rain, eutrophication, and ecological impacts.

(2) Material intensity per service (MIPS) over a product's entire lifetime is the criterion for environmental burden intensity. MIPS is, in other words, the

amount of material consumed from cradle to grave per service or function. Material inputs at all stages of the life cycle are calculated as mass units. This concept, which was proposed by Germany's Wuppertal Institute, is criticized for being based on the value that environmental impact is proportional to the movement of mass.

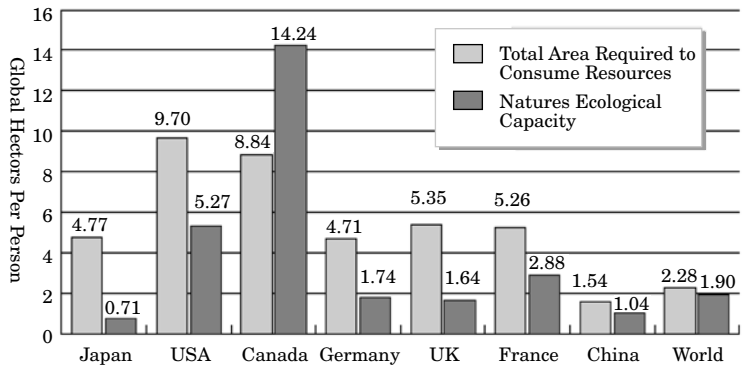
(3) Resource productivity of goods is the total service units obtainable with those resources divided by total consumption of material for a service-yielding good. In other words, it is the inverse of per-kg MIPS.

(4) Hidden flow is the materials, other than the resources intended for use, which are extracted or excavated, or which are generated as waste, in conjunction with the socio-economic activity of resource extraction. For example, if we want to extract metal resources, we dig up an amount of overburden and rock that is far greater than the amount of the resources actually used. In Japan there is little hidden flow from extracting underground resources, as most hidden flow is from the digging and backfilling of soil in construction (Fig. 1.2).

(5) Ecological footprint: The total productive land and water area considered necessary to permanently support the economic activities of a certain region, or the livelihoods of people living at a certain level of material consumption (regardless of whether that land or water is inside or outside the region). Recent research indicates that the ecological footprint of human economic activities in total is already 1.3 times the Earth's productive land and water area. The ecological footprint is higher for countries that have a high economic level, a low agricultural percentage, and a high population density (Fig. 1.3).

(6) Ecological rucksack: The primary raw-material and energy inputs needed throughout the life cycle for a certain material. It is related to the "hidden flow" concept.

(7) Food mileage is a concept which calculates and uses as an indicator the total distance food is transported from production to consumption. As distance lengthens, the amount of CO_2 emissions from transport indeed increases, but the environmental impacts of food include major problems such as eutrophication caused by fertilizers and the ecological impacts of pesticides. Hence transport distance is limited as an indicator of environmental impact.[11)]



Source: WWF, Living Planet Report 2002.

Figure 1. 3 Ecological footprints of selected countries

The Material and Hydrological Cycles

In a section of volume 1 titled "Modern Industry and Agriculture" of Marx's economic classic *Capital*, there is a passage on how capitalist production "disturbs the circulation of matter between man and the soil" because although industrial countries apply high-quality fertilizers to their farmland, the sewerage systems of big cities allow valuable nutrients to wash into the sea through rivers, thereby causing pollution. Assuming the return of human waste to the soil, this can be interpreted as describing the connection between the material cycle and water cycle, proceeding from fertilizer to agricultural produce, people, sewerage, rivers, and finally to the sea.

Urbanization has induced drastic and harmful changes in the water cycle such as subsidence caused by excessive groundwater withdrawals, frequent new kinds of flood damage to cities, the loss of abundant waterside spaces, sharply decreased flow rates downstream from dams, and changes in aquifer recharging stemming from reduced rice paddy acreage. Such water cycle changes[12] constitute part of the reason for serious water shortages and pollution, arsenic contamination and other groundwater crises, the grave state of lakes, and worsening flood damage.

These changes in the water cycle are inseparable from changes in the material cycle. Japan's enormous imports of food, for example, put water from throughout the world on Japanese dinner tables in the form of beef and other foods. This "indirect water," also called "virtual water," amounts to about 74.4 billion cubic meters annually, which accounts for about 85% of the total for agricultural, residential, and industry water.[13] Most indirect water comes in the form of beef imports from the US and Australia, which means that water shortages in those two countries are directly linked to Japan's food situation, and that the water cycle is international in scope.

Livestock Waste and the Material Cycle

At the mention of Hokkaido, many people no doubt conjure up images of cows grazing on broad pastures and of red barns, all under a blue sky, and until coming to Hokkaido I too imagined that. But a visit to a dairy farm will show that agriculture and dairy farming are quite far removed from what we think of as "natural." One reason is livestock waste. Go into a barn and you will be flabbergasted by the presence of over 100 head of cattle and by the stench and huge amount of livestock waste. This should be no surprise, as a multiparous milking cow produces 60 to 70 kg of waste a day. Dairy farmers use this as manure slurry or compost it, but they are unable to use it all due to the sheer volume.

Animal waste is the second-largest kind of industrial waste in Japan (sludge ranks first, and demolition waste third). In Hokkaido, which is home to about half of Japan's cattle, animal waste is the first-ranking industrial waste, accounting for about 50% of the total and weighing in at 20 million tons annually. About half of this animal waste is actually used as slurry or for composting.

Waste that overflows from compost piles or urine lagoons, or waste that is

left in outdoor piles or spread on farmland off season tends to run off into rivers and pollute them. In particular, Bekkai Town and other parts of the Nemuro region in eastern Hokkaido have many salmon rivers and therefore face the problem of how to coexist with the fishing industry.

In terms of the material cycle, Japan's grain self-sufficiency rate of about 30% means that 700,000 tons of nitrogen enter Japan each year as grain imports. It is often said that food exports are soil exports, and that food imports are animal waste imports, and indeed 1.6 million tons of nitrogen are generated per year including that from domestically produced agriculture and fisheries products. Subtracting the portion of this nitrogen that is recycled in agriculture leaves at least 1 million tons of nitrogen released into the environment each year. The nitrogen material cycle in the Nemuro area of Hokkaido has an influx of about 15,000 tons annually in the form of fertilizer and animal feed, while about 10,000 tons remains in the environment after subtracting about 60,000 head of cattle and the amount transferred to milk cows. Of the 10,000 tons remaining in the environment, 3,000 tons end up in rivers.[14)]

Remedial action to deal with this on the national level came in 1999 with the Livestock Waste Management Law, which provides for the proper treatment and use of livestock waste instead of allowing them to burden the environment. Under this law, the national government and prefectures develop basic policies and plans, and provide dairy farmers with loans to build facilities, whose construction by October 2004 became mandatory under the law. Farmers now have no time to lose.

Behind this issue are the growing size of dairy operations and the heavy use of imported concentrate. In 1960 each Hokkaido farm had an average of three milk cows, which increased about 30 times to 90 head over a span of 40 years. Additionally, the milk yield per head approximately doubled to 7,370 kg per year. It is the imported concentrate that made this possible.

Dairy farming originally cycled nutrients internally from the soil to grass to cattle, but now extra-system nutrient inputs accumulate on dairy farms as milk cow waste. As the number of cattle grows, these nutrients overflow out of the farm system and pollute the environment. Bovine spongiform encephalopathy (BSE) is another problem that arose in conjunction with imported feed. With the increase in herd size, the number of cows per unit area becomes an important indicator. This is now estimated to be two head per ha, and under this criterion Bekkai Town and the Tokachi region of Hokkaido have reached their limits.[15)]

Environmental degradation is not the only problem, for increased milk yield induced by feeding concentrate to cows has resulted in fourth stomach displacement, liver abnormalities, and other physical damage that have in turn led to an increased cow death/retirement rate. Unhealthy cows cannot be expected to produce healthy milk. The consequences of increasing milk yield by heavy feeding with imported concentrate are a large environmental burden from livestock waste, damage to cow health, and, for dairy farmers, longer working hours and bigger debts.

Needed corrective measures are (1)appropriate dairy farming scale, (2)lim-

iting imported feed and recycling livestock waste, and (3)lowering the milk yield standard. Dairy farming must eliminate the need for limitless expansion.

Of special interest in this regard are the efforts of the "Slow Dairy Farming Society," which aims to achieve low-input dairy farming. They are working toward dairy farming that increases income by downsizing instead of expanding, and by lessening inputs of feed and fertilizer, specifically by decreasing material inputs, simplifying tasks, shortening working hours, putting cows out to pasture more, and other means. Most of the Nemuro-area farmers with high per-head incomes have herds between 30 and 60 head, while per-head income declines if herds grow larger. Such initiatives are spawned by second thoughts on dairy farming operations that use much purchased feed because of the environmental burden they create and the economic difficulties they create.[16] In fact, research has demonstrated that pasture feeding is superior to barn feeding in terms of five indicators: (1)economics (income), (2)energy inputs, (3)nitrogen burden, (4)human satisfaction, and (5)livestock health.[17]

Mr. Moriyuki Mitomo, a leader of the slow farming movement, takes the stance of appropriately scaled operations that use local natural conditions to advantage, and points out that in terms of both securing feed and managing animal waste, farmers need to scale their herds to the land available for them, whether feed is grown on one's own land or somewhere else.[18] A characteristic of dairy farming is that milk and meat, as well as much animal waste, are produced using pasture land. Milk and meat leave the farm, while the waste is applied to fields and used to maintain and improve grassland.[19] It is possible to further enrich the lives of animals and humans, and at the same time conserve the environment, and in fact dairy farming is unsustainable unless these are balanced. Appropriately scaled operations that take advantage of local natural conditions are essential to achieving this. A cyclical society is appropriately scaled to those conditions.

Japan's Material Flow

This section is an overview of a larger material cycle (Fig. 1.4).

Japan's material flow in 2001 had a total material input of about 2.1 billion tons, of which about one-third (about 700 million tons) was emitted into the environment as waste and CO_2. Meanwhile, the recycled portion was about 212 million tons, or barely 10% of total material input.

Further, the "hidden flow" of rock and waste generated when extracting metal and other resources amounts to about 1.1 billion tons domestically, and about 2.8 billions tons abroad, for a total of 3.9 billion tons.[20] A characteristic of Japan is the large size of this overseas hidden flow. Therefore Japan's economy is sustained by the movement, inside and outside Japan, of about 6 billion tons of material annually. At the same time, Japan's economy uses about 32 billion tons of water each year.[21]

The Macro Material Cycle: Global Carbon Cycle

The significance of the material cycle to global environmental problems becomes evident by analyzing the global carbon cycle. Analysis of anthropo-

genic CO_2, forest carbon uptake, and carbon from other sources is of the greatest importance for setting basic policy to combat global warming.

The "Summary for Policymakers" of a special report by the Intergovernmental Panel on Climate Change (IPCC), "Special Report on Land Use, Land-Use Change and Forestry,"[22] explains it in the following manner (Fig. 1.5).

Both vegetation and soil in the Earth's ecosystems absorb carbon. At pre-

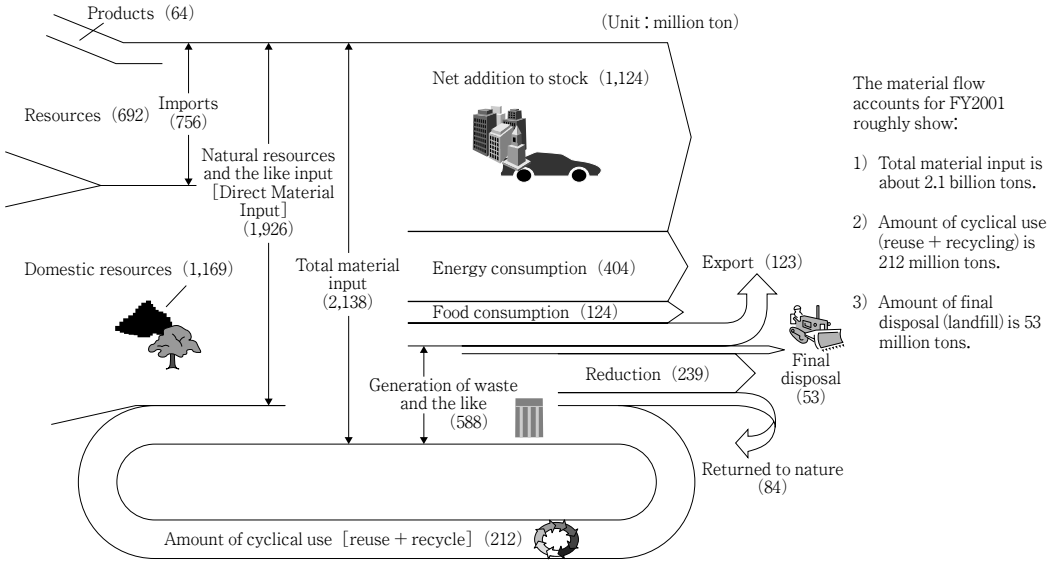
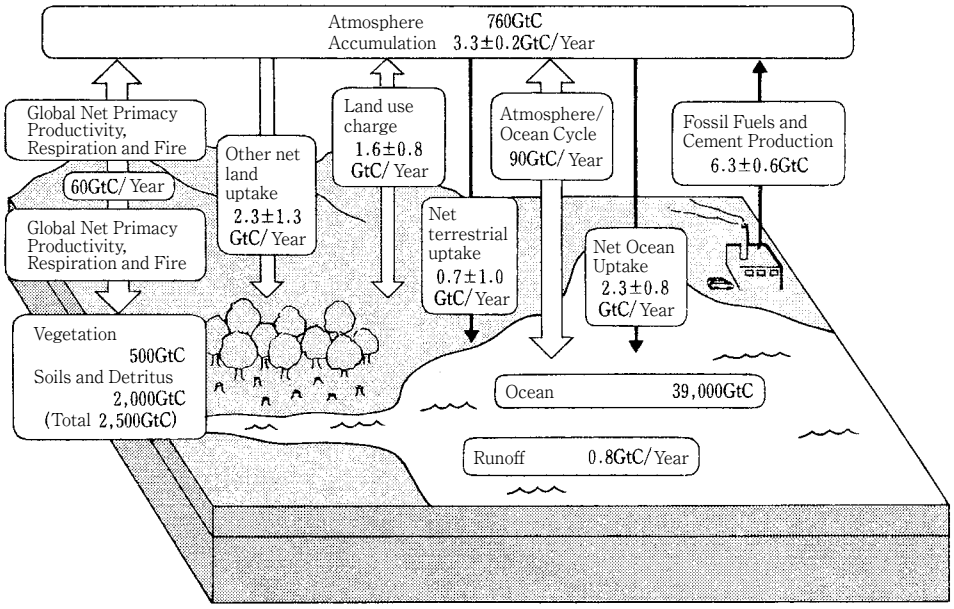


Figure 1. 4 Japan's material balance



Source : IPCC (2000), p.22.

Figure 1. 5 Global carbon cycle

sent soil holds more of the carbon stock than vegetation, with the stock held at mid and high latitudes in ecosystems other than forests being the largest.

CO_2 dumped into the atmosphere from 1850 to 1998 by fossil fuel combustion and cement manufacturing amounts to about 270±30 gigatons of carbon (GtC). Due to changes in land use about 136±55 GtC CO_2 has been released, especially from forest ecosystems. Atmospheric CO_2 concentration has increased from 285 to 366 ppm, and the atmosphere retains about 43% of total emissions. As this shows, it is clear that terrestrial ecosystems have been a comparatively small source of CO_2 during this period of time.

The yearly average amounts of the Earth's carbon balance in 1980 to 1989 and 1989 to 1998 show that the rate and trend of global carbon sequestration are highly uncertain. Net carbon sequestration on land is generally balanced with emissions due to land use in tropical forests, but arises because of (1) land use activities, (2) natural regeneration at mid and high latitudes, (3) indirect impacts stemming from human activities (fertilizer effect of atmospheric CO_2, deposition of nutrient salts, etc.), and (4) climate change (natural and anthropogenic). It is currently impossible to determine the relative importance of these processes because it differs from one region to another. Residual terrestrial uptake is 1.9±1.3 GtC a year, with a margin of error as high as 70%. With such high uncertainty, that of predictions for several decades or more are even more uncertain.

Despite this uncertainty, with reference to the discussion on the annual average carbon stock change from 2008 to 2012 caused by global afforestation and reforestation,[23] the IPCC's definitional scenario predicts a negative annual stock change of 1,591 to 1,204 megatons carbon (MtC) due to an offset by deforestation. Only when afforestation and reforestation rates increased globally by 20% would the carbon stock increase to 208 to 629 MtC a year.

On the other hand, the net carbon stock change (2010 prediction) through improved management and reformed land use activities shows that the global carbon stock is largest for agroforestry, followed in descending order by pastureland management, forest management, and cropland management.[24] In other words, improved forest and land management make a greater contribution to fixing carbon than does afforestation. Therefore analyzing the global carbon cycle allows us to understand global environmental problems in terms of macro-level material cycles.

Analysis of Micro Material Cycle: Heavy Metals

By contrast, let's take the analysis of heavy metal material flow as an example of a micro-level material cycle. Such an analysis can shed light on the issue of cadmium-contaminated rice, which has recently become an issue again in Japan. Heavy metal contamination requires analyses that integrate the contamination accumulated up to the present, i.e., stock contamination, with current flow contamination. Beginning with stock contamination, in the 1970s cropland soil throughout Japan was found to be contaminated from metal mines, smelteries, and other sources, but soil remediation was performed only in regions whose rice had cadmium concentrations of 1 ppm or

more. Semi-contaminated farmland with at least 0.4 ppm but under 1 ppm was given only symptomatic treatment to lower the cadmium concentration in rice by spreading lime, calcium silicate, or some other agent to prevent cadmium absorption, or by using water management. For that reason, 0.4 ppm or more of cadmium was often detected in rice.[25] Further, it is believed that more than 5% of Japan's rice-producing areas have at least 0.2 ppm cadmium, a level which entered the range of contamination owing to the strengthening of international standards.

Moving on to flow contamination, Japan is the world's biggest cadmium consumer because it uses 37% of the world supply. Ninety-eight percent of Japan's consumption is used in nickel-cadmium batteries. Only 20% of those batteries are recycled domestically, while the rest end up in waste incinerators or landfills to become a new source of cadmium contamination.[26] Eight percent of the cadmium consumed in Japan ends up in incinerator ash,[27] a typical example of how material is dispersed after use.

An example from outside of Japan is the material flow analysis of cadmium in the Rhine River watershed,[28] whose cadmium emissions peaked in the 1970s. The breakdown by source indicates that the metal refining industry is responsible for nearly half of those emissions, followed by the coke industry at about 20%, phosphate fertilizer at about 20%, and then manufacturing and sewage sludge. But in the late 1980s the absolute overall amount decreased substantially, and the proportion of non-point sources increased over that of point sources. Pollution by non-point sources occurs when cadmium "hitchhikes" in galvanizing and phosphate fertilizers because cadmium is an impurity found in zinc ore and rock phosphate. In the late 1980s phosphate fertilizer was found to be the source of about three-fourths of the cadmium contamination of farmland in the Rhine River watershed, thereby indicating that cadmium contained in phosphate fertilizers as an impurity is the greatest risk to public safety. Cadmium is taken up directly by crops, and can be a source of exposure when people eat contaminated crops.

As this shows, analyzing the material flow of cadmium from the perspective of the material cycle makes it possible to set the focus of contamination control measures.

Box 3 Mercury Recycling

A full-blown mercury recycling facility in Japan is the Nomura Kohsan Co.'s Itomuka Mining Office at the former Itomuka Mine in Rubeshibe Town, Hokkaido. Spent fluorescent lights and dry cells collected by local governments throughout Japan are sent by rail or truck to this facility for processing and mercury recovery.

This facility was originally created as a mercury mine in 1939 by Nomura Mining Co. (the predecessor of Nomura Kohsan), a member of the same industrial group as Nomura Securities. After closing in 1973,the facility began processing mercury after stopping production of caustic soda with the mercury process, and started recovering mercury from wastes. Thus the connection with mercury processing technology continues.

Currently the facility accepts and processes 17,000 tons of spent dry cells from 2,000 municipalities throughout Japan each year, and 7,000 tons of burned-out fluorescent lights annually from 700 municipalities. The respective recovery rates are 25% and 10% of the potential recovery rates.

Although Japan has already eliminated mercury from domestically manufactured dry cells, 10% of all discarded batteries contain small amounts of mercury because of imports. Fluorescent lights use the most mercury, followed by measuring instruments. This facility recovers 40 tons of mercury a year, of which 20 tons are recycled domestically. All the mercury used domestically is therefore provided by recycling alone.

To put these amounts in perspective, the amount of mercury that Chisso, the company which caused Minamata disease, dumped into Minamata Bay is estimated to be about 250 tons.[29)]

This recycling facility cannot cover all its operating costs by selling the mercury, glass, zinc, and other materials it recovers, so basically it depends on the processing fees that municipalities pay (80 yen per kg, now 74 yen). If the recovery rate is raised, it will be possible to decrease the environmental mercury burden throughout Japan and to make mercury recovery economically viable.

Material Cycle: Summation

As the world economy evolves, raw materials and products move across national borders, and the material cycle is not closed within any one country. Governments need environmental policies that take this reality into account.

Because a number of methods to measure material cycles have been developed, performing actual measurements makes it possible to concretely ascertain and compare environmental burdens imposed by these cycles. The purpose should dictate which measurement method is used.

A consideration of material cycle scale on the global level reveals that while the anthropogenic CO_2 contribution to the carbon level is not that large, the increase in CO_2 since the Industrial Revolution is reaching the point where it is inducing climate change. The Earth's material cycle is therefore operating in a delicate balance. In the study of environmental pollution, furthermore, it is crucial that we focus on micro-level material cycles as in the example of cadmium.

The reason for focusing on material cycles is to analyze how we can enrich life in human society while at the same time decreasing the environmental burden, and to create policies for that purpose. Material cycles should not be seen as existing for their own sake; cycle scale and state are the important questions. Moreover, it is vital to build cycling systems that are tailored to the characteristics of the materials being cycled, such as organic materials or metal.

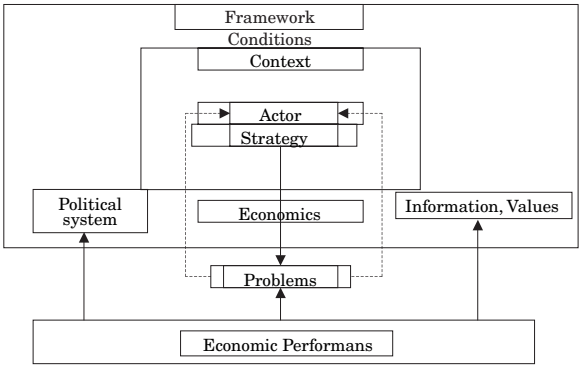
2 Regime/Actor Analysis

This book attempts to analyze the cyclical society using material cycles and regimes/actors as the key. Having covered material cycles, let us now

move on to explaining the concept of regimes and actors. Briefly put, while material cycles are used to analyze the natural science aspects of environmental problems, the regime/actor approach was developed as a conceptual device to analyze the social aspects of environmental problems. In other words, examining a certain thing requires the right pair of glasses.

What Is Regime / Actor Analysis?

Environmental political science proposes regime/actor analysis as a framework for comprehensively analyzing environmental problems. This method was devised for the purpose of ascertaining and enhancing society's overall capability for capacity-building. A regime is the framework conditions which affect human norms and customs, ranging from legal frameworks such as international conventions to domestic laws, ordinances, and agreements. A regime's conditions include: (1)cognitive information conditions (information, mass media, values, etc.), (2)political and institutional conditions (participation in the regime, capacity for integration, etc.), and (3)economic and technological conditions (GDP, resources, technology transfer, etc.) (Fig. 1.6).[30]



source: Jänicike,1995.[6]

Figure 1. 6 Regime/Actor model

Government agencies, environmental organizations, environmental industries, mass media, communities, and other entities become actors under these framework conditions, dealing with circumstantial opportunities with their respective strategies, will, and abilities. Of importance here are the type and urgency of environmental issues, and the configuration between actors (for example, relationships between a government and different industries, and relationships of competition and cooperation within an industry).

This analysis method does not see the regime as exerting one-way top-down control over the actions of actors; rather, it simultaneously examines the aspect in which actors create the regime, the aspect of interaction among actors, and their dynamics.

Regimes

In terms of regimes, there are two questions about international and do-

mestic regimes: (1)the relationships and hierarchy among internal regimes and (2) the influence of international regimes on domestic regimes.

To begin with international regimes, some international environmental agreements are the Kyoto Protocol (adopted 1997), Montreal Protocol (1987), London Dumping Convention (1972), Basel Convention, and WTO-related agreements. There are in addition domestic laws for compliance with the OECD's pollutant release and transfer register (PRTR) and extended producer responsibility (EPR) systems. In addition to the obligations under these agreements, economic globalization has allowed the regulations of another country to heavily influence Japan, as seen in the US Clean Air Act of 1970. Likewise of great significance in Japan are the EU directives on regulating wastes and the environmental auditing standard ISO 14001.[31)]

Japan's domestic regime includes the Basic Environment Law as well as a basic framework law called the Basic Law for Establishing a Cyclical Society (and its Basic Plan for Establishing a Cyclical Society), in addition to laws for creating general frameworks, the Wastes Disposal and Public Cleansing Law and Law for the Promotion of Utilization of Recycled Resources. Regulations dealing with the characteristics of individual items are provided by laws including the Container and Packaging Waste Recycling Law, Home Electrical Appliance Recycling Law, Construction Recycling Law, Food Waste Recycling Law, Automobile Recycling Law, and Livestock Waste Management Law. Also important are the environmental ordinances of municipalities (Fig. 1.7).

A problem that emerges here is the coordination and consistency of waste-related laws. Specifically, is the idea of waste reduce given a role to play in Wastes Disposal and Public Cleansing Law, and how are appropriate disposal and recycling described in different laws? Under the Wastes Disposal and Public Cleansing Law's 2000 amendment, the Environment Minister creates the basic policies for reduced waste generation, volume reduction, and appropriate disposal, while the prefectures follow these policies in developing their waste management plans. As part of this effort to control waste, the Special Measures Law on Dioxin Control was created to control air pollution by dioxins, which was one reason why the Wastes Disposal and Public Cleansing Law encourages round-the-clock operation of fusion furnaces and other facilities using the best available technology. As this means that municipal wastes will continue to be generated, there is criticism of a contradiction with the Container and Packaging Waste Recycling Law and other recycling laws.

Assuming coordination and consistency among various laws, it becomes necessary to analyze conditions including those observed earlier: (1)cognitive information conditions (information, mass media, values, etc.), (2)political and institutional conditions (participation in the regime, capacity for integration, etc.), and (3)economic and technological conditions (GDP, resources, technology transfer, etc.). Important for cognitive information conditions are environment-related information and media stance, the public's tendency toward post-materialism, and recent trends in concern for health, occupations, and personal interests. For political and institutional conditions, important considerations are the extent of real community participation, each actor's

dialog and negotiating capabilities, and policy integration. Important for economic and technological conditions are recent fiscal crises, subsidy reform, political decentralization, and development of environmental conservation technologies.

Actors

Let us now examine the actors (Fig. 1.8). In relation to wastes the government agency sector comprises (1)the central government and legislature, (2)prefectures and their assemblies, and (3)municipalities and their assemblies. While the prefectures provide administrative guidance on industrial waste, municipalities have a labor union (All Japan Prefectural and Municipal Work-

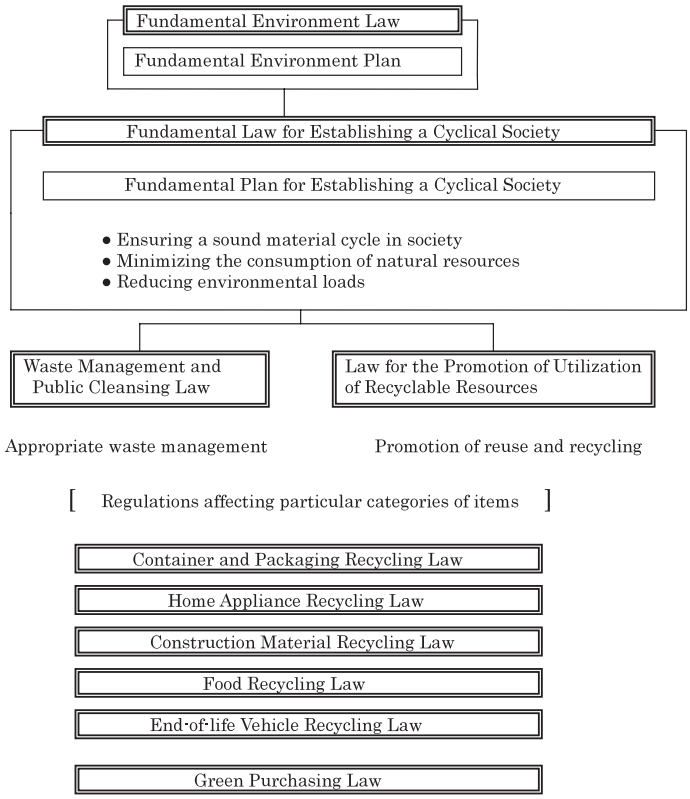


Figure 1. 7 System of policy measures in the cyclical society

Government Agency Sector
① central gevernment & legislature
② prefecture and assembles
③ municipalities
Business Sector
④ producers distributor
⑤ waste pick up and management business
⑥ waste management equipment industry
Citizen Sector
⑦ neighborhood association
⑧ NPO, NGO, and each citizens

Figure 1. 8 Actors involved with waste

ers' Union, a federation commonly known as "Jichiro") whose workers perform waste pickup and disposal.

Important in the business sector are (4)producers and distributors, (5)businesses that actually perform waste pickup and management, and (6)the waste management equipment industry.

The citizen sector comprises (7)neighborhood associations (which perform group material recovery), (8)NPOs and NGOs (not only environmental in nature), and (9)individual citizens.

Japan's environmental policy is characterized on the one hand by good dialog and networking among actors (for example, between the government and businesses, and within industry associations), but on the other hand by inadequate policy integration (coordination and consistency among laws in a regime, and compartmentalization). An illustrative example is that of dioxins, mentioned above.

I have observed that it is actually hard to fully implement the policy for generating less waste prescribed by the Basic Law for Establishing a Cyclical Society, the underlying reasons being the consistency between regimes, and—a problem faced by actors—the dilemma putting them between reducing waste and keeping their jobs. The more waste is reduced, the more work is lost by municipal employees engaged in trash collection and waste management companies commissioned for disposal.

In fact, upon passage of the Container and Packaging Waste Recycling Law, which stipulates that municipalities must collect such wastes, the Ministry of Health and Welfare had the backing of Jichiro because the union supported the law. But in some localities the neighborhood associations, another actor, were carrying out group resource recovery and doing it much more cheaply than municipal workers could. Each actor used whatever power it had to preserve its vested interests by either creating a regime or refusing a new regime, thereby inviting fiscal crises and impairing waste management efficiency.

One possible way of trying to keep jobs would be to follow the example of Germany's packaging waste recycling regime, under which responsibilities for operations and their finances are separated, and municipalities are commissioned to perform collection by the company Duales System Deutschland GmbH (DSD) (this company performs mandatory collection and reuse of used packaging in place of manufacturers and retailers, and commissions waste management companies). Further, if a country truly wants to reduce wastes, it would have to build a specific provision to guarantee reduction into its regime as Denmark did by having the central government tax municipalities based on the amounts of waste they generate. The lack of specific economic measures is also pointed out in Germany as the limitation to its Cyclical Economy and Waste Management Act.[32] In this sense the struggle to reduce waste is a struggle to reform waste-related regimes.

Business Permits from the Perspectives of Regimes and Actors

Japan's Wastes Disposal and Public Cleansing Law requires that munici-

palities issue various business permits for wastes, but in connection with the advance of the recycling business, the way in which such permits are handled under this law has become a major bone of contention with regard to political policy owing to the issue of wide-area waste management and new entrants into the waste management business.

Some specific problems are:

(1) Permission and authorization for wide-area businesses and individual municipalities (complexity, differences in determinations on each municipality)
(2) Municipality demands are stricter than those of the national government (problem of obtaining community agreement)
(3) Difficulty of improving efficiency in the face of vested interests of businesses already having permits, historical circumstances, and closedness
(4) Permission and authorization for existing businesses under new legal regulations (permission and authorization under the Wastes Disposal and Public Cleansing Law for automotive dismantlers operating under the Automobile Recycling Law)

For example, a proposal was made to review the definition of "wastes" in the Wastes Disposal and Public Cleansing Law, and the government council explored the proposal extensively, but because this issue is linked to a review of the distinction between municipal solid waste management and industrial waste management, reviewing the definition of "wastes" was postponed. This is related to problems (3) and (4) above, and requires more detailed analysis from the perspective of what changes that a new regime and business permission and authorization under that regime would engender in the stakes and vested interests of the involved actors.[33)]

Nagoya's Policy Change

In January 1999 Nagoya City announced that it was suspending its plan for making a waste landfill site on Fujimae Tidal Flat and declared a waste emergency. The city overhauled its waste policy and in August 2000 it became the first major urban area to completely implement the Container and Packaging Waste Recycling Law. In these and other ways it switched to a policy that promoted reducing the volume of waste with the full cooperation of its citizens.

After two years of hard effort, Nagoya was generating 26% less waste and had cut the amount landfilled by 52%, thereby achieving superb results that exceeded its targets. At the same time, however, this resulted in several problems. These can be distilled from an article by Professor Masaharu Yagishita.[34)]

(1) Has waste volume reduction actually lightened the environmental burden? Haven't CO_2 emissions increased? If so, then should one assess the environmental effect of conserving Fujimae Tidal Flat and reducing the volume of wastes landfilled?

(2) Has the waste issue sparked progress in the direction of the cyclical society, which is how society should be restructured? Hasn't implementing the recycling laws merely added mass recycling to the preexisting system of mass production, mass consumption, and mass disposal?
(3) Hasn't thorough recycling induced cost increases (at least three times the personnel and vehicles), thereby increasing the burden on the citizens? Hasn't Nagoya become "recycling poor" (the city's costs rose from 27.7 billion yen to 30.9 billion yen)?
(4) Is there a shared understanding among members of the community on the kind of cyclical society that is supposed be achieved?

From the perspectives of the material cycle and regimes/actors, (1) and (2) are material cycle issues, while (3) and (4) are issues of actor burdens and coordination.

Nagoya's example provides some very clear and easily understood questions, along with actual data of various kinds, for exploring the wide variety of problems involved in building a cyclical society. Further, any attempt to create such a society must find solutions to these problems.

Waste Management in Bangkok

This section will examine municipal solid waste (MSW) management in Bangkok, Thailand as an example of material cycle and regime/actor analysis. Bangkok was no exception to economic growth rate decline after the 1997 economic crisis, yet there was little decline in the amount of waste generated and collected there. In 2000 Bangkok collected 9,130 tons of waste daily. Assuming a population of 5.7 million based on statistics from the Bangkok Metropolitan Administration (BMA), each Bangkok citizen generates 1.6 kg of waste daily, putting Bangkok on a level with Tokyo. The reason is presumably that Bangkok residents declined to give up their mass-consumption, mass-disposal lifestyle once they had achieved it.

Bangkok Metropolitan Sanitation Department reports that the weight-based breakdown of unseparated wastes collected is 33% kitchen waste, 24% plastics, 12% paper, and 3% glass. Based on a document titled "Density of Municipal Solid Waste in Bangkok" obtained from the Pollution Control Department the substance composition of MSW was estimated to be 10% kitchen waste, 34.1% plastics, 12.3% paper, and 46.4% container and packaging waste (plastic and paper). Statistically one must take care to note that these densities were measured at the dumpsites because they do not include the PET bottles, glass bottles, paper, and other recyclables that are recovered before or at the time of collection, meaning that their actual percentages are higher. In consideration of this fact, Bangkok's MSW by composition is actually like that of developed countries, not developing countries (from the aspect of the material cycle).

Bangkok has 2,400 trucks for waste collection, but at the time of a study 89% of the fleet (2,141 vehicles) was running due to maintenance and other reasons. Trucks formerly collected during business hours, but they now make

the rounds from 6 : 00 p.m. to early morning to avoid Bangkok's well-known traffic congestion. The collection rate has attained about 100% in the city's central areas, but collection efficiency is poor due to the many dead-end streets, making each collector's productivity 947 kg per day. By contrast, sanitation workers in Tokyo's 23 wards each collect 1,429 kg per day.

Dead ends are not the only reason for low collection efficiency in Bangkok. To earn extra cash, sanitation workers remove recyclable items of value from trash as they work, which tends to shorten actual working hours at each waste station.

Collected MSW is temporarily gathered at transfer facilities where it is sorted by hand, and then it is landfilled at final disposal sites by BMA-authorized waste management companies. People living near these dumpsites frequently complain about the odor, but apparently this has not been alleviated. This information is part of research performed by Mr. So Sasaki.[35)]

He summarizes as follows;

- Bangkok's MSW is of the "developed country" type in terms of both quality and quantity.
- MSW management faces the problems expected in developing countries.
- Administrative costs account for much of MSW management costs, which points to administrative inefficiency. Hence efficiency would likely not improve even if collection and disposal were privatized.
- Although collection fees are levied, the fees do not induce waste volume reduction as is argued in Japan (Fig. 1.9 (A)).

For these reasons Bangkok must provide its citizens with incentives to separate and reduce waste volume by raising the fees for trash collection and processing, while at the same time paying its sanitation workers better and incorporating waste scavengers and other actors of the informal waste disposal sector into the formal waste processing sector. In fact, from the beginning of 2004 the fee was raised a maximum ten-fold from the present 4 baht per month for 20 liters to 40 baht. It is possible that, for Bangkok society as a whole, this will heighten the ability of its MSW management regime to cope with environmental problems. It is also necessary to prepare and implement a program to get the citizens to participate in separation and collection, and to raise their consciousness (Fig. 1.9 (B)). In this regard Thailand is one country that is closely watching Japan's neighborhood resource recovery system.

Are Fees the Decisive Means for Waste Volume Reduction?

Let's attempt a regime/actor analysis to examine the effectiveness of fee-based systems, which are in the spotlight as a decisive means of waste volume reduction. Fee-based systems use a wide variety of means, but generally they require that trash be put in designated bags (with a price of perhaps 60 yen each), or that special stickers be affixed before setting trash out for collection.

Date City in Hokkaido, which introduced designated bags in 1988, is a

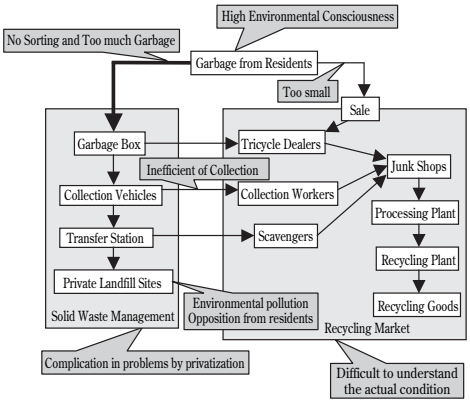


Figure 1. 9 (A) Waste management in Bangkok

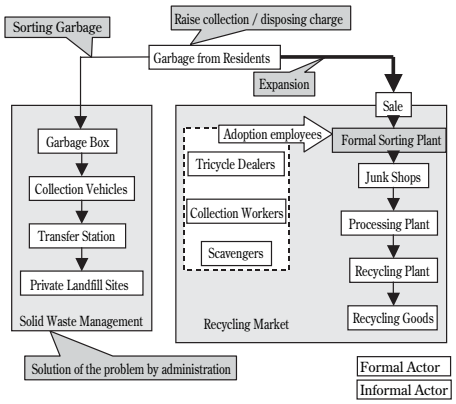


Figure 1. 9 (B) Measures to improve Bangkok's waste management

prominent example because it achieved a volume reduction of about 30%. I have been to Date to conduct interviews. The city originally started charging a fee not so much to reduce waste as to pay the operating costs for its incineration facility. Date has little snowfall by Hokkaido standards, and many of its homes have only one story. The city's initiative also led to waste volume reduction because at the same time as implementing the fee, administrative authorities offered subsidies for kitchen waste composting, residential waste incinerators, and other means of waste volume reduction. However, residential incinerators were later phased out owing to concerns about dioxin.

The Environment Ministry puts the percentages of municipalities charging fees in some way at about 72% for household waste (excluding bulky waste) and about 87% for business waste (excluding bulky waste).[36] According to the Japan Waste Management Association (JWMA), most municipalities have achieved waste volume reduction of 10 to 30% a year after launching fee-based programs. But some municipalities do not sustain their reductions, or after a while actually end up generating more waste.[37] A recent JWMA study[38] found that when a municipality is generating an especially large waste volume at the time it launches a fee-based system, it is especially effective at reducing waste. Meanwhile, some municipalities are achieving waste reduction even without charging fees.

This makes it important to find what conditions must be present for fee-based programs to bring about reduction. Generally environmental economists tend to think that environmental taxes and certain other environmental instruments are important, and emphasize their environmental efficacy, which may be seen as "instrumentalism." Regime/actor methodology holds that one cannot see the big picture without considering not only economic incentives, but also combinations of diverse policy instruments, linkages with strategic plans, policy styles such as encouraging dialog, and mutual relationships among actors.[39]

Policy instruments include economic incentives, instrument diversity,

strategic orientation, support for technical innovation, and cooperation orientation. Waste reduction needs consideration of the relationships with the possibility of obtaining reduction instruments, recyclable waste recovery regimes, how the Container and Packaging Waste Recycling Law is being implemented, fees for bulky waste, and fees for business waste. For example, the research of late Professor Nobutoshi Tanaka (Hokkaido University)[40] and others on the relationship between business waste and the possibility of obtaining reduction instruments found that the biggest factor behind changes engendered by fees in the waste stream was the reduction, at an average of 50%, of business waste that is mixed into other waste, followed by suppressing waste generation at 21%, home composting of kitchen waste at 16%, and home incineration of paper waste at 7%.

Policy style includes, but is not limited to, dialog, calculation possibilities, motivation, flexibility, management orientation, and policy integration. Important for policy style are: sufficient dialog and information disclosure among citizens and between citizens and administrative authorities, compatibility and integration with other waste volume reduction instruments, and good planning. For example, the research[41] of Professor Hajime Yamakawa (Kyoto Prefectural University) and Professor Kazuhiro Ueta (Kyoto University) found that the relationship between fees and waste reduction efforts is not a simple matter of people reducing waste because of the expense incurred through fees; rather, fees prompt people to take more interest in waste and environmental issues, and that in turn motivates them to make waste reduction efforts.

Some of the mutual relationships among actors are networks of regulating authorities, networks of regulated parties, networks of regulating authorities and regulated parties, and the influence of stakeholders. When instituting fee-based systems it is essential to have cooperation and coordination involving the national and prefectural governments and municipalities, especially between adjacent areas, sufficient dialog and information disclosure between citizens and administrative authorities, and the cooperation of local businesses and waste management contractors.

If one merely quantitatively investigates the level of fees and the extent of waste reduction without analyzing these factors above in detail, meaningful results will be unobtainable (one recent econometric analysis[42] of fee-based systems covering 3,230 municipalities throughout Japan found that the fewer the number of household members and items to be sorted, and the higher the population density, the less effective charging fees is at reducing waste).

From the perspective of public policy, the problems that need consideration when instituting fee-based systems are: (1)regressive rates for low-income citizens, (2)illegal dumping, and (3)double taxation.

One means of regressive rates for low-income citizens is providing them with a certain number of designated trash bags at no charge, but other matters that must be taken into account are that because of old age, and in Hokkaido because of other factors such as heavy snowfall, an increasing number of households (such as in Otaru City) find it difficult even to put out the trash.

Results of studies indicate that, among other things, illegal dumping was

already a problem in nearly all municipalities that suffer from illegal dumping since launching fee-based systems, and that municipalities which change their sorting procedures when instituting fee-based systems are prone to illegal dumping.[43] This means that illegal dumping and fee-based systems must be examined in connection with other policy instruments.

If the purpose of charging fees is not to raise waste management funds, then in relation to double taxation municipalities must consider: maintaining revenue neutrality, charging extra for excess amounts, making the fee an object tax, putting collected fees into a fund for waste reduction and other purposes, and using collected fees to fund measures for promoting recycling.[44]

Summation of Regime / Actor Analysis

With its Basic Environment Law and its suite of recycling laws, Japan has embarked on the journey toward a cyclical society, but it must still find what parts of its regime need fixing. The regime/actor concept is the analysis tool which determines that.

Necessary to begin with are three preconditions: awareness, a political system, and an economic and technology analysis. Historically, Japan has tried to solve environmental problems mainly with economic and technological means.

From the regime perspective, one notices that Japan's domestic regime is heavily influenced by the international regime, which is because Japan imports high percentages of energy and resources, and exports many manufactured products and wastes. But although Japan has a domestic regime, its laws are not consistent enough and in some ways contradict one another. For example, while the Basic Environment Law calls for generating less waste, incinerators are encouraged with subsidies to operate around the clock to hold down dioxins, which in fact invites the continued generation of solid wastes. Further, vested interests and other factors make it difficult to incorporate systems having concrete provisions that guarantee lower waste generation.

It is important to study under what conditions fee-based waste management systems will reduce waste. The methodology of regime/actor analysis points to the need for examining not only economic incentives, but also policy styles such as combinations of diverse policy instruments, linking with strategic plans, and a dialog orientation, as well as the mutual relationships among actors.

Wastes involve many different kinds of actors, which are different depending on the type of waste. For each type of waste, let's explore what kind of regime will get actors actively involved and make actor networks function effectively.

Chapter 2 Basic Challenges Faced by the Cyclical Society

1 The Cyclical Society and Wastes

What Are Wastes?

Let's start with the question of what wastes are, to clarify the matter before starting discussion of the cyclical society. Every living thing must die, humans included. But what about modern civilization? Years ago during Japan's rapid-growth period the environmental scholar Professor Tomitaro Sueishi gazed down on the Osaka-Kyoto-Kobe region from an aircraft and intuitively observed, "This is all waste." He proposed that we see the world through "waste-colored glasses."[1] Twenty years later the Kobe earthquake made his observation come true. City buildings and the commodity lining supermarket shelves all have a limited lifetime and inevitably end up as trash.

In addressing the question of what wastes are, it is important to be aware of the dual nature of commodity. It is not enough to see wastes as being defined only in terms of value as commodity, i.e., wastes are things that no one will pay for. One must also see them in terms of commodity utility value (usefulness), i.e., they must be disposed or processed when they are no longer useful, which is defining them in terms of what they really are. In this way we can prevent the subterfuge that something is not waste if people will pay money for it.

Commodity having no utility value is valueless, but on the other hand some things have no exchange value, or have minus value, even if they have utility value. A typical example is that until a few years ago one had to pay recyclers to take post-consumer paper and other recyclables. Hence even though used paper has utility value, it has a negative value when there is an oversupply because when recovery, transport, and processing costs are subtracted from its value as papermaking feedstock, a business takes a loss. In that case, one must pay to have the paper accepted (owing to rapid economic growth in China, recent fierce competition to get used paper is known there as "voracious eating"[2]).

Recently excellent research on waste economics has been published from the standpoint of modern economics, and that research casts doubt on the neoclassical assumption of free disposal.[3] There is a need for theoretical work on disposal cost.

When wastes have value, new utility value is "discovered" in things that were formerly discarded, which endows them with value as commodity. For example, Japan's postwar petrochemical complexes recovered byproducts that until then had been discarded, and used them as feedstock for plastics which were then sold.

Here is a good place to discuss market value conditions for recycling in

connection with the value of wastes. It is necessary that the price of commodity made with recycled materials be lower than that of commodity made with virgin materials, and that the price difference be maintained for a certain length of time. But in reality the price of recycled materials is influenced by the trend in virgin material prices, which are affected by fluctuations in foreign exchange rates and do not include externalities such as environmental damage by resource extraction. Further, coal and other resources are sometimes subsidized. Therefore virgin materials tend to be price-competitive with recycled materials.[4] Recycled material prices are also affected by the cost of landfilling wastes instead of recycling them. It is essential, after having first achieved a basic awareness in terms of utility value and price, to perform concrete analyses on raw materials and the generation of wastes, and on economizing the use of constant capital, and analyses in terms of reproduction and industrial structure.

Here is what I mean by raw materials and the generation of wastes and, economizing the use of constant capital. Business strategist Professor Michael Porter advances what is called the "Porter hypothesis,"[5] which states that companies which generate wastes are being wasteful, and that if strict environmental regulations spur reviews of their current production processes, they will be able to eliminate wastefulness while complying with environmental regulations; in brief, strict environmental regulations make companies more competitive. Raw materials do not all become products because in the manufacturing process some become wastes or suffer other fates. The rate at which they become products is called yield. Accordingly, reducing waste also raises yield and economizes raw materials. This usually requires new investment in plant and equipment.

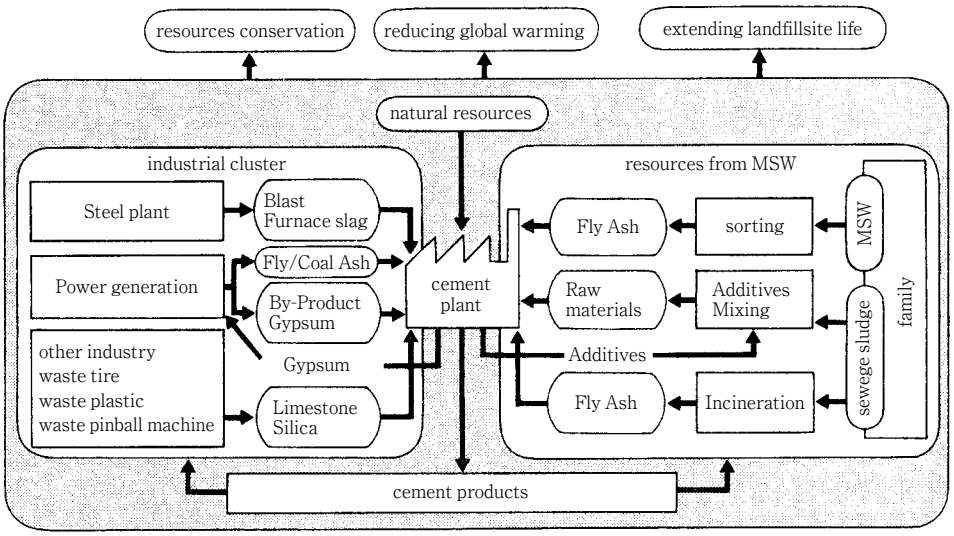
Specifically, a company will compare the capital that would have been spent on the raw materials saved with the capital required for new investments, based on the strictness of environmental regulations. In doing so it will develop new technologies on which it can obtain patents, and it can expect the spillover effect of raising its estimation with the public, and in some cases increased demand. The paper and pulp industry, for example, improved its black liquor (the lignin that does not serve as fiber for paper) recovery rate, which improved the water quality of its effluent, and extracted energy from the extra recovered lignin in its boilers. Here is an example in which better effluent treatment (decreased environmental burden) resulted in cost cutting.

Reproduction and industrial structure mean, for example, that materials industries such as paper/pulp, cement, steel, and nonferrous metal refining, which were typical of the smokestack industries, are now making a reappearance as the core practitioners of waste reuse (Tab. 2.1). The paper/pulp industry's acceptance of waste paper (its use of waste paper is about 50%), the steel industry's use of waste plastic as blast furnace reducing agents, the recovery of metals from automobile shredder dust by nonferrous metal refiners, and the use of wastes as cement feedstock (about 350 kg per ton of cement) came to a total of 34.2 million tons in 2001 (Fig. 2.1). Because that amount equals 70% of Japan's total municipal solid waste,[6] it means the materials industries play

industry	Paper/pulp	Iron/steel	nonferrous	cement	total
Use in 2001(A) 10000 ton	583	19	12	2806	3420
Potential use(B) 10000 ton	659	664	60	3164	4547
Future use(B-A) 10000 ton	76	645	48	358	1127
Economic effect Billion yen	136.1	10.1	3.0	161.5	310.7
Potential economic effect	147.1	332.6	15.0	233.1	727.8

Source JBD:2003.

Table 2. 1 Use and economic scale of recycled feedstock in four material industries



Source : Taiheiyo Cement Environmental Report, 2000.

Figure 2. 1 Use of waste by the cement industry

a central role as recycling industries.

Several characteristics emerge when the materials industries are seen in this role as leading recyclers. Among them are: (1)They can process large quantities, (2)they can use their existing business resources, including distribution systems, heat treatment processes and other facilities, and their expertise in managing hazardous substances, and (3) they can use wastes as fuels in their own processes, leaving few problems in assuring the marketability of recycled goods.

The economy for recycled goods (used goods being reused, the recycling and repair of end-of-life goods) is estimated at 50 trillion yen annually, which is about 10%of the GDP.[7] This indicates that the cyclical economy is in the processes of forming and expanding.

Waste Processing Costs

Waste processing involves eliminating or reducing the environmental burden of wastes to prevent that burden from causing loss to society. And when so-

cial losses have already occurred, it includes mitigating and remediating them. Thus in a broad sense, the costs incurred in waste processing are, with respect to production, the costs incurred in consumption. Recycling likewise should be assessed not only from the perspective of conserving and economizing resources, but also from that of preventing the social loss known as environmental damage. To consider only the former perspective is to discount the energy and environmental burdens entailed in the recycling process.[8] The reasons that wastes are of economic importance are processing costs and the impacts on health and the environmental arising from improper handling.[9]

As a specific example let's consider nuclear power plants, which are in the spotlight as a way to reduce CO_2 emissions. At issue in Japan are:

(1) Disposal of radioactive wastes
(2) Dismantling of decommissioned reactors and plants
(3) Back-end costs of nuclear fuel reprocessing and recycling

In its first long-term calculations (2002-2003), the Federation of Electric Power Companies found that these costs will amount to about 30 trillion yen nationwide by 2045. Nuclear fuel reprocessing and recycling alone will cost about 19 trillion yen.

There are low-and high-level radioactive wastes. The latter kind is governed by the Law on the Final Disposal of Specified Radioactive Wastes (2000), which assumes their disposal as glass logs in stable geologic formations, but the disposal cost of high-level glass logs is estimated to be about 3 trillion yen. A model project for dismantling decommissioned reactors and nuclear stations estimated the cost of dismantling at about 200 billion yen per unit. For spent fuel reprocessing the initially anticipated cost ballooned to an estimated 10 trillion yen.

Nuclear power was supposed to be cheap, but it is not necessarily so when waste disposal costs are included.

Industrial Waste Disposal

Wastes that are explosive, toxic, infectious, or otherwise will by nature damage human health or the living environment are designated "specially managed wastes," and disposed by contractors with special permits.

To see how these specially managed wastes are disposed, let's take a look at the industrial waste treatment plant in Tomakomai City, Hokkaido. This facility performs the incineration, shredding, and neutralization of five kinds of specially managed industrial wastes (hazardous waste,sludge, waste oil, waste acids, waste alkalis, and infectious wastes) and ordinary industrial wastes (cinders, waste plastics, waste rubber, dust, etc.). The plant's centerpiece is a 50-meter rotary kiln incinerator that is 4.7 meters in diameter. Using heavy oil, waste oil, and waste plastics as fuel, it burns at a temperature of at least 850℃. Exhaust from the kiln goes to a secondary combustion system and a quenching tower, which reduce dioxins in the exhaust to the absolute minimum. Ashes and cinders are recycled as raw material for cement.

Of primary importance is the technology for properly mixing the various wastes. It is therefore crucial to determine beforehand the compositions, hazards, heat value, and other properties of wastes. Exhaust and effluent emitted by the plant are properly treated by exhaust scrubbers and effluent treatment facilities so that they satisfy legal regulations.

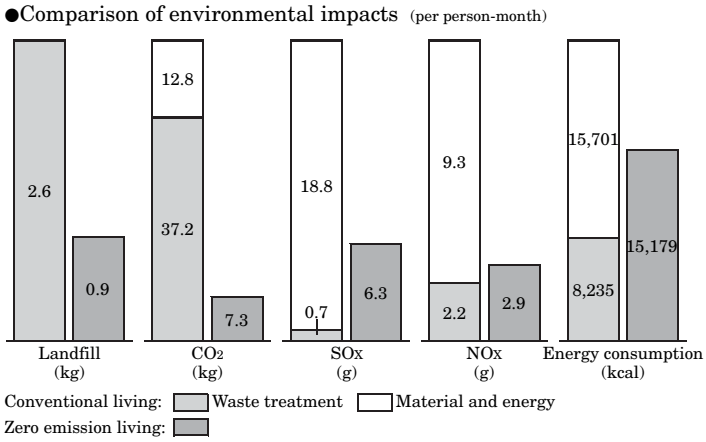
This plant originally made iron pellets and sulfuric acid from pyrites, but after becoming uncompetitive it switched to the waste processing business and used its equipment for that purpose. Recently it has been recycling electronic office equipment. Circuit boards and other components are calcinated and shredded, then sent to the Saganoseki Smelting Plant in Oita Prefecture, where gold, silver, platinum, and copper are recovered. Here is a typical example of how materials industries have switched to the waste treatment and recycling industries and now play a sustaining role in waste reuse.

2 Reduce, Reuse, and Recycle

Is "Zero Emissions" Really Environmentally Friendly?

If a factory emitted no wastes whatsoever, we would not have wastes to deal with. For that reason more and more companies are trying to help achieve the cyclical society by working on zero emissions, meaning that all wastes are recycled. But is this really environmentally friendly? To put this to the test, the Sekisui Chemical Co., Ltd.'s zero-emission community development project performed joint research with the University of Tokyo Institute of Industrial Science, using the LCA method to compare the conventional lifestyle that depends on the incineration and landfilling of wastes with the zero-emission lifestyle that completely sorts and recycles[10] (Fig. 2.2).

In sum, the zero-emission lifestyle is able to substantially reduce landfilled amounts and CO_2 emissions, and in terms of energy consumption and other attributes, the research found that it can considerably reduce environmental burdens in consideration of the extra materials and energy needed if



Source : Sekisui Chemical, 2002.[10]

Figure 2. 2 Conventional and zero-emission lifestyles compared

wastes are not reused. An especially important difference is that the conventional lifestyle requires extra materials and energy to make paper, cement, fuel, and other items.

Reduction

The Recycling Society Law sets this order of priority for wastes: (1)Reduction, (2)reuse, (3)recycling, (4)heat recovery, and (5)appropriate disposal. Let's examine each in turn.

Reduction means holding down the very generation of wastes, which is achieved by innovation and improvement of production methods. An example is Canon's adoption of the cell production system, which abandons the conventional conveyor belt-based mass production system, and instead has products made to completion by small groups or individuals. This reduces the needed amount of production space, the automatic warehousing of parts, and the use of conveyor belts, in turn allowing reductions in space conditioning energy and electricity for motive power. In three years these production innovations achieved a CO_2 emission reduction equivalent to 7% of the Canon Group's emissions in 2001.[11] Here is an example of how production innovations lower environmental burdens by reducing emissions.

Reuse

Reuse means that products which are broken or old are repaired and used again instead of being manufactured over again, which saves resources and energy. For example, residential electric meters have a fixed usage period and are replaced after that period has elapsed. To make effective use of the materials, those meters are inspected, repaired, and reused. Gas turbine generators taken out of use in Japan are reused in the US.[12]

Recycling

Recycling means remanufacturing a used product and then reusing it. Although remanufacturing needs additional resources and energy, the additional inputs are less than those required to make totally new products. Some products become the same thing again, like aluminum cans, while in other cases they become different products. An example of the former would be train tickets, almost all of which have an iron powder backing so they can be read by automatic ticket readers. Fortunately, there is a now technology to separate paper fiber from the iron powder, allowing these tickets to be recycled.

The East Japan Railway Company (JR East) sends the used tickets recovered at stations and other facilities to paper mills. In 2002, 99.9% of approximately 760 tons of used tickets were reused as bathroom tissue, cardboard, and business cards at Yamanote Line stations and other company facilities. JR East is also reducing the use of paper tickets. Its IC card "Suica," which was introduced in 2001, allows rewriting of the information printed on the card. Passengers are therefore able to use the same card repeatedly when renewing commuter passes.[13]

Box 4 Is recycling post-consumer paper really environmentally friendly?

Recycling is important for reducing our environmental burden, and the government has started setting national recycling rate targets. But recycling also causes pollution and other problems, giving rise to the argument that we should not recycle. To comprehensively examine the environmental burden induced by recycling, research[14] is being conducted to analyze the environmental burden of post-consumer paper recycling, using the input-output tables developed in economics.

Paper recycling is meaningful because it prevents the depletion of forest resources, but transporting the recovered waste paper costs money and generates CO_2. And although recycling conserves pulp, it makes for less black liquor (a byproduct of pulp production), which is used as fuel. Compensating for that loss requires more fossil fuels. The effects of paper recycling are quite complex, but they can be analyzed using input-output tables. Following is a rundown of the results.

(1) A simulation that changed the ratios of virgin pulp and waste paper pulp used as inputs in papermaking (technically, it is possible to use up to 85% waste paper) showed that while recycling paper is effective in reducing overall CO_2 emissions, it reduces CO_2 from black liquor, wood waste, and other biomass, but increases CO_2 emissions from fossil fuels. In other words, the more you recycle, the more fossil fuels are consumed, and the more CO_2 is emitted from their combustion.

(2) A simulation that changed the energy consumed in transporting a ton of waste paper found that when the per-ton consumption exceeded 725 megacalories, it was larger than the CO_2 emissions of the base case. This corresponds to a round-trip distance of 360 km by truck.

Because more CO_2 is absorbed if trees that have attained a certain age are logged and the area replanted, some people propose a broad recycling system that includes afforestation and waste-to-energy power production, in which logged trees are used to make paper, and paper trash is recovered and burned for power production to reduce the amount of paper waste taking up insufficient landfill space. This should be seen as an example in which recycling does not necessarily reduce the environmental burden. At the same time, incineration leaves about 15% as residue that is landfilled. If paper is recycled, good use can be made of the residue, and final disposal sites will last longer. As this analysis shows, the best way to diminish the environmental burden is to decrease the very use of paper.

An environmental report[15] by the Oji Paper Co., Ltd. says that Japan's waste paper utilization rate is 58% nationally, and that the Oji Group's rate is 59%. An LCA of paper products showed that at the manufacturing stage CO_2 emissions are small for high-quality paper and other products that use much wood pulp, and that emissions are relatively high for newsprint and other products that use waste paper (Fig. 2.3). This indicates that using much waste paper increases CO_2 emissions.

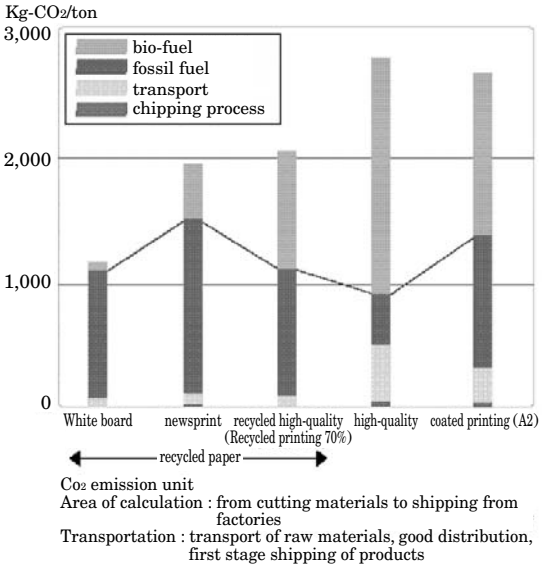


Figure 2. 3 Lifecycle assessment of paper products

Cyclical Production of the "Utsurundesu" Camera

At one time the "Utsurundesu" camera made by Fuji Photo Film Co., Ltd. was criticized for being disposable, but now it is a typical example of product reuse and recycling. Cyclical production of this disposable camera, which had been developed in 1986,became possible in 1990 because it was sure to be recovered after use for developing the film. These cameras are dismantled upon their return to the factory, and remade with two kinds of parts (1)parts that are cleaned, inspected, and reused, and (2)recycled parts made by remolding shredded plastic. The camera's environmental burden has lessened thanks to: a reduction in material use by making it smaller and lighter, reuse through unitized and common parts, and improvements in the manufacturing process (such as how bodies are molded).

Front covers and other parts that cannot be reused were formerly shredded and pelletized, then molded, but to eliminate the environmental burden of pelletization, Fuji Film developed a method to directly mold parts from shredded plastic.

In 1998 the company started operating a cyclical automated factory that implements the idea of inverse manufacturing. Instead of stopping at just using resources over again, this factory has a totally automated line which, to ensure the quality of the Utsurundesu, does everything from sorting to dismantling, inspection, and manufacturing.[16)]

Extended Producer Responsibility

The acts of production and consumption generate municipal solid wastes and industrial process wastes, and sooner or later when a product comes to the end of its life, it too becomes waste. From the perspective of public health, production/consumption wastes in Japan initially came under the purview of the

Sewage Sanitation Law (1900), then the Public Cleansing Law (1954), and finally the Wastes Disposal and Public Cleansing Law (1970). Consumer end-of-life product wastes include packaging/containers and household appliances, which were originally part of the things that consumers purchased as products from manufacturers, and which entail special costs and difficulties for disposal by consumers themselves and by municipalities. In other words, these "product wastes" are industrial products by manufacturers, they present consumers and municipalities with disposal difficulties, and although they are wastes generated by consumers, they are differentiated from kitchen and paper wastes in terms of the material cycle.

Since the 1990s a system in which the manufacturers of these product wastes take the responsibility for their recovery and disposal has been broadening in Germany and the Nordic countries, and discussion on this by the OECD resulted in extended producer responsibility (EPR), which was incorporated into Japan's Cyclical Society Law.

EPR means that responsibility for the management of products after consumption is imposed on manufacturers and sellers. The OECD guidance manual includes both the responsibility for recovery and recycling, and the financial responsibility in EPR. Thus, this principle expands producer responsibility to cover not just manufacturing itself, but pre-manufacturing design for environment, and post-manufacturing recovery/recycling.

The rationale is that because producers and other business have the most capability and information on making environmentally friendly products, if they are made to pay these costs, then businesses which make the more easily recycled products can offer products for lower prices and can make environmentally friendly products. Scholars of environmental law see this as similar to the OECD's polluter pays principle (PPP), which requires that companies take responsibility for their own pollution.[17)]

But others argue that EPR and PPP are different. They distinguish the "responsibility" of EPR from payment of costs, and claim that while companies are responsible for everything up to appropriate disposal and recycling, the payment of costs is determined separately on the basis of the market mechanism.[18)] Indeed, even though PPP may superficially make it look as though companies are paying the cost of their pollution, that cost is actually added to product prices and ultimately paid by consumers. It is therefore necessary to discuss this issue by distinguishing between the responsibility for recovery and recycling, and the payment-of-costs issue.

Although ownership and the right of use for a product are transferred to the consumer after purchase, the manufacturer still shoulders a certain responsibility. In this respect EPR in some ways resembles lease agreements (in which ownership is not transferred). As such, some point out that types of cost and risk apportionment in lease agreements offer clues for determining the producer's responsibility for product recovery and recycling under EPR.[19)]

The Cyclical Society Law has four provisions pertaining to EPR : keeping raw materials from becoming wastes (Article 11.1), making improvements in labeling and design (Article 11.2), measures for takeback and recycling (Article

11.3), and using recyclable resources (Article 11.4). Especially regarding take-back and recycling measures, the following are to be taken into account (Article 18.3): (1) Those which require apportionment among the appropriate actors, the national government, local governments, businesses, and the public (municipalities cannot assume all the roles), (2) those for which the role of businesses is deemed important from perspectives including design, choosing raw materials, and the collection of recyclables (the sales process is used for recovery), (3) technological difficulties in disposing of recyclables (whether they are wastes for which appropriate treatment is impossible), and (4) the possibilities for cyclical use.[20)]

I will specifically examine in the following chapters how these have or have not assumed concrete form in the Container and Packaging Waste Recycling Law, the Home Electrical Appliance Recycling Law, and other laws. One immediately notices that, for example, the provisions of (2) above are not incorporated into the Container and Packaging Waste Recycling Law.

3 Is Just Burning Wastes Enough?

Dioxin and Incinerators

One can't avoid the trash incineration issue in a consideration of the cyclical society. Japan incinerates about 70% of its municipal solid waste (MSW). In response to the observation that MSW incinerators (which are owned by municipalities and a few administrative associations) are a primary source of atmospheric dioxins, the former Ministry of Health and Welfare established the "New Guidelines (Guidelines on Preventing the Formation of Dioxins)" in January 1997. These guidelines were the basis for taking emergency and permanent measures.

Emergency measures required that within one year (by the end of November 1998) incinerators would have to suspend operation or be decommissioned unless they reduced the dioxin concentration of emissions to under 80ng-TEQ/Nm^3.

Permanent measures provided that within five years (by the end of November 2002) emission concentrations from waste incinerators had to be reduced below 0.1 to 5.0ng-TEQ/Nm^3 depending on the incinerator type and whether a facility is new or existing.

In particular, achieving the permanent measures required that a facility operate continuously around the clock at high temperature, and that it process at least 100 tons per day. For that reason the government decided to pursue wide-area regional waste disposal that would make continuous operation possible by shutting down some small and medium-sized incinerators and combining their processing loads.[21)]

Here is an example of Japan's technofix solutions to environmental problems: the government dealt with growing waste volume by building more incinerators, which in turn produced more dioxins that necessitated the use of large continuously operating incinerators.

Below are four problems with the wide-area disposal plan and affiliated

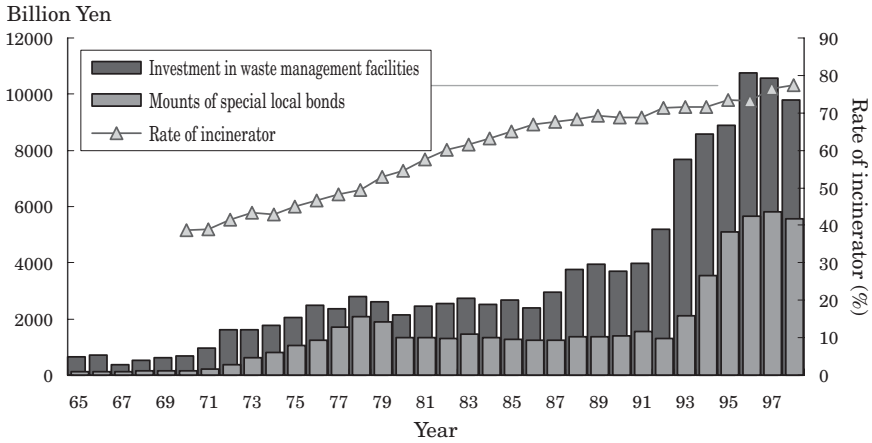
plans formulated under the 1997 New Guidelines.[22]

First is the technical information asymmetry between the incinerator plant makers, which are the technology development actors, and municipalities, which are the actors that implement waste disposal technologies. This could be called the inter-actor asymmetry of information, a situation that prevents fair transactions because one party has enough information while the other does not (see Box 12). In the case of incinerators, this is the reason why municipal officials are dependent on plant makers' technical information, and therefore are at their mercy. There are few small and medium incinerators because technical information is slanted toward large facilities. About 30 companies are in competition over new incinerator types especially in demand owing to the dioxin issue, which is behind the collusive and fraudulent bidding by companies, and the lobbying and intervention by politicians. Further, doubts have been expressed about the technological immaturity of melting furnaces with respect to construction delays, added measures, the use of slag, and other matters.

Second, the government has instituted BAT (Best Available Technology) based subsidies as a fiscal measure, which in effect promotes mainly large incinerators. This problem comprises the hierarchy of administrative actors (national and local), and the technology based subsidy regime. Although it is possible for environmental administrators to set only the environmental quality standards to be met and allow those directly responsible to chose their methods, the specifying of certain technologies restricts even those methods by using subsidies.

Government subsidies in effect favor large continuously operating melting furnaces as the ultimate solution for dioxins,[23] but even if municipalities manage to receive government subsidies and tax grants, they must still shoulder huge financial burdens to finance the remainder. In addition to higher equipment costs, the new incinerator types cost more than the old because running costs increase due to less electricity sold and higher costs for heavy oil and other fuels, and slaked lime for bag filters (Fig. 2.4[24]). A case in point is Sapporo. At first this city did not plan on building an ash melting facility, but it was subsequently added under the 1997 New Guidelines, and the city paid about ¥10 billion of the total ¥57 billion, but the facility has yet to achieve stable operation. The new incinerator alone is enough to meet dioxin emission standards. In view of this situation, the Japan Waste Management Association has especially asked the Environment Ministry to ease the requirements for granting government subsidies to consider local circumstances so that even municipalities that build incinerators but do not include melting and solidification will be eligible.[25]

A survey[26] by the *Asahi Shimbun*, a national newspaper, found that many of the new incinerators which municipalities built to cope with dioxins are too big (60%, or 111 municipalities, built larger facilities than before). By contrast, some municipalities dealt with dioxins by reducing their emissions with thorough waste separation, and doing their own remodeling of small incinerators (for example, Ohi Town in Saitama Prefecture).



Source : Yatsugi 2003.

Figure 2. 4 Investment in waste management facilities and amounts of special local bonds floated

What is more, little progress is being made in dismantling incinerators decommissioned or shut down owing to dioxin regulations, and many are simply abandoned. The government beefed up measures to prevent dioxin dispersion when dismantling, and it requires strict safety precautions by sealing facilities and wearing protective clothing. Hence the high cost effectively prevents cash-strapped municipalities from dismantling facilities, which get no financial help from the government. In Hokkaido, for example, 74 of 121 facilities have been decommissioned, but there is a dismantling plan for only one.[27)]

Third, there is no clear consistency between measures for reducing dioxin emissions and those for recycling. Under the Cyclical Society Law framework, the amount of waste recycled is supposed to grow because of the Container and Packaging Waste Recycling Law and the Home Electrical Appliance Recycling Law, and thus the amount of waste incinerated to fall, but the introduction of large continuous-operation incinerators could run counter to recycling. That is to say, it seems there is a contradiction in the government's waste policy regime. Further, government financial assistance should not conform to demand; instead it must be designed to show approval for municipalities' waste reduction efforts. Denmark, for example, has instituted a system that taxes municipalities according to the volume of wastes disposed, instead of granting subsidies for incinerators.

Fourth, there is not enough citizen participation in instituting wide-area waste disposal. This is a matter of coordination among actors. In spite of the exceeding importance of community members' participation and creativity in solving waste problems, the development of wide-area waste disposal plans is the province of prefectural governments, and wide-area administrative mechanisms do not sufficiently assure citizen participation. The plan itself is not moving forward because municipalities have yet to coordinate among themselves.[28)] In Hokkaido's case, the island has been divided into 24 wide-area blocks; six are slated to phase out incineration, while the rest will adopt wide-area incineration.

A cost-effectiveness analysis[29] on measures to curb incinerator dioxin emissions found that with the emergency measures the per capita per year cost of avoiding the loss of life expectancy is ¥7.9 million, but that with the permanent measures it is ¥150 million. The emission reduction cost of dioxin 1g is about 4 million yen with the emergency measures, 96 million yen with the permanent measures.[30] The assessment is that while the former is efficient, the latter is quite poor. It is said that if at the least the permanent measures for curbing dioxin emissions were somewhat delayed, and the funds earmarked for them used instead to mitigate emissions from diesel vehicles, risk could be quite efficiently reduced.[31]

Refuse-Derived Fuel

In response to the 1997 New Guidelines, the government encouraged wide-area waste disposal by taking advantage of the refuse-derived fuel (RDF) advantages of storageability and transportability, which brought about the construction of about 200 RDF-related facilities and 16 (including planned) power plants throughout the country. But as seen in the 2003 explosion at the RDF generating plant in Mie Prefecture's Tado Town, the use of RDF still involves problems of safety and economy. A Fire Defense Agency study found that accidents have occurred at about 50 facilities involving processes such as compacting, drying, and storage. RDF formation consumes much energy. At the same time, preexisting MSW generation has become more efficient, so that if wide-area waste disposal is the aim, this can be achieved to a certain extent with simple transport to transfer stations. More than anything else, encouraging material recycling is incompatible with turning combustibles into fuel. In the final analysis, this too is a matter of consistency between the regimes for waste reduction and incineration.

Summation

This is the heyday of recycling, but its evaluation in environmental terms is not easy. Generally recycling is used to include reuse, as in what are called "recycling shops," but in strict terms recycling is limited to recycling the materials in discarded items, which requires another energy input. Reuse, by contrast, needs no more energy. However, because continuing to use inefficient products will consume much energy, it is not always the case that reuse has the lower environmental burden. LCA is needed to assess this.

The term "waste" actually includes a wide variety of things that are divided roughly into human and livestock waste, and end-of-life products. Some of the former still have utility value and are used if certain economic conditions exist, such as high prices for virgin resources.

End-of-life industrial products are wastes that cannot be appropriately disposed and managed in the same way as municipal solid waste. Having manufacturers take responsibility for their disposal is the idea behind EPR, which would be an incentive for manufacturers to design products for disassembly. However, although EPR establishes the responsibility of businesses, fiscal responsibility is another matter. Hence there is as yet no decision on

whether prices will be internalized or added on.

Japan has invested heavily in controlling dioxin emissions from waste incinerators, but this should not be used as a means of cleaning up after the cyclical society. Changing the system into a regime that makes actors play a more positive role and assures they will reduce waste emissions has a great possibility of lowering both the fiscal burden and environmental burden. The next chapter's comparison of the container and packaging recycling regime with group material recovery will be of interest in that respect.

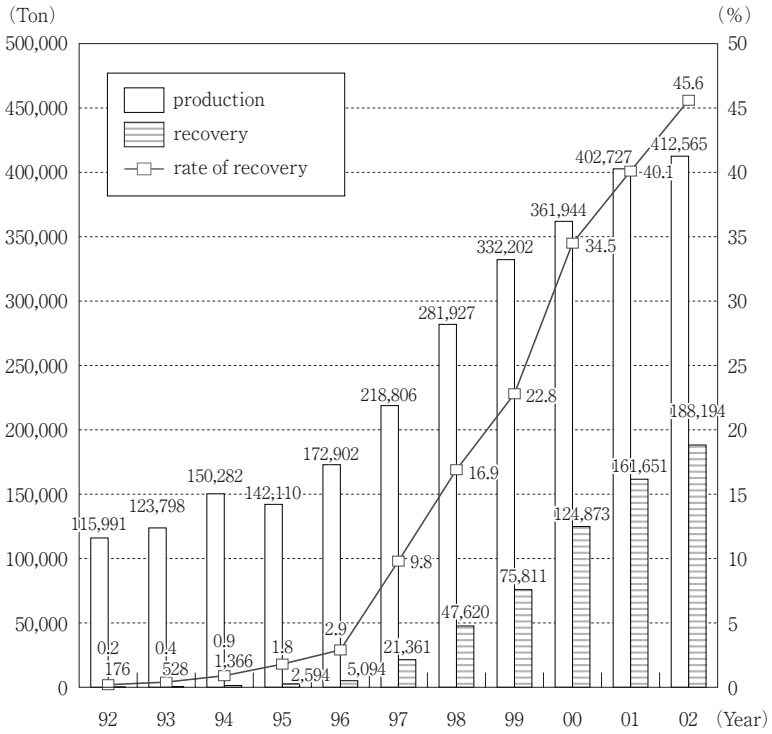
Chapter 3 Container and Packaging Recycling

1 Less Trash from Containers and Packaging?

Why More PET Bottles?

These days one often sees college students drinking tea or other beverages from PET bottles, even during lectures. Cell phones and PET bottles are now part of the everyday scene. And it is not only Japan, for I observed the same phenomenon when lecturing in China at Tsinghua University and Beijing University. In China pollution from plastic waste is known as "white pollution." As tap water is unsuitable for drinking in many Asian countries, consumption of beverages in PET bottles is rapidly increasing.[1)]

Because Japan's tap water is drinkable, the rising use of PET bottles in Japan (Fig. 3.1) is likely due to convenience: people can visually determine the quality and quantity of the contents, PET bottles are light, they can be carried around because they can be capped, they do not break if dropped, and they can be put in the freezer. Owing to increased PET bottle use, the Japanese are



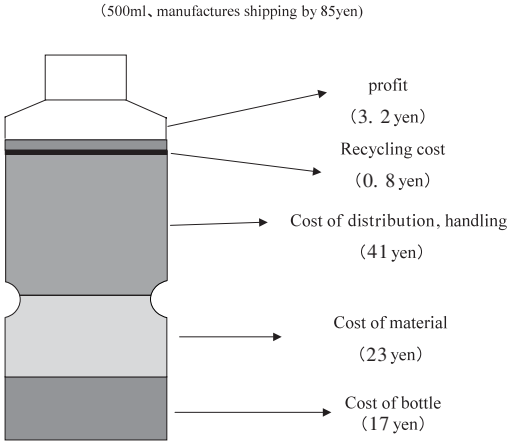
Source : PET Bottle Recycling Promotion Association.

Figure 3. 1 PET bottle production volume and recovery rate

consuming fewer beverages in glass bottles and cans. On the other hand, PET bottles have drawbacks that consumers are not conscious of.[2] For example, carbonation slowly leaks, partially consumed beverages are readily contaminated by bacteria, the bottles are bulky waste, and they are the most expensive containers. In terms of the material cycle, container and packaging waste comes mainly from the consumption of foods and beverages, and in addition to the traditional glass and steel containers, there are now plastic, PET (polyethylene terephthalate), and other materials. Such waste now accounts for half of municipal solid waste (MSW) by volume, and that makes collection and transport expensive.

Surprisingly, it is canned beverages that give manufacturers the highest profit margins. PET bottles cost between 20 and 40% more than aluminum cans, yet beverage makers are supplying more PET bottles in response to consumers' predilection for convenience. For that reason some beverage makers now cut costs by importing the PET flakes and setting up production lines that integrate bottle production and filling. Those who control the bottles also control the beverages.[3]

At one time beverage makers voluntarily refrained from using small PET bottles. However, because the imports and sales of mineral water in small PET bottles were on the rise, and because beverage companies anticipated that the Container and Packaging Waste Recycling Law would become effective in 1997, they abandoned their self-restraint, and that led to a sharp rise in PET bottle use. Since profits are lower than those from canned beverages, makers try to cover their losses with razor-thin margins and high turnover, leading to a further increase in PET bottles.[4] It is estimated that the price of a 500-ml PET bottle with beverage shipped to volume retailers is about ¥85, which includes about ¥17 for the bottle, and a recycling contracting fee of about 1% (¥0.8). These costs are certainly not cheap when considering the manufacturer's margin of ¥3.2 (Fig. 3.2).[5] Apparently PET bottles are used as containers in new product development, and only one in 1,000 new bever-



Source: Nikkei Shimbun, 2003.7.4.

Figure 3. 2 Cost of soft drinks in PET bottles

age products survives a year after being put on the market.[6)]

At the same time, calculations have found that PET bottle recycling has created about 20,000 jobs nationwide, induced about ¥60 billion in plant and equipment investment, and has created a recycled resin market of about ¥ 5 billion annually.[7)] The problem is: Who pays?

It is estimated that the actual cost of a 500-ml PET bottle is in the neighborhood of ¥17 or ¥18, so assuming that bottle collection cost is added to the product price, if collection costs, say, ¥200,000 per ton and each bottle weighs 30g, that comes to a mere ¥6 or so per bottle (this figure is about the same as that calculated using data from municipalities in Hokkaido's central region). Even if bottle cost is included, this comes to about ¥25 per bottle, which is approximately 17% of the ¥150 commodity price. Some municipalities are considering "PET bottle taxes" to deal with the situation. Tokyo's Higashi-Murayama City plans to make either the consumer or the vendor pay a tax of ¥20 per bottle, which would bring in ¥300 million in tax revenues annually to be used for reducing waste volume and recycling.[8)]

Box 5 International Comparison of Municipal Solid Waste

A comparative international study[9)] was performed on household waste content. In 1998 and 1999 it analyzed the constituents of household waste in several cities ranging in population between 100 and 300 thousand: Neyagawa City in Osaka Prefecture, Japan; Freiburg, Germany; Cambridge, UK; and Åarhus, Denmark.

Plastic packaging and containers discarded per capita per day amounted to 73g in Neyagawa, 54g in Cambridge, and 37g in both Freiburg and Åarhus.

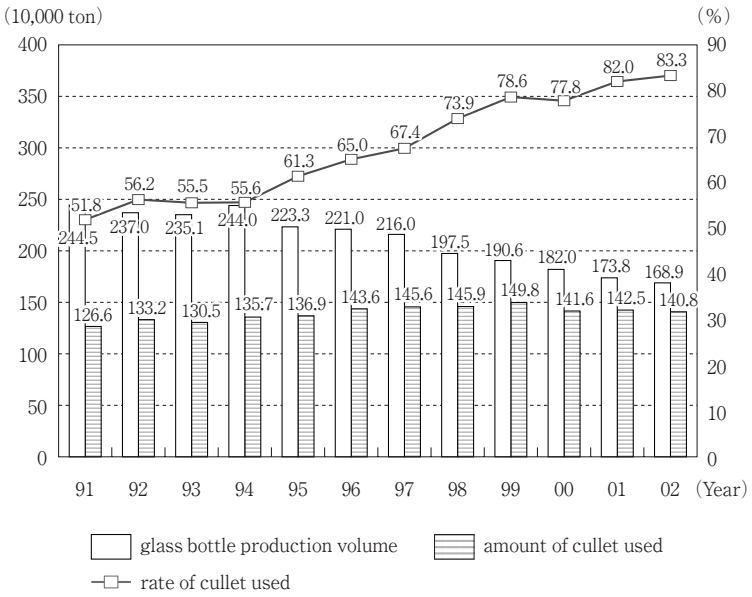
Glass bottles were 99g in Freiburg, 50g in Cambridge, 43g in Åarhus, and 17g in Neyagawa.

In all cities about 70% of household waste was food packaging. In particular, the reasons that the amount of plastic food packaging is large in Japan and small in Europe include the sale of fruit and vegetables by weight (no packaging), charging for plastic bags, and deposits on glass bottles. By contrast, in Japan much packaging of various kinds is used at each stage of sales and service. Another characteristic of Japan is the small regional differences in MSW content, which is easy to see from the uniformity of convenience stores and supermarkets throughout the country.

Glass Bottles

Glass bottle use has tended to decline since 1990 due to the increasingly widespread use of PET bottles, and even the use of returnables (beer, milk, and sake) has fallen to around 20% of the glass bottle total. Containers used in the beer industry as a whole are 60% cans and 20% bottles, with the bottle percentage falling rapidly (bottles accounted for 37% in 1996, but only 17% in 2003[10)]).

One-way bottles are crushed into cullet and used to make new bottles, but recently the use of cullet has leveled off owing to lower bottle demand. Available cullet is not being completely used (Fig. 3.3).



Source : Glass Bottle Recycle Promotion Association.

Figure 3. 3 Glass bottle production volume and amount of cullet used

Plastic Packaging and Containers

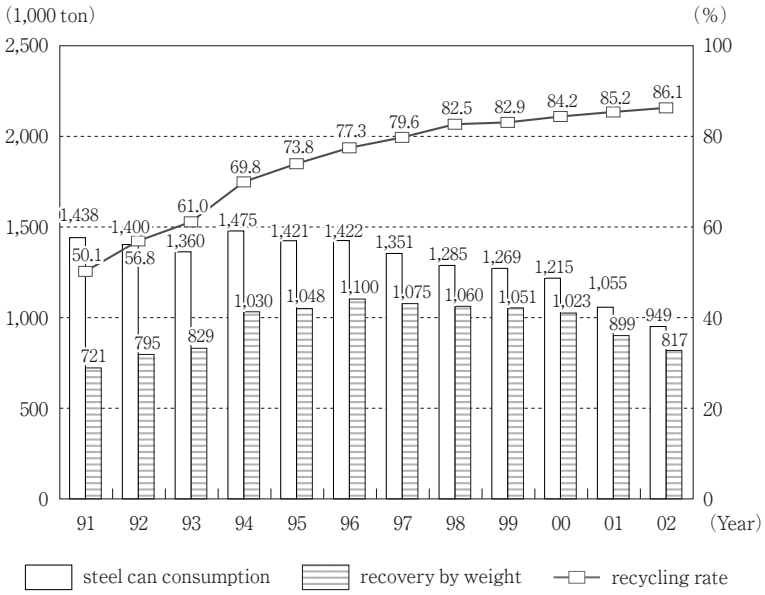
Over 40% of Japan's domestic plastic production is for trays and other packaging and containers, the largest single application. In 2000 plastics started being regulated under the Container and Packaging Waste Recycling Law, and municipalities started separating and collecting them. However, this saddles municipalities with a heavy burden because they must create systems for the purpose, and so far only about 40% of municipalities nationwide have implemented this part of the law.

Even the same types of plastic are not covered by the law if they are not packaging or containers, and it is hard to obtain citizen cooperation. If the program is to be continued, the government should consider including commercial plastics such as plastic eating utensils. Further, 2002 nationwide data on plastic recycling show that material recycling to reuse plastics as raw materials amounts to only 14%, the rest being used as fuel. This leads one to ask whether it is worth the trouble to separate and recover plastic packaging and containers from wastes.

Steel Cans

Consumption of steel cans, which are used as containers for foods and beverages, has tended to decline somewhat over the past decade, and currently stands at about 1 million tons annually. At the same time, resource recovery from cans collected for steel scrap rises year by year, hitting 85% in 2001 (Fig.3.4).

Considering steel and aluminum cans as an environmental issue brings up the matter of power consumed and scenery spoiled by Japan's beverage



Source : Steel Can Recycle Association.

Figure 3. 4 Steel can consumption and recovery by weight, and recycling rate

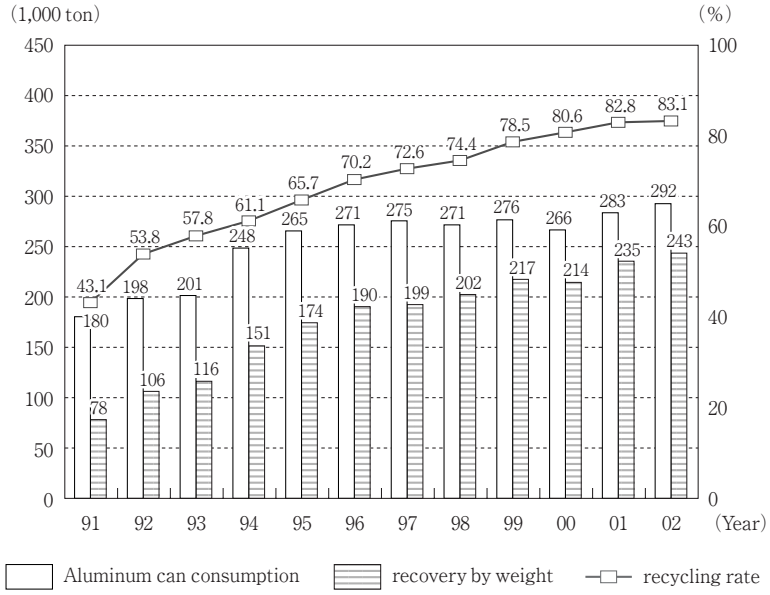
vending machines, which are said to number as many as 2.6 million. Because powering all Japan's vending machines (about 5.5 million, selling everything from beverages to cigarettes, food, and tickets) requires 1,000 MW, reducing the number of these machines is unavoidable if Japan is to meet its Kyoto Protocol CO_2 reduction target. This is why, for example, there is a proposal in Nagano Prefecture to halve the number of beverage vending machines.[11] Merely recycling the cans does not support claims of being environmentally friendly. The vending machine power consumption issue shows that the material cycle comprising the distribution and consumption of foods and beverages in containers is highly energy consumptive.

Thirty years ago Professor Tomitaro Sueishi observed, "Even though there were sometimes harmful canned beverages, the recycling of empty cans is justified on the basis of the heavy consumption of beverages in cans."[12] I couldn't agree more. The heaviest energy burden for steel cans is the aluminum top.

Aluminum Cans

Consumption of aluminum cans, which are used for beer and soft drinks, was 280,000 tons in 2001, coming to 125 cans per Japanese each year. Eighty-three percent of aluminum cans are recovered, and 75% of the recovered cans are recycled into new cans (Fig. 3.5).

As aluminum cans have always been called "canned electricity," can-to-can recycling naturally helps save energy by cutting down on the heavy energy input for refining aluminum from bauxite. Note that because it is possible to sell collected steel and aluminum cans, businesses are exempt from the obliga-



Source : Ministry of Environment originated from the data of Aluminum Can Recycle Association.

Figure 3. 5 Aluminum can consumption and recovery by weight, and recycling rate

tion for recycling under the Container and Packaging Waste Recycling Law.

2 An Assessment of Packaging and Container Recycling

Implementation

The Container and Packaging Waste Recycling Law, which became effective in 1997, stipulates that: (1)consumers must sort the container and packaging waste they generate, (2)municipalities must sort, collect, and transport, and (3)businesses must determine who plays what role in recycling, which may be contracted to a designated corporation. As such, this law assumes there are four actors—consumers, municipalities, businesses, and the designated corporation, and creates a regime under which these actors divide up the duties of sorting, collection/transport/sorting, recycling, and performing recycling under contract.

Of the approximately 50 million tons of MSW generated annually, about 2.5 million tons are collected separately under this system. Bottles and cans, which had been collected separately since before the law's enactment, were in 2003 collected separately over 90% of Japan's municipalities. More than 90% of municipalities practice separate collection for PET bottles, and in 2002 they recovered about half of the bottles produced.[13] In Tokyo's 23 wards, which mainly divide MSW into combustible and noncombustible categories, glass bottles and cans are in many cases recovered through group material recovery.

A Regime that Puts Recycling First

As I mentioned in Chapter 2, in Japan the term "recycle" is also used to mean "reuse," as in the stores for secondhand goods called "recycling shops." But actually "recycle" means to return products to raw materials and use them to make new products, which is different from "reuse." Although the Container and Packaging Waste Recycling Law opens the way for businesses to voluntarily recover returnable glass bottles and other containers (Article 18), the law in fact gives greater precedence to recycling than to reuse, leading to the crushing of returnable bottles. For example, under this law some municipalities have their citizens remove cans, glass bottles, and PET bottles from the preexisting category of noncombustible waste once a week, and put them in separate bags, which are then collected by ordinary trash collection trucks. In this case, glass bottles end up as cullet instead of being collected as reusable bottles.

The Cyclical Society Law's order of precedence, from highest to lowest, is supposedly reduce, reuse, and recycle. It certainly does not put recycling first. The current system under the Container and Packaging Waste Recycling Law encourages the use of one-way glass bottles over returnable ones, and if that is inducing the increase in PET bottles, the system certainly does not accord with the basic philosophy of the cyclical society. At the same time, this does not mean that reuse always imposes a lower environmental burden than recycling does. Which is better must be determined by a life cycle analysis (LCA).

Assessing the Container and Packaging Waste Recycling Law

As we saw in the introduction, the government's Basic Plan for Establishing a Cyclical Society establishes three material flow indicators and sets targets for the input (resource productivity), recycling (cyclical use rate), and output (final disposal amount). But since the cyclical society concept is subordinate to the "sustainable society," the superior concept must, as a problem-oriented approach, (1) determine environmental burden and environmental impact (resource use, CO_2 emissions, fossil fuel consumption, etc.), and then within that framework analyze the (2) cyclical resource use rate and recycling rate, (3) final disposal amount, and other factors.

By contrast, a concept-oriented approach assesses (1) incentives to reduce environmental impacts, (2) incentives to reduce resource inputs and to recycle, (3) the extent of cost internalization, and other factors.[14)]

Cost-benefit analyses to assess government policies must be conducted individually based on these conceptual analyses.

Changes since the Container and Packaging Waste Recycling Law was implemented can be summed up as followed from the perspective of the problem-oriented approach. Nationally, the amount of MSW collected has tended to rise slightly, from 51.2 million tons in 1997 to 52.1 million tons in 2001, and of that total, the proportion of container and packaging waste overall decreased from 27 to 24% on a wet weight basis, but PET bottles and other plastics remained almost unchanged at 10%. On the other hand, the proportions of paper, glass, and metal are lower. Overall the total amount of container and

packaging waste generated is slightly less, but the proportions of paper, glass, and metal are lower, while those for PET bottles and other plastics are higher.[15)]

A government assessment[16)] of the Container and Packaging Waste Recycling Law's policy effectiveness says that such waste generated about the time the law became effective amounted to 1.5 million tons (1996) but then declined to under 1.1 million tons (2000). However, while the total amount of container and packaging waste generated exceeds 12 million tons on a wet weight basis, the seven types covered by the law total only about 2.7 million tons (1996), which decreased slightly to about 2.6 million tons in 2000. Although the law has effectively increased recycling (from 1.2 to 1.6 million tons), it has hardly reduced waste generation.

Cost Burden on Municipalities

When performing a regime/actor analysis on the Container and Packaging Waste Recycling Law using the concept-oriented approach, the biggest problem is allocating costs among actors, and whether that makes the regime into one which reduces the amount of container and packaging waste generated. The former Ministry of Health and Welfare's Water Supply and Environmental Sanitation Department performed calculations on the costs imposed on municipalities by enforcing this law (this task was subsequently taken over by the Environment Ministry),[17)] and predicted that costs related to recycling containers and packaging, which are part of municipalities' overall waste management costs, would over the short term increase a maximum of 6%, but in the future would hardly involve any cost increase.

Meanwhile, the Japan Waste Management Association (JWMA), an organization comprising municipalities, has produced concrete figures showing the increased burden on municipalities based on a study performed in 16 cities throughout Japan.[18)] Calculations using eight municipalities that added PET bottles to their waste collection after the law took effect found that collection costs them about ¥83,000 per ton. Compared to the 1999 per-ton collection and transport costs of major cities that release their per-ton waste management costs, which average ¥22,000, collection and transport costs under this law are 3.8 times higher. The ¥61,000 difference is effectively an increase and amounts to a new burden.

The Environment Ministry emphasizes in its calculations that the law is effective in reducing landfilling costs because container and packaging waste is recycled, but for PET bottles alone this extends landfill lifetime only 0.03 years.

JWMA calculations for 1998 found that the collection, transport, sorting, and other intermediate processing of glass and PET bottles in all Japan's municipalities created a ¥56.5 billion burden, while specified businesses (the manufacturers and users of the bottles) got off with a ¥3.9 billion burden[19)] (however, in 2002 their burden skyrocketed to ¥49.2 billion).

As this shows, in the sense of reducing waste, this system does not give the actors in manufacturing and distribution sufficient incentive. Moreover, it

regulates some products when emitted as waste by consumers but not by businesses. JWMA points out that these and other defects amount to an "indulgence for mass production." Those who argue that mass disposal should not replace mass recycling are absolutely right.

Sapporo's Initiative

Sapporo began collecting glass bottles, cans, and PET bottles in 1998 in accordance with government legislation, and in 2000 it started collecting other kinds of plastic. As a result, the approximately 13,000 tons of cans and glass and PET bottles collected in 1998 more than doubled to about 30,000 tons in 2001. A breakdown shows that residue accounts for about 40%, followed in descending order by 24% for cans, 21% for glass bottles, and 16% for PET bottles. Here I would like to focus on the fact that 40% (national average is one-third) is foreign matter and residue that cannot be recycled. The problem is that glass bottles of the wrong color, fragments present due to mixed collection, contents remaining in containers, foreign matter adhering to containers, and the like amount to as much as 40%, which cannot be recycled and is landfilled or incinerated because citizen actors did not sufficiently cooperate, even though they paid for collection through their taxes. The largest percentages of residue in terms of volume is PET bottles whose caps are not removed, and in terms of weight is glass, which happens because glass bottles break during mixed collection.[20] Collection for recycling must be done differently than that for incineration.

Glass bottles, cans, PET bottles, and plastic are classified as industrial waste when generated by businesses, and are therefore not covered by the Container and Packaging Waste Recycling Law, but in Sapporo the waste management companies with permits have their own recycling businesses. Sapporo follows the nationwide trend of increased sales of products in PET bottles, and the amount collected tripled in three years, showing that the waste management regime is not very effective at reducing waste, and in some ways businesses are actually getting a free ride (businesses shoulder a mere ¥1.1 per PET bottle).

Let's analyze this situation economically by comparing the city's costs before and after it started recycling containers and packaging (Tab.3.1). Data indicate that recycling glass bottles, PET bottles, and cans increased costs by

Can, Glass, PET

	Before	After	Change
Collection	492	670	178
Treatment	−	1,000	1,000
Landfill	501	−	−501
Total	993	1,670	677

Plastic

	Before	After	Change
Collection	218	521	303
Treatment	126	639	513
Landfill	81	−	−81
Total	425	1,160	735

Table 3. 1 Comparison of costs to Sapporo before and after start of container and packaging waste recycling (according to 2001 account, ¥ 1 million)

70% because although the cost of landfilling was eliminated, the savings was exceeded by intermediate processing such as sorting, compaction, packing, and storage. For trays and other plastics, the intermediate processing cost increased a whopping 2.7-fold.

Who pays the most to implement the law, the city of Sapporo or businesses? PET bottle recycling data for 2000 indicate that the recycling cost was about ¥1.2 billion, and that the city paid 69% of that, or ¥800 million. Neighboring Ebetsu City shoulders 71% of its PET bottle recycling burden.[21)]

According to nationwide data for 2002, trays and other plastics get recycled in the following ways and proportions: feed for coking ovens, 50%; reducing agent for blast furnaces, 26%; feedstock for plastic products, 14%; hydrocarbon oil, 4%; and gas, 6%.

As a result of Sapporo's bidding process to choose recycling contractors, two-thirds (in 2001, one-half) of the plastic sorted and collected by the city is transported far south to be used as a blast furnace reducing agent instead of being taken to the liquefaction facility (Sapporo Plastic Recycling) built with its sorting and storage facility. Two liquefaction facilities were subsidized (¥2.6 billion of the ¥5.2 billion construction cost) under the government's Eco-Town program, but is not fully operating.

Underlying this situation is that nationwide plastic collection is not going according to the plan for separate collection, and the capacity for recycling does not correspond to the amount of plastic collected. Specifically, plastic is not being collected in localities with blast furnaces. Experts have also noted that the technological capacity of liquefaction facilities did not receive a sufficient economic assessment. Liquefaction of chlorinated plastics involves high cost because of the added processes for dechlorination, pyrolysis, recovery of oil formed, and other processes (according to the Japan Containers and Packaging Recycling Association, the successfully bid unit costs in 2002 were ¥98,111 per ton liquefaction, and ¥83,083 for blast furnace reducing agent).

The View from Waste Accounting

The Research Group Seeking Amendoment of the Container and Packaging Waste Recycling Law conducted a questionnaire survey of all municipalities about how they conduct waste accounting, and released the resource recovery rates and cost burdens of 160 municipalities nationwide in 2000.[22)] The survey, which covered a population of 31.8 million, found that (1) there were no standards that unify "calculation of costs" with the "cost allocation by item," (2) it is impossible to show the burden ratios for "recycling costs," and other reasons for differences among municipalities in how they approach the problems of determining costs and information disclosure. However, the Research Group applauded the fact that they were able to obtain from 160 municipalities the waste accounting information that is not even disclosed by the government. Analyzing the overall trends revealed the following characteristics.

(1) The resource recovery rate (the total amount recovered from the total

amount emitted) averages 21%.

(2) Municipalities shoulder 70% of recycling costs.[23]

(3) When population rises, it is likely that "total waste" including business waste will increase, and that when the number of collections is increased and other plastics are collected, resource recovery costs will rise.

Although the results allow confirmation of the same trends identified by the JWMA study, it is important to note that part of the revenue sources (or the minimum) needed for separate collection are guaranteed by taxes allocated to local governments.[24]

3 Reforming the Container and Packaging Waste Recycling Regime

Germany's DSD

Japan's Container and Packaging Waste Recycling Law is sustained by municipalities, which use tax revenues to perform the most cost-intensive tasks of collecting and separating wastes. Germany's system contrast with this. In Germany a system called Duales System Deutschland (DSD) was founded with investment from recycling-related businesses, industry organizations, and other parties. The DSD-contracted waste management companies and municipalities use collection boxes differentiated from MSW collection boxes by their yellow color to collect and sort container and packaging waste. Costs for DSD and its 17,000 workers are covered by the "Green Dot" fees paid to DSD by its approximately 87,000 participating businesses, which must pay fees allowing them to put the Green Dot on their containers and packaging. Fees are weight-based for each type of material. For example, plastic is 2.95 DM per kg, and glass is 0.15DM per kg (fees since October 1994). It is reported that in 2000 incentives to reduce container and packaging waste saved or avoided the use of 1.6 million tons of container and packaging material. A DSD questionnaire survey of companies about extended producer responsibility (EPR) found that 35% said costs were higher, 39% said savings were canceling out costs, and 14% said costs were lower than their DSD fees. However, DSD has faced financial crises owing to the "free riders" such as small butcher shops and bakeries.

As this shows, the DSD regime is supported by businesses instead of municipalities, and it not only collects and recycles container and packaging waste, but also effectively reduces waste. This is the most significant thing that Japan should learn from Germany in view of Japan's current situation.

Another important point is that DSD is required to not only collect and sort, but also to attain recycling rates. For example, DSD must achieve material recycling rates of 75% for glass and 60% for plastic, and various recycling technologies have been developed and brought into use to attain these targets. DSD currently recycles 600,000 tons of plastic annually, a rate of 68%.

Third, Germany has a double system for containers, in which one-way containers are covered by DSD, and returnable containers by a deposit system under which people can return containers anywhere in Germany and get their

deposit back. There was a provision that a deposit system for one-way beverage containers would be instituted once the proportion of returnable containers fell below 72% for two years running. Under this system, which was launched January 1, 2003, containers under 1.5 liters have a deposit of 25 euro cents, and those 1.5 liters or larger are 50 euro cents. Deposits are charged on glass bottles for beer, mineral water, soft drinks, and other beverages except for wine. These are removed from DSD's purview. Industry (especially large beer companies, the distribution industry, and others) fought in court to stop this system until the very last, but the Constitutional Court dismissed the industry motion twice. Because of industry's attempts to stop the system, Germany did not at first have a uniform national system, and consumers could only get their deposits back from the store where they bought the beverages. A few supermarkets quitted stocking beverages in one-way containers.[25] Apart from this, in 2001 the German environment minister attempted to amend the government ordinance on packaging by levying deposits after dividing containers into those which are and are not environmentally friendly based on LCAs by the Federal Environmental Agency instead of the 72% rule or whether containers are returnable or one-way. Although the Bundestag passed the amendment, it was rejected by the Bundesrat, which represents state governments.

Fourth, despite the recycling regime differences with Japan, the two countries have many things in common regarding container and packaging market trends: plastic film/sheet products have enlarged their share of the container and packaging market; overall, containers and packaging have become thinner, lighter, smaller, and softer; and packaging makers are moving away from PVC materials. Some examples of this trend are thin-layer EC lamination, spouches, heat-insulating paper cups, and self-standing pouches for refills.[26] For both Germany's DSD and Japan's Container and Packaging Waste Recycling Law, intervention by administrative authorities in the system can only accelerate major market trends, not change their direction.[27] Because Japan's law imposes costs on businesses according to packaging weight, businesses try to alleviate that cost burden by using composite materials for greater thinness, which in turn makes packaging waste harder to deal with.

Environmental Burdens by Container Type

The Container Comparison Research Group has released its research comparing environmental burden by container type.[28] This group's purpose is to use mainly existing data already publicly available, while filling in gaps with interviews and other means, to perform, as impartially as possible, LCA comparisons of the environmental burdens arising during the life cycles of containers made using different materials.

Products examined were PET bottles, one-way and returnable glass bottles, aluminum cans, steel cans, and paper containers. In terms of function, they looked at only how beverage containers retained their contents, not at how well they preserved or how long they held their contents. All beverages were non-carbonated soft drinks, and the contents themselves were not evalu-

ated in any way. To have a functional unit of "the same amount per container use," the researchers chose 500-ml containers as the functional unit because all the containers covered by the study were sold in that size.

To make the study's scope (system boundary) as impartial as possible, the researchers decided to make it broad and cover the following for all containers: resource extraction, material manufacturing, container manufacturing, filling, distribution, recycling (transport to treatment facility, secondary materials, making recycled materials, etc.), and disposal (incineration, shredding, landfilling, etc.).

Assuming that in the future the usage rates would rise for cullet from glass bottles and secondary ingots from aluminum cans, the study predicted the environmental burden created by such increases (70% rate for open market cullet, and 80.85% rate for aluminum secondary ingots) and showed them as future values.

Returnable glass bottle analyses were performed for five-use (80% recovery rate) and 20-use (95% recovery rate) scenarios.

To avoid differences in transport conditions for containers and materials, conditions were standardized to a 90% load and a round-trip transport of 100 km each way for trucks, while ship transport was a 95% load round trip. The results (Fig. 3.6) found that:

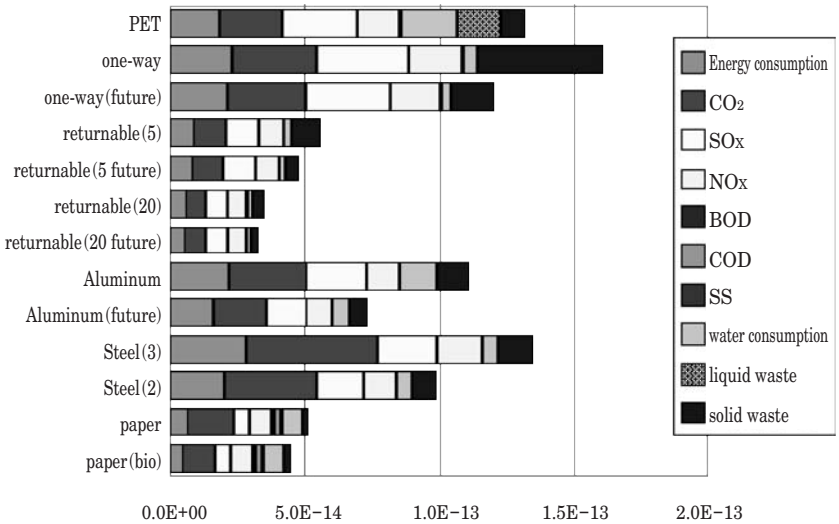


Figure 3. 6 Environmental burdens of selected container types

(1) The combined environmental burden values (energy consumption, CO_2, SOx, NOx, BOD, COD, SS, water consumption, liquid waste, and solid waste) were high for one-way glass bottles, PET bottles, steel cans, and aluminum cans.
(2) Returnable glass bottles and paper containers had small values.
(3) Environmental burdens of future values for all containers were smaller.
(4) The more times a returnable glass bottle can be used, the smaller its environmental burden.

However, since this method does not assess the raw materials substituted in recycling, it is disadvantageous to some kinds of recycling such as cascading (recycling in line with quality deterioration), as when steel cans are put in electric furnaces to make rebar.

Meanwhile, a study[29] commissioned by the Environment Ministry performed a LCA using real data and found that while paper cartons tend to consume more energy as their recovery rate goes up, the environmental burden of other containers is lessened by encouraging their reuse and recycling. When 500-ml PET bottles are recovered for material recycling, a comparison of 0% and 100% recovery rates indicated that energy consumption and CO_2 emissions go down 22% and 41%, respectively. As the current recycling rate is 44% it is apparently possible to further raise it. But results indicated that if the foreign matter and residue present when collecting PET bottles are included in the amount of waste generated, that amount jumps by over 60%. Further, because this study did not consider the costs of collection and recycling, it still remains to analyze the cost effectiveness of reducing environmental burden through recycling.

Assessment of PET Bottle Recycling

Chapter 1 described Nagoya's efforts to reduce waste volume, but a comparison of 1998,before those efforts started, and 2001 shows that the increase in voluntary collection accounts for far more of the 26% reduction than the Container and Packaging Waste Recycling Law does. Dioxin emissions are one-tenth, while those of CO_2 are 90%.[30] Keeping this example of Nagoya in mind, LCA research on PET bottle recycling[31] compared recycling with landfilling and found that when PET bottles are recycled, the reclaimed PET resin is produced as a byproduct, so that amount is economized. Hence, an impartial comparison with landfilling cannot be made unless the environmental burden of producing reclaimed PET resin is added to landfilling. Doing so shows that recycling creates a lower environmental burden in terms of solid waste, CO_2, NOx, and SOx.

The problem is the economic assessment. Recycling currently costs more than landfilling when mainly the costs of collection and recycling are totaled, and that is why in assessments recycling is at a disadvantage. However, one has to consider limitations such as: only a few substances are considered in gauging environmental impacts; the cost of landfilling is currently underestimated because it does not reflect the value of remaining landfill space; and, there is room for streamlining collection, transport, and pretreatment.

Competition with Group Material Recovery

Before the Container and Packaging Waste Recycling Law took effect, collection of recyclables in Japan was widely achieved through group material recovery by neighborhood associations. Citizens recovered post-consumer paper, glass bottles, metals, cloth, and other materials with subsidies from municipalities, and the sale of paper and metal was a valuable source of revenue for the neighborhood associations. But enactment of this recycling law created

competition with citizen recycling because glass bottles and metals are recycled by the associations and under the law.

The Hokkaido city of Ebetsu is a case in point. During 2001 the city collected 834 tons of waste under the law, while group collection brought in 5,689 tons. Even glass bottles and metals, the items over which the two systems compete, were recovered in greater amounts by group collection. Furthermore, the costs of group collection are covered by subsidies amounting to only one-tenth of the costs incurred by the Container and Packaging Waste Recycling Law, figures which are borne out in Tokyo's Arakawa Ward.[32] Only PET bottles are individually collected under the law. In Ebetsu other plastics are not collected individually because the city has a new type of melting furnace.

If PET bottles and plastic containers are collected separately, group material recovery will cost municipalities less because material recovery companies will perform collection, transport, and sorting in place of the municipalities. Hence there are many instances of group material recovery being used in small and medium cities like Ebetsu, not just in Tokyo. In light of cost effectiveness, group material recovery still plays a major role.

Box 6 Minamata's 21-Category Waste Separation (Tab. 3.2)

Kumamoto Prefecture's Minamata City, which is well-known for Minamata disease, has been working on MSW reduction and resource recovery as part of its effort toward environmental revitalization. For that reason it started separate waste collection in 1993,and in 2003 it initiated collection in 21 categories.

Note that not only are there many categories, but also that wastes are completely recycled. Minamata's separated wastes are applauded as "brand-name trash" and they are the first choice of recyclers. People living alone, two-breadwinner homes, and households which otherwise have difficulty with separation get help from their neighbors. Working together on separation encourages dialog and mutual assistance, and facilitates reconciliation over the Minamata disease issues. There is also a campaign to reduce the amount of waste.

Categories		
Potential resources	Bottle	Reusable
		Other transparent
		Water
		Brown
		Green
		Black
	Waste plastic	
	Can	Steel
		Aluminum
	Pans	
	PET	
	Used paper	Newspaper
		Journal
		Carton
	Clothes	
Product waste	Used appliance, furniture	
Hazardous waste	Battery, fluorescent light	
Burnable		
Food waste		
Landfill		

Table 3. 2 Minamata City's 21 waste categories

The Possibilities of Reusable Glass Bottles

A certain cooperative compared CO_2 emissions when its own reusable glass bottles were used repeatedly, and when bottles were recycled after only one use (Fig. 3.7). Recycling releases about three times as much CO_2 as reuse. We are supposed to cut emissions of this greenhouse gas, and as we have seen by comparing the environmental burdens of various containers, results will vary depending on the number of times used and on transport distance, but in this case reusable bottles are more environmentally friendly.[33)]

Figure 3.8 diagrams commodity costs using a 500-ml glass vinegar bottle as an example. Under the Container and Packaging Waste Recycling Law, businesses pay a small "recycling fee" for one-way containers (about ¥0.15, too small to show in the diagram), but collection and separation costs are covered

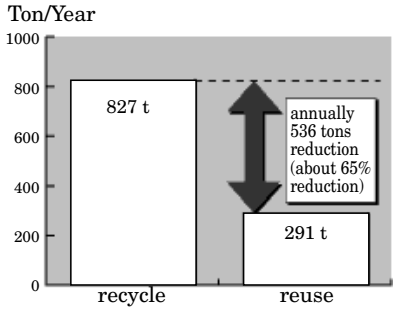


Figure 3. 7 CO_2 reduction effectiveness of reusable glass bottles

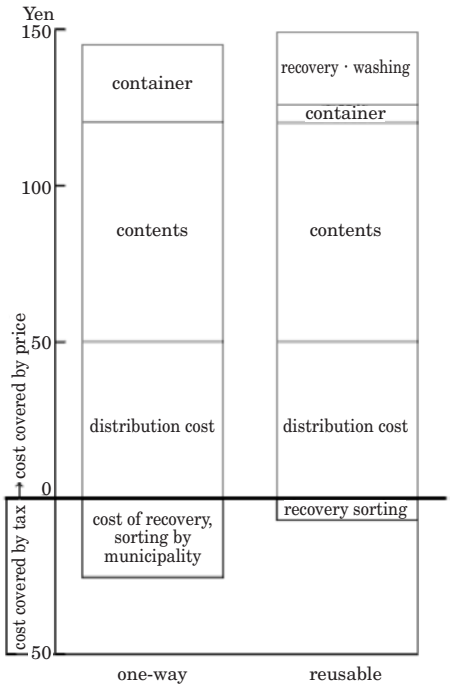


Figure 3. 8 Do one-way containers get a "free ride" ?

mainly by municipal taxes. But because reusable glass bottles must reflect almost all costs in the product's price, it is possible to give one-way containers lower prices. What's happening is that one-way containers get lower prices by taking a "free ride" on the system.

Moreover, recently there have been increases in the recycling unit volumes for glass bottles, with that for transparent glass bottles up 1.8 fold for a five-year period.[34] This induces a vicious circle in which declining glass bottle production is depressing the sale price of cullet and raising the recycling cost, which in turn leads to less and less glass bottle use. Therefore one way of addressing the increases in waste management costs and the environmental burden is to boost the use of reusable (returnable) glass bottles.

Three things should be considered when revising the Container and Packaging Waste Recycling Law to encourage more use of reusable glass bottles, which impose a lighter burden on the environment.[35]

(1) In line with extended producer responsibility (EPR), include the costs of recovery, sorting, and storage in the product price. Although one-way glass bottles are priced more attractively than returnables, they are still more expensive than PET bottles, cans, and paper cartons.

(2) Levy a surcharge when containers are manufactured. A surcharge would be taken when a food or beverage company purchases newly made containers from a container manufacturer as containers for alcoholic beverages, soft drinks, condiments, or other products. There would be no cost burden when using reusable containers that are used by consumers more than once and recovered afterward. Businesses which pay the surcharge are the bottlers, and the amount they pay is added to the commodity price. Accordingly, the more times a container is reused, the more economically advantageous it becomes.

(3) Charge deposits on containers with low recovery rates, PET bottles, and paper cartons.

Because one-way containers are used only once and their cost always comes at the new-container stage, they appear as the horizontal dotted line A in Figure 3.9. On the other hand, if reusable glass bottles are used again and again, their cost per use drops as indicated by curve B. If one-way containers are more advantageous no matter how many times reusable bottles are used, those conditions are the most disadvantageous for reusable bottles, but if a surcharge is levied on new bottles only, their costs are represented by dotted line A′ and curve B′, making it possible to give the advantage exclusively to reusable bottles, whose cost goes down with each use.[36] A model analysis[37] of glass bottles found that raising the recycling rate about 10% requires ¥2,000 per ton under a subsidy system, and about ¥2,200 per ton under a charge system.

Problems and System Reform

As we have seen, the Container and Packaging Waste Recycling Law has a number of problems including the heavy cost burden on municipalities, weak incentives to reduce waste emissions, supply and demand imbalance, and the

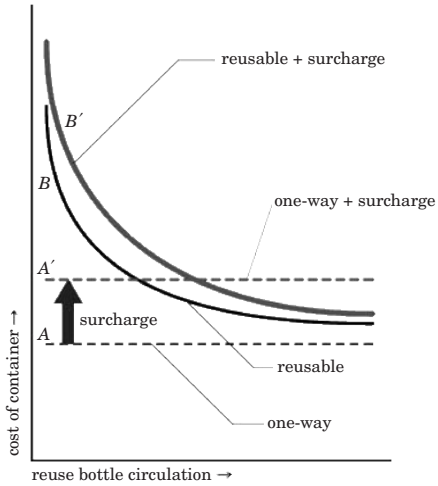


Figure 3. 9 Surcharge effect

bidding system. Let's discuss these once more.

Heavy cost burden on municipalities Many municipalities are saying they want the Container and Packaging Waste Recycling Law amended. The Japan Association of City Mayors in its 2003 document titled "Requests Concerning Waste" made the following requests regarding the law.

(1) Promote the wider use of returnable containers and institute a deposit system as part of efforts to reduce container and packaging waste and to prevent illegal dumping. Additionally, expand channels for voluntary recovery by businesses.
(2) Provide measures to assist with the costs of separate collection and recycling so that municipalities' fiscal burdens are not too heavy. The government should consider ways to have manufacturers and other actors recover containers in line with EPR.
(3) Municipalities pay recycling costs arising from small businesses that are exempted from recycling, but the government should have businesses as a whole shoulder these costs, and otherwise provide for the reassessment of the allocation of costs and roles to municipalities and businesses.
(4) Impose greater responsibility on businesses, such as reducing their waste emissions and developing and manufacturing easily recycled products.
(5) Provide for expanded recycling, such as PET bottle recycling methods.
(6) Because the current unified labeling for packaging type is inadequate, individual labeling should be required, and recycling symbols should be made larger for the elderly and others.

The mayors' association also proposed a provisional measure under which specified businesses would, through the designated corporation, pay intermediate processing costs, which are an excessive burden on municipalities. This

is because removing caps and foreign matter is originally part of the recycling responsibility to be assumed by specified businesses. Even when municipalities are required to collect wastes, as in France, businesses must pay subsidies based on the types and amounts of recycled materials, and purchase them.

Weak incentives to reduce emissions Under Germany's DSD regime, businesses pay according to container material. For example, for plastic they must pay a cost that is about 20 times that of glass for the same unit weight, which is an incentive to reduce the amount of hard-to-manage container and packaging waste.

But in Japan the amount that must be recycled is calculated indirectly from the production amount (no matter what the amount of containers and packaging, the amount that recycling facilities must recycle is determined by their capacity, and specified businesses pay costs only on that amount). Furthermore, contracting fees are hard to pass on to someone else because of market competition, resulting in little waste-reducing effect. In fact, it was because beverage makers anticipated the new system under the Container and Packaging Waste Recycling Law that they abandoned their self-restraint on small PET bottles, whose sales jumped more than three-fold from 1996 to 1997. In this way they took advantage of the new system's weakness.

What is more, under this system the costs paid by the manufacturers and users of containers and packaging rise with the recycling rate, which provides no incentive to boost it. The fact is, it is hard to shift the container cost and recycling fees, even though that shift can be seen as the principle of EPR, which is at the foundation of the Container and Packaging Waste Recycling Law. It is possible that shifting the costs will happen only when recycling rates increase substantially, in turn making manufacturers and users pay more. Possibly that will in turn induce a switch to containers with lighter environmental burdens, but in fact market competition is already making companies use containers and packaging that are thinner and lighter.

Supply and demand imbalance Owing to the supply-demand imbalance, storage facilities have mountains of glass bottles, cans, and PET bottles that have been collected but not reprocessed. In 2001, 170,000 tons of PET bottles were collected, but there was an excess of processing capacity at 240,000 tons. Problems also arise because the designated corporation decides which recycling business will perform recycling. For example, Sapporo built a liquefaction facility for "other plastics," but "other plastic" containers and packaging are instead taken for use as blast furnace reducing agents by businesses that gave the designated corporation a low bid. This is partly because the bidding system encourages efficient recycling (for example, the contracted recycling unit cost declined from ¥102 per kg in 1997 to ¥64 in 2003), but local resource cycling is compromised because the wastes collected must be transported long distances.

Bidding system The current system is built around a designated corporation called the Japan Containers and Packaging Recycling Association, which en-

ters into contracts with municipalities and takes bids from recyclers. Successful bidders receive collected containers and packaging from municipalities. Municipalities and recyclers do not deal directly with each other because the Association comes between them. A problem arising here is that a municipality and recycler work together only a year until the Association chooses a different recycler. Unlike ordinary commercial transactions, the parties do not directly choose whom to deal with.

From a municipality's point of view, there is no guarantee that a bidder will be successful, and even when there are bidders, the waste acceptance quality criteria are in actuality different every year. From a recycler's point of view, waste comes from a different source every year. As there is no assurance that separated wastes will be taken by a recycler, municipalities must comply with the strictest technological standards, and because it costs them much to satisfy the sorting criteria (Box 7), they are left with huge amounts of collected wastes left over (about 30% of the whole) because those wastes do not meet the criteria. Municipalities and recyclers both face the problem of being exposed to changes in waste treatment amounts and criteria every year. This is because, unlike Germany's DSD in which collection and recycling are integrated, the collection and recycling actors are different, and they are further separated by a third actor, the designated corporation.

Recently China is importing PET bottle flakes at an annual cost equivalent to about 100,000 tons (20% of Japan's production), which takes processing facility capacity utilization down to about 60%.

In sum, the Container and Packaging Waste Recycling Law does not sufficiently incorporate the perspective of waste reduction,[38] and it has not extricated itself from a mindset fixated on how to manage wastes. It should therefore learn from the Household Appliance Recycling Law by creating arrangements that order container and packaging makers to take back their own products and achieve a certain recycling level, and that impose some sort of requirements on material makers or provide strong incentives to assure take-back.

One conceivable way of going about this is to create a system that collects container and packaging waste separately from MSW, and that takes responsibility for covering costs, while actual responsibility is shouldered by waste management companies under contracts from municipalities or, even when municipalities collect wastes, that reinforces assistance by businesses and their obligation to purchase wastes. As seen above, an interim measure worth considering is having certain businesses pay, through the designated corporation, the intermediate processing costs that are an excessive burden on municipalities.

Box 7 Sorting Criteria for Plastic Containers and Packaging

(1) As a rule, the amount collected shall be that equivalent to the maximum that can be loaded on a truck whose maximum capacity is 10 tons.

(2) One kind of container or packaging should not be adulterated with waste made with mainly other materials.

(3) One kind of container or packaging should not be adulterated with another kind or have foreign matter adhering to it.
(4) Wastes must be compacted, the sole exception being white polystyrene foam food trays.
(5) Wastes must not be adulterated with polyethylene terephthalate containers for beverages or soy sauce.
(6) Caps other than those made of plastic must be removed.
(7) White polystyrene foam food trays alone must be washed clean and dried.

Summation

Over seven years have passed since the Container and Packaging Waste Recycling Law took effect. As a result, in terms of the material cycle the containers that increased were PET bottles, and those that decreased were glass bottles and steel cans. Although glass bottles and steel cans have higher recycling rates, their production volumes are down. PET bottle production doubled, and their recovery rate is 50%. While overall the amount of container and packaging waste generated is slightly lower, PET bottles have a bigger part of the mix, but the recycling rate is up.

In terms of the regime and actors, municipalities cover about 70% of the costs, and businesses the rest. Since there is no decrease in container and packaging waste, and the recycling rate is up, this naturally means costs are higher. As such, municipalities and recycling businesses are both paying more. On the other hand, traditional group material recovery directly involves resource recovery companies but not municipalities or the designated corporation, so in many places it recycles wastes with lower costs than the Container and Packaging Waste Recycling Law system.

Under this system, a designated corporation comes between the two other actors: the municipalities, which recover wastes, and the recycling contractors, which have to bid competitively. For this reason each municipality is teamed with a different recycler every year, leading to uncertainty. And because municipalities expend large sums on complying with sorting criteria, about 30% of noncomplying collected wastes are left over. Further, the weight-based fees that businesses pay are an incentive to make containers and packaging lighter, but because their economic burden also rises with the recycling rate, this is not an incentive for businesses to raise recycling rates.

Some ideas for reforming the system are a return to the principles of waste reduction and reuse for a reassessment of returnable glass bottles and group resource recovery, and a reconsideration of how we allocate intermediate processing costs, which are now covered by municipalities; in the way of a drastic overhaul, create a system like that of Germany that integrates recovery and recycling, have involved businesses finance it, and have municipalities run the programs for initial recovery, thereby separating the responsibility for such programs from the financial burden.

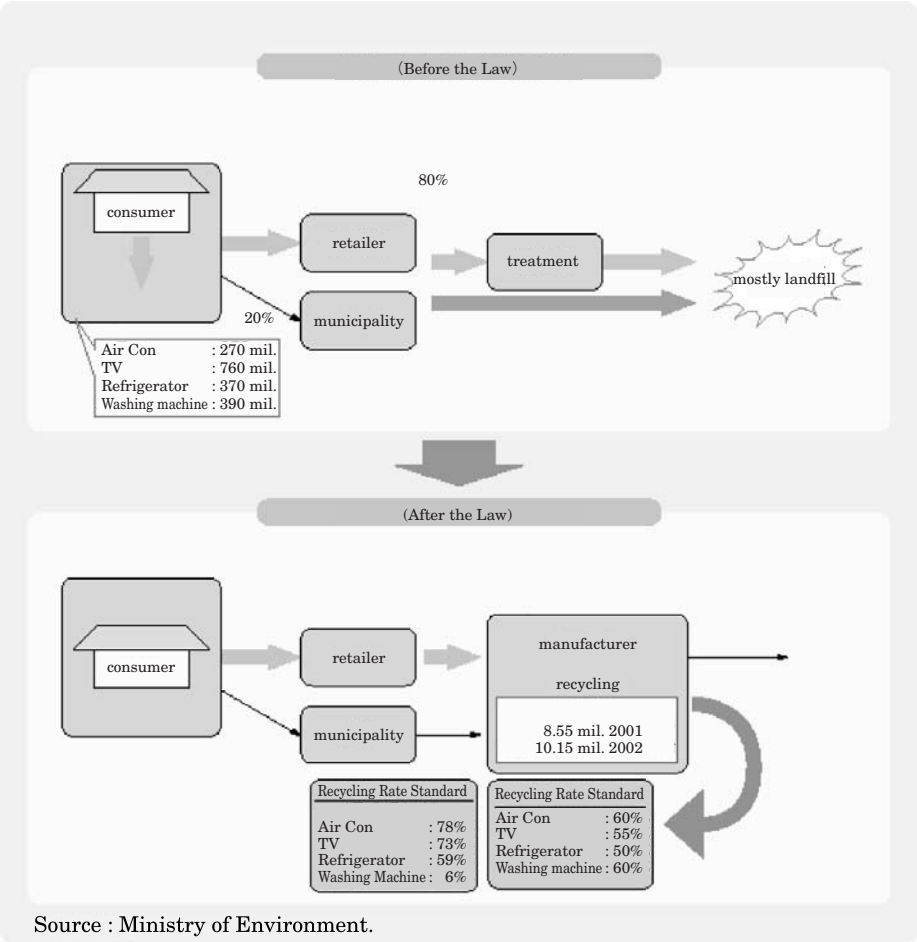
Chapter 4 Appliance Recycling

1 The Real Story behind Appliance and Electronics Recycling

End-of-Live Appliance Disposal

In light of the material cycle, the recycling of televisions, refrigerators, air conditioners, washing machines, and other consumer appliances should include the recovery of materials including the lead in TV picture tubes and the heavy metals in electronic circuit boards, the refrigerants in air conditioners, and the plasticizers in plastics, while the recovery of ferrous and nonferrous metals conserves and makes effective use of resources.

Each year the Japanese discard 600,000 tons of the so-called "four



Source : Ministry of Environment.

Figure 4. 1 State of electroscrap management

types" of appliances: TVs, refrigerators, air conditioners, and washing machines. About 20% have been recovered as bulky waste by municipalities, and the remaining 80% have been recovered by appliance dealers (Fig.4.1). Of those recovered by dealers, one-fourth have been processed by municipalities. This means that municipalities have done 40% of the processing, and private processors the other 60%. Disposal of these appliances has almost always been landfilling as is or after shredding, and the amount of metal recovered after shredding has been low at about 10%.

Using actual data to estimate this, the overall figures for the "four types," which are covered by the Home Electrical Appliance Recycling Law, are 20 million units discarded each year (estimate for 1999), about 70% of these or 14 million units treated and disposed, about 25% or 5 million units exported as used appliances, and about 5% or 1 million units sold domestically as used units.[1)]

Home Electrical Appliance Recycling Law

In view of this situation, the Appliance Recycling Law took effect in April 2001 to provide for the proper disposal of these wastes and the effective use of resources. Japan's system emphasizes the effective use of resources more than that of the EU does.

Under this law retailers must take back and, and manufacturers (including importers) must recycle the four types of consumer appliances: consumer air conditioners, TVs, refrigerators, and washing machines. Consumers (the waste generators) are required to pay a fee for collection, transport, and recycling when discarding one of these four types. There were two changes in April 2004: (1)manufacturers must recover and reuse the blowing agents in refrigerator and freezer insulation, and (2)freezers were added to the appliances covered by the law (Fig. 4.2).

When manufacturers take back and recycle scrapped appliances they must achieve a prescribed recycling rate (between 50 and 60%) and recover the refrigerants from consumer air conditioners and refrigerators.

According to the law, the government's role is to provide the necessary information about recycling, and to take measures for corrective recommendations, orders, and penalties against businesses that charge unreasonable fees.

One assurance that this system really works is its manifest system, which makes sure that electroscrap turned in by consumers is properly transferred to manufacturers by retailers. This also allows consumers to confirm that appliances are really being recycled.

Visits to Appliance and Electronics Recycling Facilities

Appliance recycling Group A has 24 facilities nationwide, Group B has 15, and there is one facility shared by both. Group A is affiliated with Matsushita and Toshiba, which use existing processing companies, while Group B is affiliated with Hitachi and Mitsubishi, which use distribution companies. Apparently the formation of two groups happened owing to the Ministry of Economy, Trade and Industry's (METI) policy of encouraging competition. I had opportu-

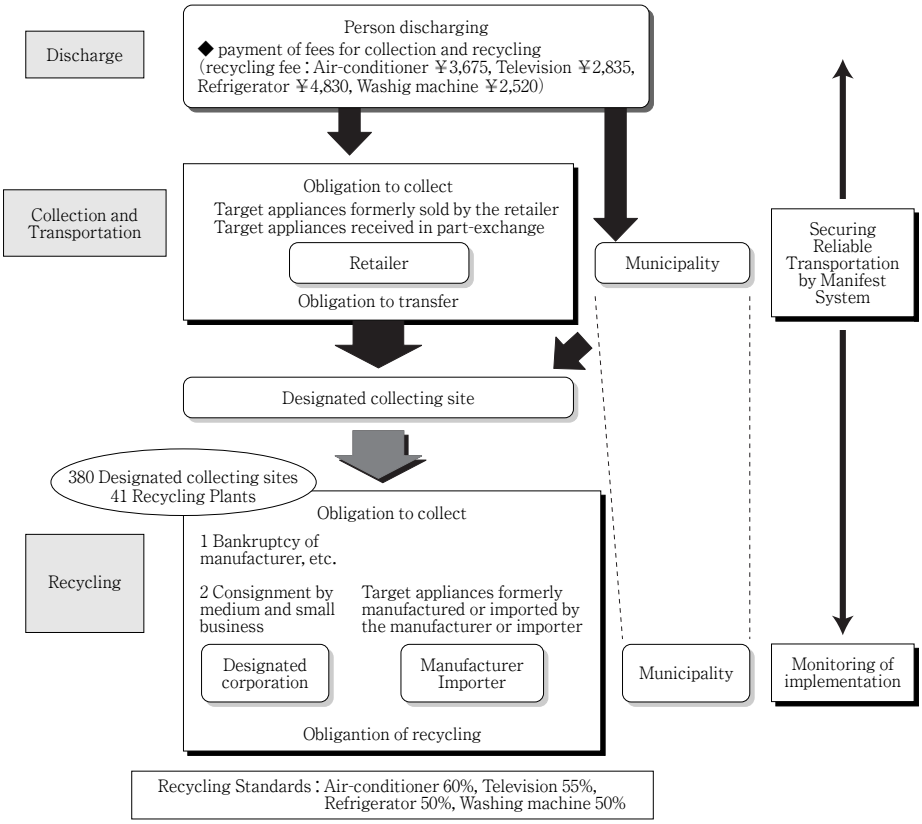


Figure 4. 2 Home Electrical appliance recycling flow

nities to visit three of these facilities.

JFE Urban Recycling, which belongs to Group B, is a plant that "melds steel making with consumer appliance recycling" and is sited at the JFE Steel Corporation East Japan Works in Kawasaki City. The system's features include: (1)material recycling is possible (iron, copper, aluminum, and plastic are recovered and used as raw materials in the iron-making process), (2) a high resource recovery rate (at least 80% when including waste plastic used in blast furnaces), and (3) recovery of blowing agents from insulation.

Of the four appliance types, televisions are the most work and occupy 40% of the workers, but few of the resources recovered from TVs are used in the iron-making process. In particular, the recovered and cleaned lead glass is sent to domestic CRT manufacturers, but with the tapering of domestic demand, the facility must export this glass to other countries which make CRTs. Although consumer appliances and electronics contain a wide variety of screws and other components depending on the type of device, this facility can handle them all, and it can also process items other than the four appliance types, including old personal computers, copy machines, and vending machines.

The Suzuki CO.'s Hassamu Recycling plan, which belongs to Group A and is located in Sapporo, recycles TVs for Group A in Hokkaido. Group A makes

good use of the equipment and transport systems of existing companies. For example, it has an advantage in that it can use existing shredders. This plant has a recycling line for office equipment and it processes discarded equipment from manufacturers under contract. In finding takers for lead glass and the broad variety of items recycled, this plant faces the same problems as Group B. To raise its recycling rate, the facility goes to much work on CRTs by brushing, panel/funnel separation, washing, and other processing, making CRTs into cullet that meets the standards of CRT glass manufacturers. Yet, going to much trouble to recycle CRTs results in more parts that are not recycled, and because the recycling rate is calculated as percent by weight, this means a decline in the rate. The Suzuki Co.'s Ishikari Plant (which has a scrap iron shredder) processes refrigerators and washing machines, and it installed new equipment to recover insulation blowing agents. However, consumer appliances make up a small proportion of the plant's work. Apparently to raise its recycling rate the facility will have to separate out all plastics through means such as the hand disassembly of washing machines.

Group B's Hokkaido Eco-Recycle Systems is sited in an industrial park in eastern Tomakomai. Half of its ¥1.6 billion capital investment was subsidized (¥660 million by the government and ¥130 million by Hokkaido). With an annual capacity of 300,000 units, the facility processed 252,000 units in 2003 and therefore is just over its breakeven point of 240,000 units. It handles about 60% of the appliances in Hokkaido, and of special note is that TVs account for 44% of the four types, yet just as at other such facilities, TVs require the most effort. In 2003 the plant recovered over 60% of the potential recovery volume of four types (estimated to be about the same as the rest of Japan[2]), and if this percentage rises, the plant will get more profit. Plant officials say that even if the desired recycling rate is attained, the way plastics are processed is important to whether the plant actually turns a profit. The facility must (1) raise its recycling rate, (2) reduce processing costs, and (3) lower transport costs. To increase the recycling rate, appliances are converted to materials and fuels, but it is essential to sort the products and find buyers. Problems peculiar to Hokkaido are that the dispersed population makes distribution costs high, and that appliances are large and difficult to handle.

Following are some problems that all three appliance recycling facilities share.

(1) Raising the recycling rates of the appliances handled is necessary to improve capacity utilization and earnings. One thing that might be considered is recovery of the four types as well as other kinds of appliances and electronics.

(2) Recycling TVs is so costly that the current ¥2,700 recycling fee is not enough to cover expenses. It is especially urgent for recyclers to find buyers for CRT lead glass. In 2004 Japan shut down its last domestic CRT production sites, which means that changes in the implementation of the Basel Convention, which restricts the transboundary movement of wastes, are necessary to secure overseas recyclers. Japanese appliance recycling facilities run by nonferrous metal refiners[3] (such as Eco-Recycle in Akita

Prefecture) run CRTs through their lead refining processes, which eliminates this problem. An economical system for plastic recycling is also crucial.

(3) The Appliance Recycling Law stipulates only recycling rates, not recovery rates. Problems with this include: interpretation of the law as to whether transport cost is included in recycling costs, and that because recycled materials must be sold, the stricture against paying businesses to accept the reclaimed resources is a hindrance to recycling from a comprehensive point of view.

Increased Illegal Dumping of Electroscrap?

The greatest concern at first over the Appliance Recycling Law's implementation was that it would increase illegal dumping. When consumers discard appliances they must pay, in addition to the fees for collection and transport, recycling fees of ¥2,400 for a washing machine, ¥2,700 for a TV, ¥3,500 for an air conditioner, and ¥4,600 for a refrigerator. Hence, it is said, "It costs money even to part with your appliances." There were concerns that this would induce illegal dumping because the system differs from those of Japan's own automobile recycling system, and the appliance recycling fee systems elsewhere, such as the EU, South Korea, and Taiwan, where fees are tacked onto the sale price.

Is there actually more illegal dumping? Data released by METI and the Environment Ministry[4] show that overall from April through September 2003 illegal dumping of the four appliance types increased slightly. Specifically, it increased in 45% of municipalities (1,304 municipalities), remained unchanged in 18% (542), and decreased in 37% (1,084). However, the number of dumped units was 1.5% that of the number of recovered units (150,000 of 10 million units).

In response to this situation, municipalities are asking that manufacturers shoulder collection and recycling costs for illegally dumped electroscrap. Municipalities actually budget their own funds to address illegal dumping.[5]

But which actor is the cause of illegal dumping? Appliances dumped near ordinary curbside collection sites are in many cases thought to be left by members of the public, while appliance-related businesses are usually assumed to be behind the large-volume dumping found in places like mountain valleys. A typical example is the November 2002 discovery of a large amount of electroscrap illegally dumped by a Sapporo secondhand goods dealer. This dealer, which had contracts with about 80 consumer appliance retailers in the two cities of Sapporo and Otaru, dumped about 160 appliances including TVs, refrigerators, washing machines, and air conditioners in the mountains of Atsuta Village. It appeared that this dealer had obtained about 1,000 units from retailers at fees under half the regular amounts, sold half of the appliances to secondhand good shops, and dumped the rest (a violation of the Wastes Disposal and Public Cleansing Law). Although the Appliance Recycling Law requires sellers which accept the four appliance types to take them to designated takeback points, this dealer allegedly did not do this and thereby violated the

law's contracting criteria. Competition among retailers had induced them to charge consumers less for transporting appliances and waive recycling fees, which left retailers with growing burdens which they tried to relieve by contracting with the violating dealer.

2 Assessing Appliance Recycling

New Initiatives and Their Results

The Appliance Recycling Law has brought at least 10 million units of electroscrap back to manufacturers annually, and that has in turn spawned three new initiatives and their achievements.[6)]

First, the stable supply of used plastic from appliance recycling plants is important in terms of the stability of both quality and price. This raises the possibility of markets for recycled plastic and reused parts of guaranteed quality.

Second, it is possible that because manufacturers gain actual field data from the used products that come back, they will make progress in long-life design, start reassessing their production technologies, and move ahead with design for easy disassembly. There will perhaps be progress in the standardization of labeling for disassembly and materials.

Third, the consumer appliance and consumer electronics industries are disclosing environmental information about their products on their websites and environmental reports. Disclosure of product environmental information by the Japan Electrical Manufacturers' Association (JEMA) took a pioneering step when JEMA put the data for member companies' products in table form so they can be compared. Information is also being provided at the product design stage.

Analyzing Cost and Benefit

To gauge the economic efficacy of the Appliance Recycling Law, METI performed a cost-benefit analysis[7)] of the law in September 2001, a half year after it had gone into effect. It estimated the costs and benefits before and after the law took effect as shown in Table 4.1. Results are in Table 4.2.

In terms of costs, the burden on municipalities decreased from ¥38 billion to ¥2.4 billion because after the law took effect, municipalities no longer had to shoulder the costs of processing and final disposal of electroscrap, being left with only the cost of collection and transport in places such as outlying islands.

On the other hand, private-sector costs ballooned from ¥27.1 billion to ¥50.3 billion because the law imposed recovery and transport costs on retailers, and recycling and final disposal costs on manufacturers.

Total combined costs decreased from ¥65 billion to ¥53 billion because the decrease in municipalities' costs was larger than the increase in private-sector costs.

Changes in cost-benefit terms are revealed by the sale prices for recycled resources, which can be expressed as monetary value. Combined public-private sales were ¥4.9 billion before the law took effect, and increased to

	Before the Law	After the Law
cost	• collection and transportation cost of used home electric appliance by municipality • treatment cost of used home electric appliance by municipality • final disposal cost of used home electric appliance by municipality • collection cost of used home electric appliance by retailer • treatment cost of used home electric appliance by industrial waste treatment business • final disposal cost of used home electric appliance by industrial waste treatment business	• collection and transportation cost of used home electric appliance by municipality • transportation cost to the collecting sites by retailer • recycle and final disposal cost of used home electric appliance by manufactures
benefit		• recycled resources • profit by selling recycled resources • others

Source: METI,2001.[7]

Table 4. 1 Cost and benefit before and after the Home Electrical Appliance Recycling Law became effective

		Before the Law			After the Law		
		municipality	private	total	municipality	private	total
cost (million)		37,941	27,124	65,066	2,467	50,329	52,796
benefit	Recycled resources(ton)	25,117	136,078	161,195	0	225,637	225,637
	Profit from recycled resources	201	4,723	4,924	0	7,618	7,618
	CFC recovered (thousand)	750	765	1,515	0	5,174	5,174

Source: METI,2001.[7]

Table 4. 2 Estimated cost and benefit before and after the Home Electrical Appliance Recycling Law became effective

¥7.6 billion after.

Therefore overall, the Appliance Recycling Law has decreased costs and increased benefits, but this analysis leaves some factors out of consideration relating to both costs and benefits. The shipping of discarded appliances abroad eliminates the cost of recycling domestically, which is the greatest expense, and doing so increases benefit. But social costs are generated if those appliances cannot be properly managed abroad.

Significant benefits include extension of landfill life because of less landfilled waste, and preventing the contamination of groundwater and soil. Also important are resource and energy conservation through recycling, and environmental burden mitigation.

Appliance Maker Burden

During the Appliance Recycling Law's first year (2001) the actual number of recycled units was about 8,550,000 the total of the four types. In 2004 11.2

million units were recycled. Consumer appliances are now used for an average of 13 to nearly 15 years, the reasons being better performance and avoidance of the recycling fee required by the law.

Appliances are actually recycled by two groups, A and B (Tab. 4.3). Group A tries to hold down cost through the greatest possible use of the equipment of existing waste management companies, while Group B has spent money on new recycling plants but tries to reduce costs through efficient integration with the distribution system.

	A group	B group
manufactures	Matsushita, Toshiba, Victor, Dakin 14 members designated collection points 190 recycled plants 24	Hitachi, Mitsubishi, Sharp, Sanyo 20 members designated collection points 190 recycled plants 15
Scheme	・ Plant is research center ・ cooperation with waste treatment business	・ Self made plants ・ Cooperation with Eco-town ・ cooperation with distribution business
features	・ Dicentralised system ・ Initial investment is small ・ Strategic Location of designated collection points ・ Easy to change of demand ・ Possible to future extension ・ Not easy to model change ・ Because of not depending on home electric appliance, low incentive to recycle	・ centralized system ・ initial investment is big ・ Location of designated collection points is limited ・ Limit to change of demand ・ Compliment to designated designated points ・ Easy to model change ・ Because of depending on home electric appliance, high incentive to recycle

Source: DBJ,2001.[9]

Table 4. 3 Cost-cutting measures for consumer appliance recycling

One study[8] claimed that in its first year the system would be about ¥7.5 billion yen in the red, and that all of the four types would be in the red. Because refrigerators in particular have the problem of refrigerant recovery, calculations on whether manufacturers were making money at recycling appliances found that due to the extra expense of that recovery, refrigerators had the biggest per-unit loss, which depressed by about 50% the business revenues of divisions specializing in white goods. Based on interviews I conducted, I estimate that Group A is not in the red, but that Group B is in the red when depreciation on capital investment is included.

Needed to improve the recycling balance sheet are (1)a higher appliance recovery rate to improve facility capacity utilization, and (2)higher recycling fees. To raise the recovery rate it is essential to address used appliance exports and illegal dumping. Although the Appliance Recycling Law specifies a required recycling rate for recovered electroscrap, it does not specify a recovery rate, unlike the EU's WEEE Directive, which is covered in the following section.

Raising recycling fees will necessitate changing the current system of paying a fee when discarding an appliance so that consumers instead pay the recycling fee as part of the purchase price.

Changes in the Public Sector Burden

The effect of lower costs for municipalities figures big in METI's cost-benefit analysis, but how are municipalities' burdens really changing ? Let's take a look at a study on this matter commissioned by METI and performed by the Mitsubishi Research Institute.

Mitsubishi's study[10] made the following findings based on interviews in 11 cities including Tokyo's 23 wards, Kyoto, Sendai, Hiroshima, and Fukuoka. Collection, transport, processing, and disposal costs for the four appliance types as a percentage of total costs for all wastes including the four types ranged widely from 3% in Nara Prefecture's Ikoma City to 19% in Tokyo's 23 wards. There were also wide differences in per-kg processing costs for the four types, in the approximate range of ¥30 to ¥200. But overall, the four-type cost percentage was not necessarily high due to the proportions of certain items in bulky waste, which in Tokyo, for example, run in descending order from futons to bicycles, chairs, TVs, and kerosene space heaters.

This study found that the Appliance Recycling Law reduced the cost burden in Fukuoka City, Ibaraki Prefecture's Hitachinaka City, Chiba Prefecture's Nagareyama City, and in Ikoma. In these cities costs were reduced by reflecting the decreased amount of bulky waste collected in calculations of the contracting cost for collection and transport.

Meanwhile, Sendai, Hiroshima, and Saitama Prefecture's Kawaguchi City began charging for the bulky waste collection when the Appliance Recycling Law entered into force, which substantially reduced the amount of bulky waste collected. One way to see the public acceptance of pay collection for bulky waste is that it is an indirect effect of the Appliance Recycling Law.

In summation, several factors determine the changes in municipalities' burdens under the Appliance Recycling Law. These include: the proportion of the four appliance types in total bulky waste, whether or not municipalities contract out waste management, and the connection with pay collection of bulky waste.

The discussion above shows that municipalities' burdens would be considerably reduced by a more comprehensive system based on recovering extended producer responsibility (EPR) for recovering consumer appliances/electronics and hard-to-manage wastes.

3 How to Reform Appliance Recycling

The EU's WEEE Directive

The European Union's Directive on Waste Electrical and Electronic Equipment (WEEE) offers much of value in reforming Japan's Appliance Recycling Law. In March 2003 this and one other directive entered into force: the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS). Both give concrete form to the EPR principle as follows.

The first WEEE directive characteristic is its comprehensive scope, which takes in (1)large consumer appliances, (2)small consumer appliances, (3)IT

products, (4)consumer electronics, (5)lighting appliances, (6)power tools, (7)toys, (8)medical equipment, (9)monitoring and control equipment, and (10)vending machines, which means the comprehensiveness of the system.

Second is recovery responsibility and the allocation of costs. For products released after the directive takes effect, each producer is responsible for its own products after consumers discard them; for products already on the market, all producers share the costs upon disposal by consumers. Requirements for new products are (1)provision of monetary security by producers (membership in an organization that manages funds for managing discarded products, recycling insurance, and bank accounts from which withdrawals cannot be made), and (2)products must have been shipped 30 months after the directive entered into force (i.e., producers must recover them), and must be marked to identify their manufacturer. This clarifies producer responsibility.

Third, the recovery target is 4kg per capita by December 31, 2006. Recycling rates (material recycling and fees paid to recyclers to accept reclaimed materials, not including thermal recycling) were set at 75% for large consumer appliances and vending machines, 65% for IT products and consumer electronics, and 50% for other products.

Fourth, RoHS will ban the use of lead, mercury, cadmium, hexavalent chrome, PBBs, and PBDEs (brominated flame retardants) by July 1, 2006. Unlike WEEE, under RoHS the same regulations will govern the EU single market according to Article 95 of the 1997 Treaty of Amsterdam (guarantees the free movement of goods in the market and limits the member states' right of free discretion). But owing to pressure from Japanese industry there are some exemptions such as lead in the glass of CRTs and other items, high-melting-point solder, fluorescent light mercury under a certain amount, and anti-corrosion hexavalent chrome.

The third and fourth characteristics aim at control of the material cycle related to electrical equipment.

The EU's WEEE and RoHS have already considerably influenced Japan's IT makers. For example, in October 2001 the Dutch authorities told Sony that one of the peripheral devices for its PS One Console (a miniaturized Play Station) made for Europe contained more cadmium than allowed under that country's regulations, and Sony stopped shipping them temporarily.[11] Part makers are also considerably affected.

As this shows, EU regulations impose heavy EPR on producers because (1) they cover a wide variety of products, (2)they shoulder producers with responsibilities and costs, (3)they set recovery targets and recycling rates, and (4)they restrict the use of hazardous substances.

Holland's Experience

Before the WEEE directive several countries were already making domestic progress in managing electroscrap. EU countries were the Netherlands and Sweden, and non-EU countries were Switzerland and Norway. In particular, since January 1999 Holland has had a system that covers almost all electrical and electronic goods, both consumer and business.

To characterize the Dutch system, first of all, manufacturers and importers set up recycling plans (commissioned to the Metal and Appliance Product Recycling Association of Holland). Takeback and recycling costs are covered by a fund whose money is collected as a waste recycling fee from consumers when they purchase the products (for example, a refrigerator buyer pays €17). Though it is a manufacturer-pays system, the cost is collected by having consumers pay it in advance when they purchase products. It is the same as Japan's Automobile Recycling Law.

Second, products are recovered through two channels: retail stores and municipalities. A retail store must take back a used product free of charge if a consumer bought it new there (this accounted for 10% of recoveries in 2001). Municipalities accept electroscrap when consumers request recovery of individual items and pay either a bulky waste collection tax or bulky waste collection fee. Of the two recovery channels, the retail stores do not charge a fee on recovery, which aims to take advantage of consumer psychology.

Third, in addition to recycling, Holland's system allows two channels for reuse (sale as used goods). In other words, it officially incorporates both reuse and recycling.

In view of its effectiveness in terms of the material cycle, the Dutch system recovers 4.6kg of electroscrap per capita annually, and it has exceeded its recycling rate target. What we can learn from this system is that it: (1)covers the broadest possible range of products, (2)makes consumers pay recycling costs in advance, and (3)incorporates reuse.

One other fact of note is that transport costs almost half as much as processing, showing that transport is a significant part of overall system cost.

IT Product Recovery and Management

Although the four appliance types are recovered and managed in accordance with the Appliance Recycling Law, consumer appliances and electronics other than those are currently recovered and managed by municipalities. I personally investigated this situation when, as a participant in a study[12] commissioned by the New Energy and Industrial Technology Development Organization (NEDO) to the Mitsubishi Research Institute, we sent questionnaires to 250 local governments (prefectural governments and other major municipalities) and received responses from 40% of them. Our study found that many IT products (such as computers and cell phones) are recovered by municipalities as noncombustible MSW, instead of being recovered by the manufacturers or waste management companies. Municipalities collect IT products or parts and landfill them after processing such as shredding, incineration, or melting. Not a few municipalities landfill this waste after shredding only, and hardly any of them recover cadmium or other environmentally damaging substances.

Other than cell phones, hardly any IT products are recovered by their manufacturers, and even cell phones that are recovered by their manufacturers or retailers are almost always passed on to recovery and disposal contractors that are mostly small and medium-sized companies or microenterprises,

hardly any of which specialize in the recovery and disposal of IT products. And because none of these companies knows the recovery amounts of individual product types, it is very hard to know the amounts of environmentally damaging substances released in recovery and disposal processes, or about exposure to them. Except for a few materials, a material cycle has not been achieved in these recovery and disposal processes.

Meanwhile the lead, cadmium, and other heavy metals contained in electroscrap are accumulating in final disposal sites. Those metals are hazardous industrial wastes, but can also be regarded as potential "urban mineral deposits." At existing final disposal sites we must adequately address soil and groundwater contamination, and make effective use of their resources. The new melting incinerators can also recover metals from incinerator ash and wastes.

Substances in Personal Computers and Cell Phones

From the perspective of the material cycle, IT products require caution because of the hazardous substances they contain. To begin with, Japan's domestic shipments of personal computers in FY 2000 were 12 million units. Assuming that each desktop computer averages 10 kg and each notebook computer averages 2kg, estimating the amounts of metals and chemicals discarded in personal computers shows that copper is considerably greater than other metals, at 170,000 tons annually. Its uses are wiring and printed circuit boards. Next comes lead at 60,000 tons, which is used in CRTs, printed circuit boards, and rechargeable batteries. Nickel and antimony are used in circuit boards and rechargeable batteries. Presently computers contain very little cadmium and mercury. On the other hand, LCDs are on the increase and contain various chemicals such as esters, biphenyls, PHCs, and phenylpyrimidines.[13)]

Recent research[14)] has found that the amount of circuit boards in audio equipment and personal computers that are discarded by consumers rivals that from TVs, and that many of the components mounted on those boards are resistors and capacitors that contain scarce metals such as tantalum, palladium, platinum, and silver.

Cell phone ownership is over 60 million, and the average user has a phone less than two years. Apparently 70,000 units are discarded in a single day. A report from NTT Docomo says that the per-kg amounts of metals in mobile phones are 0.25 g of gold, 1.9 g of silver, 120g of copper, and 0.18g of palladium. Additionally, in the form of beryllium oxide, the element beryllium is reported to cause acute and chronic disorders.[15)]

Meanwhile, the Kosaka Smelting Company in Akita Prefecture, which has a technology for processing "black ore" (kuroko), is recovering gold, silver, and palladium from the circuit boards of business electronics. Palladium makes up more than 80% of the materials it reclaims. At the same time, Sharp Corporation, the biggest liquid crystal manufacturer, has developed a technology jointly with INAX Corporation to recycle discarded liquid crystal glass into the raw material for tile. In 2001 it recycled about 310 tons of liquid crystal glass

in this way.[16)]

This review has shown how various recycling technologies have been developed to bring IT products into the material cycle. Problems to be solved are how to set up recovery systems and what roles to assign to the actors.

Box 8 Growing IT Use and Change in Paper Demand

Paper and paperboard demand over the last decade (Tab. 4.4) has been more or less steady for packaging and converted paper, while demand for printing and copy/fax paper has soared. Except for the increase in corrugated cardboard, the demand for packaging and converted paper tends to decline, which indicates that Japan is making little progress toward replacing plastic packaging and containers with their paper counterparts. This is because while Germany and other countries impose comparatively high fees on the use of plastic in containers and packaging, Japan's Container and Packaging Waste Recycling Law does not incorporate such a system.

On the other hand, since 1995 (the year Windows 95 went on sale) there has been a sharp increase in demand for certain kinds of printing paper (other than

(In thousand tons : % change over previous year) January 20, 2005

	Grade	2002	% change	2003	% change	2004 (Preliminary)	% change	2005 Outlook	% change
Paper	Newsprint	3,702	-0.9	3,677	-0.7	3,749	2.0	3,729	-0.5
	Uncoated Printing	3,271	-4.2	3,195	-2.3	3,188	-0.2	3,170	-0.6
	Coated Printing	6,314	-1.0	6,538	3.5	6,788	3.8	6,903	1.7
	Communication	1,888	1.1	1,937	2.6	1,985	2.5	2,000	0.8
	Printing & Communication Total	11,473	-1.6	11,670	1.7	11,961	2.5	12,073	0.9
Paper-board	Unbleached Packaging	595	-4.3	599	0.7	602	0.5	598	-0.7
	Bleached Packaging	359	-2.2	348	-3.1	353	1.4	351	-0.6
	Packaging Total	954	-3.5	947	-0.7	956	1.0	949	-0.7
	Hygienic	1,705	-2.0	1,710	0.3	1,726	0.9	1,733	0.4
	Others	1,059	1.1	1,039	-1.9	1,046	0.7	1,050	0.4
	Paper Total	18,893	-1.5	19,043	0.8	19,438	2.1	19,534	0.5
	Linerboard	5,538	-0.8	5,543	0.1	5,590	0.8	5,624	0.6
	Corrugating Medium	3,607	0.2	3,647	1.1	3,686	1.1	3,708	0.6
	Containerboard Total	9,145	-0.4	9,190	0.5	9,275	0.9	9,332	0.6
	White Board	2,025	0.7	2,029	0.2	2,042	0.6	2,044	0.1
	Recycled Board	209	-6.3	210	0.5	208	-1.0	206	-1.0
	Folding carton	2,234	0.0	2,239	0.2	2,250	0.5	2,250	0.0
	Other Paperboard	878	-7.2	881	0.3	880	-0.1	864	-1.8
	Paperboard Total	12,257	-0.8	12,310	0.4	12,405	0.8	12,446	0.3
	Paper & Paperboard Total	31,150	-1.2	31,353	0.7	31,843	1.6	31,980	0.4

Notes : Domestic demand = Domestic shipment + imports or + adjustments of distributors inventory
Figures each lines are rounded.

Source : JAPAN PAPER ASSOCIATION.

Table 4. 4 Paper and paperboard demand

newsprint): lightly coated paper, fine coated paper, and lightweight coated paper. This is likely due to higher demand for manuals and printing paper, which are in turn due to increasing personal computer ownership. The information society was supposed to be "paperless," but instead it has induced greater demand for printing and copy/fax paper.[17)]

That growing demand means more paper waste. I was able to obtain detailed data from a study on the composition of business waste that Sapporo offices took to processing sites, and found that while in 1998 paper accounted for 37%, it was 40% in 2001. Meanwhile, a study on household waste composition found that, perhaps due to the collection of container and packaging waste, the proportion of paper in combustible waste increased from 29% in 1998 to 33% in 2001.[18)]

Appliance Recycling Challenges

The foregoing discussion has described the great significance of how the Appliance Recycling Law has created a system for recycling end-of-life consumer appliances and electronics. Nevertheless, many problems remain. Let's examine them individually.

Switching from fee payment when discarding to when purchasing An issue since the law was created is that paying the recycling fee when disposing of an appliance has induced illegal dumping. Reasons for payment on disposal include (1)price changes between the times when a product is purchased and discarded, and (2)the payments are applied to already-purchased appliances. But actually it is likely the system was so designed out of concern about raising appliance prices by adding on this fee.

Causing illegal dumping is not the only problem with paying the recycling fee at disposal time. There are also concerns about recovery channels, and concerns that because the fee is not paid when an appliance is reused or exported, there is no way to adequately ascertain and control the flow of appliances as they change hands.

This is the reason for the recovery of consumer computers under the Law for the Promotion of Utilization of Recycled Resources, and why the Automobile Recycling Law requires the payment of vehicle recycling fees when purchasing a vehicle instead of when retiring it.

Incorporating reuse and export channels The recycling rate of the four appliance types (discarded appliances actually recovered as a percentage of the potential number of appliances to be recovered) is estimated at between 50 and 60%, which was nearly 10.2 million units in 2002. The rest are thought to be stored by owners, reused by someone else, or exported. Some volume appliance retailers take back old appliances from consumers without recycling fee payment, and sell them as used appliances or send them for export. Although exporting old appliances does not violate the Appliance Recycling Law, 25 to 35% of TVs taken back in Japan are exported.[19)] Even if consumers pay the recycling fee, there is no way to know for sure without checking the manifest

date if their appliances were reused or exported, and in fact in February 2004 a transport company was found to have illegally exported appliances. Hence there are in fact three systems that handle electroscrap: the Appliance Recycling Law system, industrial waste processing, and reuse/export.

One way to solve this problem—actually employed in the Netherlands—would be to eliminate the disincentive of payment upon disposal by taking the recycling fee at purchase time so that when users bring their old appliances to retailers or municipalities, the recycling fee already collected is reallocated according to which channel is chosen for any one appliance: (1)reuse, (2)recycling, or (3)export.

Covering more products The Appliance Recycling Law covers four appliance types (TVs, air conditioners, refrigerators, and washing machines), but other consumer appliances and electronics such as VTRs and microwave ovens, and IT products such as faxes and cell phones, are not covered. Their recovery and disposal are performed by municipalities (as bulky waste) or by businesses. Because many of these products are landfilled by municipalities, there are concerns about contamination by heavy metals and chemicals that are difficult to manage as part of the material cycle.

Meanwhile, appliance recycling facilities are not necessarily operating at high capacity utilization rates, and many places also have equipment that can handle recycling of VTRs, microwave ovens, and other products. In fact, some appliance recycling plants recycle business electronics right alongside the four appliance types. Thus broadening the range of products covered by the Appliance Recycling Law is necessary to reduce the burden on municipalities, to improve the utilization rates of recycling facilities, and to raise their revenues. At the same time, the government must take regional differences into account when rewriting the regulations. For example, in Hokkaido there are few air conditioners but many kerosene space heaters, so recycling should be able to take these heaters (which are now bulky waste, including their motors), which requires changing the Fire Services Act and other regulations.

The Basel Convention As noted previously, at least 90% of TVs are imported, and it is estimated that at least 30% of old TVs are exported. What is more, even CRT recycling is down at domestic factories, and the lead glass that is recovered under the Appliance Recycling Law cannot all be reused domestically. However, if Japan abided by the Basel Convention, which prohibits the transboundary movement of hazardous wastes, lead glass could not be exported. This means that the Basel Convention cannot cope with globalizing commodity transactions. The convention was originally aimed at pollution caused during the transboundary movement of hazardous substances, or pollution caused at the receiving end, what is known as exporting pollution.[20] As such, if Japan were, for example, to take the responsibility for building eco-friendly recycling plants in receiving countries, that would be a step toward eliminating the Basel Convention's concerns. A problem arising here would be that local virgin lead would be cheaper than reclaimed lead from Japan.

Personal Computer Recycling

Personal computers are not included in the Appliance Recycling Law, but since April 2001 computers discarded by businesses must be recovered and recycled pursuant to the Law for the Promotion of Utilization of Recycled Resources. However, consumers were not obliged to do so. Consumers' computers are estimated to have accounted for 40% of the 12 million personal computers shipped domestically in 2000. Consumers own 21 million computers, and over half of all households have them. Although one study found that the average lifetime of a consumer computer is 13 years, one reason for this figure is that consumers put unwanted computers in storage instead of discarding them.

Consumers discard an estimated 9,000 tons of old computers (2001). Because junked computers increase as consumer ownership rises, this will likely more than double to over 20,000 tons, and in 10 years rise about eight-fold, thereby necessitating quick action. Currently about 80% of discarded computers are desktop models, while notebook computers account for only about 20%. Nearly all discarded personal computers have been disposed by municipalities, many being landfilled.

In response to this situation, in May 2002 the METI Industrial Structure Council's Waste and Recycling Subcommittee and the Environment Ministry's Personal Computer Recycling Panel issued a report titled "Measures to Encourage the Recovery and Recycling of Consumer-Discarded Personal Computers Pursuant to the Law for the Promotion of Utilization of Recycled Resources," which considers "setting up a system provided with flexibility that can encourage business diversity and creativity on the part of involved parties," and states that the problems should be addressed with the voluntary initiatives of manufacturers and other parties in accordance with the Law for the Promotion of Utilization of Recycled Resources (Tab. 4.5).

	Time of purchasing	Collection business	Cost bearing	municipality
Consumer use	After Oct.2003.	Japan Post	Including purchasing cost	Municipality collection
	BeforeSep.2003	Japan Post	At discarding	
Business use		Distributor business	At discarding	No collection by municipality

Source, Nikkei PC.2003.4.28、p25.

Table 4. 5 How scrapped computers are recovered

Regarding cost allocation, which is the biggest problem, the report suggests that recycling costs should be assessed when products are sold, the reason being that "because computers are small and light, consumers find them easy to carry and might very well put them out with trash collected by municipalities, and because it might even lead to illegal dumping." However, already-sold computers require the fee to be paid upon disposal, just as with the four appliance types. The cost would be ¥7,000 for a desktop computer with monitor, and about ¥3,000 for a notebook computer. Plans call for post offices to do the takeback.

In the first year (2001) of the manufacturer takeback program for business computers, personal computer makers took back about 210,000 desktops and

about 70,000 laptops. The computers and monitors jettisoned by businesses totaled about 70,000 tons, while the total recovered by manufacturers is estimated to be only 10% of that. Most of the rest were either handled by ordinary waste management companies or sold as used computers. There are already 19 manufacturers that have received "wide-area certification" (meaning permission is no longer needed for industrial waste management) to perform take-back services in 2003.[21)]

The secondary (rechargeable) batteries used in consumer electronics, communications equipment, notebook computers, and other devices are now often lithium-ion, NiCd, NiH, and other types, but in 1999 only 19% of NiCd batteries were recovered. A decision was therefore made to encourage recovery and recycling by setting out more free battery collection boxes and providing other incentives under the Law for the Promotion of Utilization of Recycled Resources.

The Growing Used Computer Market

The requirement that manufacturers take back and recycle old consumer personal computers encouraged consumers to take their computers to the used computer market to avoid the ¥3,000 to ¥7,000 recycling fee charged when discarding an old machine. In fact the used computer market is about one-tenth that of the new computer market, handling over 1 million units annually. Already IBM and NEC have entered the used personal computer market. Two of the reasons for growth of the used computer market are that consumers who just want to use email and the internet do not want new high-performance models, and new models lack attractive functions.[22)]

From this discussion we see that instead of limiting the appliance recycling system to the four appliance types, creating a more comprehensive waste management regime will make the material cycle more complete.

Building a Cyclical Society Including All of East Asia

As we have seen, East Asia already has a large product and material cycle, making it impossible to create a cyclical society conceived for Japan alone. Therefore I would like to discuss the challenges for each actor in building a cyclical society system in East Asia, while taking into consideration the proposals[23)] mentioned thus far.

First, it is essential to assemble statistical data on the used consumer appliances/electronics and automobiles that are exported. This is impossible to determine from current Ministry of Finance customs statistics. We must also find out how resources are being recycled in importing countries. In view of the need for this information, the government must start by assembling statistics.

Second, information exchange and discussions on wide-area recycling should be carried out on the government level. Haste is needed especially on issues related to the Basel Convention. The EU practices wide-area waste management on the grounds that within the EU this does not constitute transboundary movement under the convention.

Third, in relation to manufacturers, the government should consider the application of EPR to used products and those produced overseas. Unless this is done, exporters cannot escape criticism that they are trying to avoid domestic environmental regulations.

And fourth, recyclers should run recycling businesses—not only in Japan, but in other Asian countries as well—that use their technology and expertise to advantage. Of course environmental friendliness and transparency will be crucial, and they should start with pilot projects.

Box 9 China's Recycling Business

Japan exports not only electrical and electronic goods, but also many discarded products and scrap metal to China. Yet, in Japan we know hardly anything about how they are handled, transported, or processed. For that reason RE-TEM Company is using the same procedure used in Japan to build a recycling system in China.

First, recycled parts (motors, compressors, etc.) from consumer appliance processing plants in Japan are brought together at a RE-TEM-specified site where they are inspected to check for and remove hazardous substances. They are then shipped to affiliates' storage sites where they are checked again, categorized, and loaded on ships.

About a week later the products arrive in China and undergo customs inspections, and are then taken to the designated resource recovery plant in Taizhou City where they are put in storage sites according to product type. Using RE-TEM's expertise and technical guidance, Chinese workers disassemble and sort the products into aluminum, iron, copper, nonferrous metals, and plastics for reuse. Nevertheless, it is not always clear how items are being recycled there.[24] (Tab. 4.6)

	Chinese side		Japanese side	
Problems	(resource use) regulation to import of used home electric appliance from 2002 (impossible to recover usable resources)	(environmental aspect) ① Environmental pollution only by profit seeking ② After import, selling through illegal channels ③ health effect	(resource use) ① impossible to export recyclable goods ③ for Chinese recyclers, it is not easy to recycle in terms of good and quality ④ necessity of risk reduction about distribution	(environmental aspect) ① impossible to identify illegal export business ② mixture of debris through the process of export ③ danger of including hazardous substances in gray-zone waste
Measures		① dialog and cooperation with developed countries ② consistency with capacity and permitted amounts ③ environmental and health effect assessment	① diversification of waste category ② improvement of information routes with Chinese recycle business ③ filling up of software and hardware with venous distribution	① permitting system with importer of potential recycable waste ② standard setting to stop debris ③ solving gray-zone waste problems (standard setting for export)

Source: Kojima and Yoshida,2003.[25]

Table 4. 6 Problems of Japan-China recycling business and remedial measures

Summation

The Appliance Recycling Law is a milestone law in that it created a system to recover and recycle discarded consumer appliances that had theretofore been landfilled. Yet, the system is limited to four appliance types, its scheme for paying recycling fees at disposal time induces illegal dumping, and about 30% of used TVs and air conditioners are exported.

Consideration should thus be given to improving the system in four ways: (1)change the pay-on-disposal scheme to pay-on-purchase, (2)incorporate reuse and export channels, (3)make the law cover more product types, and (4)accommodate the Basel Convention.

Instead of limiting the appliance recycling system to the four appliance types, Japan can create a more comprehensive waste management regime that will make the material cycle more complete.

Chapter 5 Automobile Recycling

1 Current State of Automobile Recycling

Automobiles as Waste

It was only when the automobile shredder dust (or automobile shredder residue, ASR) dumped illegally on Teshima, a small island in the Seto Inland Sea, became a matter of public concern that the public gained wide awareness of automobiles as waste.

When end-of-life vehicles (ELVs) regarded as part of the material cycle, their first characteristic is the sheer volume-about 5 million units annually. In consideration of Japan's approximately 74-million-vehicle fleet size, that comes to one car-owning household in 15 discarding a vehicle each year. The recovery breakdown of those 5 million ELVs, which are taken out of service after an average of nine years, is: 70% or about 3.5 million are taken by Japan's approximately 50,000 used-car dealers and approximately 80,000 repair garages, and 25% or 1.25 million are taken by new-car dealers (Fig. 5.1).

Second, ELVs generate between 450,000 and 750,000 tons of automobile shredder dust each year, or about 160 kg per vehicle. Formerly ASR was landfilled in least-controlled landfill sites that lack seepage containments, but it is now taken to controlled landfill sites with seepage containments because of concerns over soil contamination. Owing to rising disposal costs and low market prices for ferrous scrap, businesses were charging to accept the scrap.

Third, for environmental considerations, the hazardous substances in ELVs require special measures. In addition to ASR itself, fluorocarbons, airbags, and other items must be recovered, while items such as lead-acid batteries and waste oil should be recycled.

From the perspective of regime/actor analysis, the first characteristic is that there has long been a huge used car market, and the recovery of ferrous scrap and other marketable wastes has a long history. Automotive dismantlers apparently account for about 5,000 of Japan's small and medium-sized enterprises, which have been removing engines and other reusable or recyclable parts from ELVs. There are about 140 companies that shred automobile hulks (what is left of an ELV after removing the engine, tires, and other parts). The metals in the shredded vehicles are recycled.

Second, by comparison with other countries Japan imports few automobiles (290,000 vehicles of a total annual 5.9 million new vehicles), but one in five ELVs, or between 800,000 and 1 million vehicles, is exported. And because automobile hulks can be sold as scrap, about 350,000 of them are exported yearly. There are concerns about environmental damage caused by improper processing in the importing countries.[1] Used parts from the large number of older scrapped automobiles are also exported in large quantities. In Vladivos-

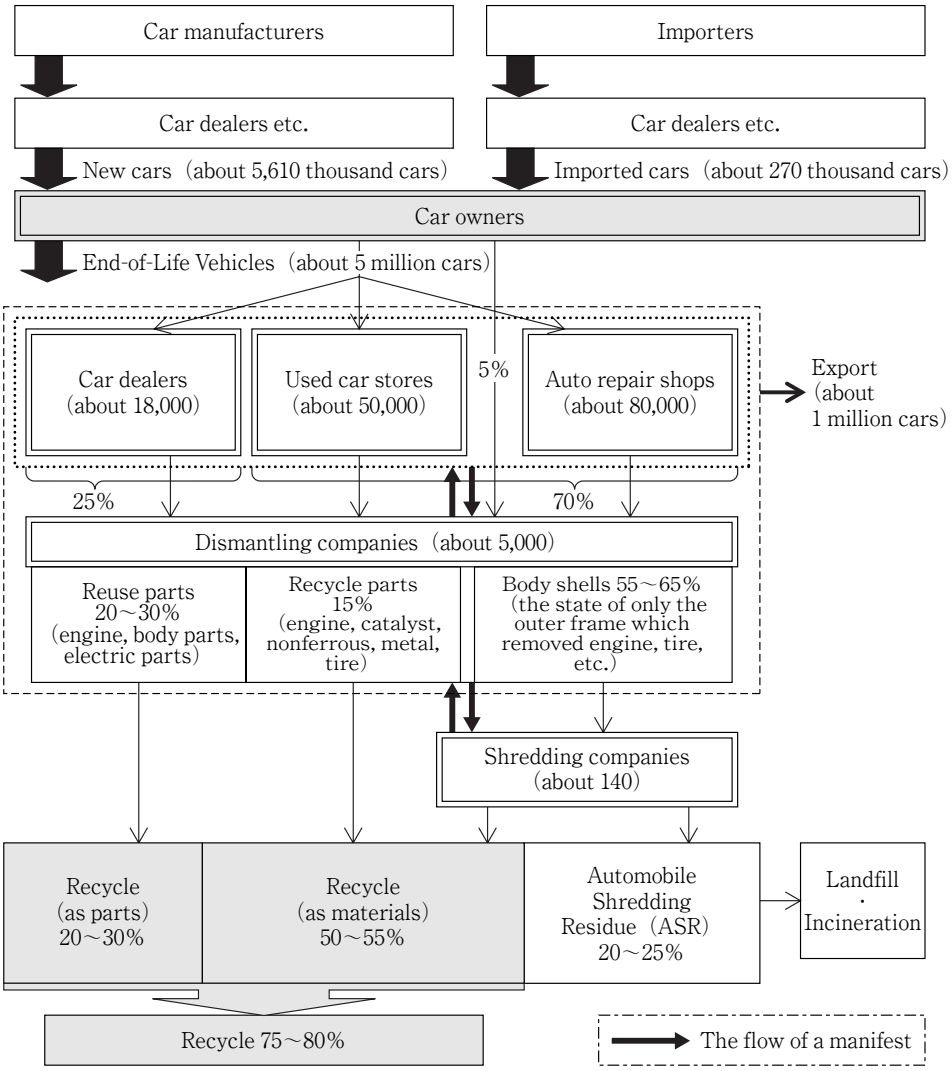


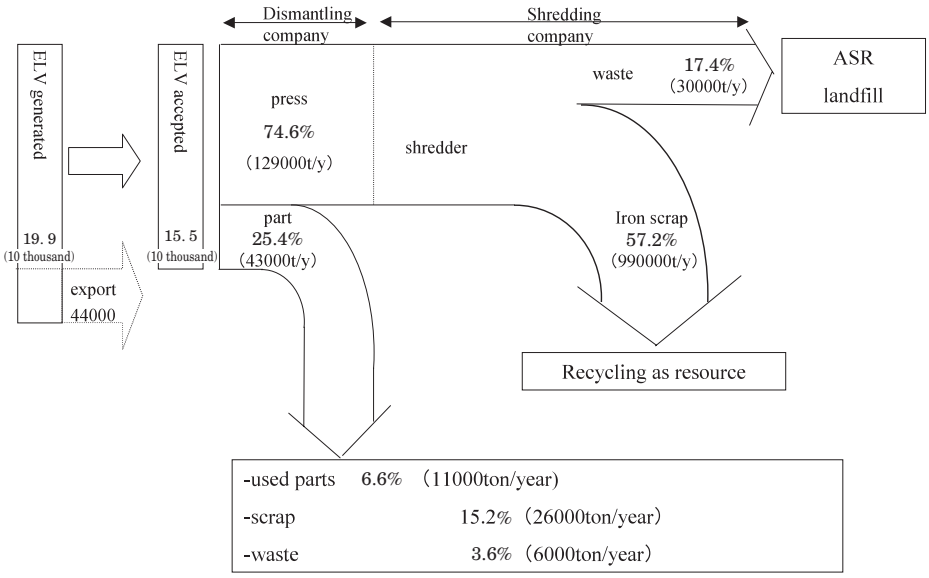
Figure 5. 1 End-of-life vehicle management

tok, Russia I spotted a Sagawa Express truck and initially thought that the company had expanded into Russia, but it was just a used truck. Over half the vehicles in the Russian Far East are used vehicles from Japan.[2)]

Paying Recyclers to Accept Waste Is Now Common (Fig. 5.2)

This section will use Hokkaido as an example for a detailed look at the problems of ELV management.[3)]

Owing to the poor market conditions for ferrous scrap and the rising costs of managing ASR and other waste, automobile shredding businesses (which cut automobile hulks into small pieces to obtain ferrous scrap) started charging to accept ELVs. Formerly businesses that dismantle ELVs (automotive dismantlers) brought in revenue by recovering and selling parts from ELVs, and by selling the remaining hulks to shredding businesses.



Source: NTT DATA, 2001.

Figure 5. 2 Management of ELVs in Hokkaido

But as shredders started charging dismantlers to accept vehicle hulks and as the costs of dismantling and other processing increased, dismantlers started charging to accept ELVs, and the practice spread throughout the ELV processing chain. The recent recovery of the ferrous scrap market is improving the situation.

The recovery and sale of parts and auto bodies is the main business of dismantlers, but the recovery and recycling rates of ELV parts, bodies, and the like (excluding tires and batteries) are not necessarily good, except for parts that sell in higher quantities. Also, most of the recovered parts that do not sell as used parts or the like end up in landfills as is or as shredder dust owing to deficiencies in the system for reuse and recycling.

Further, all the approximately 30,000 tons of ASR generated annually by Hokkaido's automotive shredders are currently disposed in controlled landfill sites with seepage containments.

Even in ELV transactions that require the payment of dismantling costs, some automotive dismantlers, because of factors such as transactions for used parts, do not charge for dismantling or, even if they invoice for dismantling costs, do not receive the invoiced amount. Because dismantlers have borne the brunt of this cost reversal, large numbers of ELVs are left sitting somewhere by auto repair garages and other parties.

Long-Term Storage by Dismantlers

Hokkaido has 66,000 ELVs in long-term storage or merely abandoned. A prefectural survey found that 61% of them are in long-term storage by automotive dismantlers (Tab. 5.1). There are concerns about them causing eyesores along roads and train lines, and polluting due to engine oil leakage and other

	Storage days			total
	Before dismantling	Process of dismantling	After dismantling	
Longest	400	267	100	607
average	60	45	16	93
shortest	1	1	1	2

Table 5. 1 Number of days Hokkaido automotive dismantlers keep ELVs in storage

causes. Reasons for long-term storage include the acceptance of ELVs in numbers that exceed dismantling capacity, dismantling which starts only after orders for parts are received, and the costs incurred in shredding. It is vital that quick remedial action be taken.

A nationwide study (released in February 2003) by the Environment Ministry on automotive dismantlers found that on average each dismantler has seven employees, dismantles about 1,000 automobiles a year, and takes 16 days from accepting an ELV to delivery of parts and scrap. By contrast, the Hokkaido study determined that ELVs are in storage much longer there. Reasons are that Hokkaido dismantlers have plenty of space, land is inexpensive, and there is little movement of ELVs in the winter.

Visit to a Dismantler

How are automobiles actually dismantled? Let's answer that question by visiting a modern dismantling plant that follows proper procedures. The company is MATEC in Hokkaido's Ishikari City. It has ¥600 million in capital investment, 22 employees, and can process 2,000 vehicles a month. The plant is joined to a shredding facility and automatic part management warehouse, and comprises seven stations.

Station 1 does preprocessing that removes tires, hoods, airbags, fluorocarbons, and tools. Tires are resold, burned as fuel, or landfilled, steel wheels are recycled for new steel products, aluminum is recycled, and tools are sold.

Station 2 removes hazardous liquids such as fuel (gasoline, diesel fuel), oil, and antifreeze. Fuels are consumed on site, oil is sent to a contractor for recycling, and antifreeze is sent to a contractor for proper disposal.

Station 3 is where actual dismantling begins, and workers remove batteries, seats, weather stripping, and fuse boxes. Batteries are sold to lead refiners, seats are used as fuel and material for making steel, weather stripping is used as fuel, and fuse boxes are sold.

Station 4 is where remaining hazardous items are removed: floor mats, soundproofing sheet, audio equipment, and plastic parts. Floor mats are sold or burned as fuel, soundproofing is fuel, audio equipment is sold, and plastic parts are put in storage.

Station 5 performs dismantling with a turner system. Workers remove engines, radiators, catalysts, running gear components, and rear windows. Engines and running gear become reused parts or ferrous scrap, some of the radiators and catalysts are sold, and some rear glass becomes road bed material.

Station 6 removes door glass, the windshield, and plastic items. Glass is used as road bed material, and plastic is put in storage.

Station 7 performs final dismantling, consisting of removing heater cores,

bumpers, lamps, and electronic instruments, after which the hulk is taken to the shredder. Instruments are sold.

Economic problems that trouble automobile dismantling are, first of all, low prices for ferrous scrap and the rising cost of ASR disposal, which induce dismantlers to charge for their services, although recently the situation is slowly improving because of ferrous scrap market recovery.

The second problem is proper ASR disposal. Dismantler-owned residue landfill sites will be full in fewer than five years, and the Eco Valley Utashinai facility that is to dispose of waste plastic is not operating yet (It was scheduled to start in the latter half of 2003, and burn municipal solid waste with plastic).

Third, in relation to the three items (fluorocarbons, airbags, and ASR) which automakers must take back, developing markets and creating networks for exported parts and domestic used parts are essential for the dismantling business. There is a supply-demand imbalance in that dismantlers cannot find enough buyers for the parts they have painstakingly sorted with manual labor.

Environmental Efforts Expected of Businesses

In 1997 the former Ministry of International Trade and Industry (the present Ministry of Economy, Trade and Industry) released its "End-of-Life Vehicle Recycling Initiative" on raising the ELV recycling rate. The ministry encouraged initiatives aimed at lifting recycling rates in automobile-related industries, and facilitated this by, in 2000, passing the Cyclical Society Law and amending the Law for the Promotion of Utilization of Recycled Resources, and in July 2002 by passing the Automobile Recycling Law.

In the past ELVs were sold by end users to dismantlers and then to shredders. For that reason dismantlers in particular worked under conditions making it easy to pollute as when handling engine oil and batteries, yet these were not treated as wastes, and guidance by administrative authorities was often lacking. ELV-related businesses did not necessarily have a very elevated environmental consciousness.

As we can see from the growth of the ISO 14001 series in recent years, the broadening initiatives aimed at creating a cyclical society and the increasing concern for the environment are inducing a need to further raise the ELV recycling rate, and to take quick environmental action to prevent pollution by leaks of engine oil and other substances, and to address noise, vibration, dust, fluorocarbons, and other problems.

Further, establishment of the 2001 "Hokkaido Ordinance for Creating a Land of Beautiful Scenery" is an indication of the growing public demand for preserving scenic views as the underpinning of the tourism industry, Hokkaido's most important. At present, however, adequate steps are not necessarily being taken on regulating the facilities and equipment of ELV-related businesses, especially dismantlers, in order to protect the environment and scenic views.

Design for Recycling

Decisive requirements for recycling automobiles are modifying their structures at the design stage to facilitate recycling and making it easy to recycle resins, which end up as ASR. An example of a design change at Nissan Motor Co., to make parts easier to remove is reducing from 32 to 12 the number of places where bumpers are attached to car bodies, thereby reducing dismantling time by 40%. Other steps facilitating material separation are making any one part using one material only, and making it easier to distinguish one material from another. Initiatives to develop easily recycled resins include expanding the use of thermoplastic resins and unifying polypropylene resins.[4)]

2 The New Automobile Recycling Law

Automobile Recycling Law

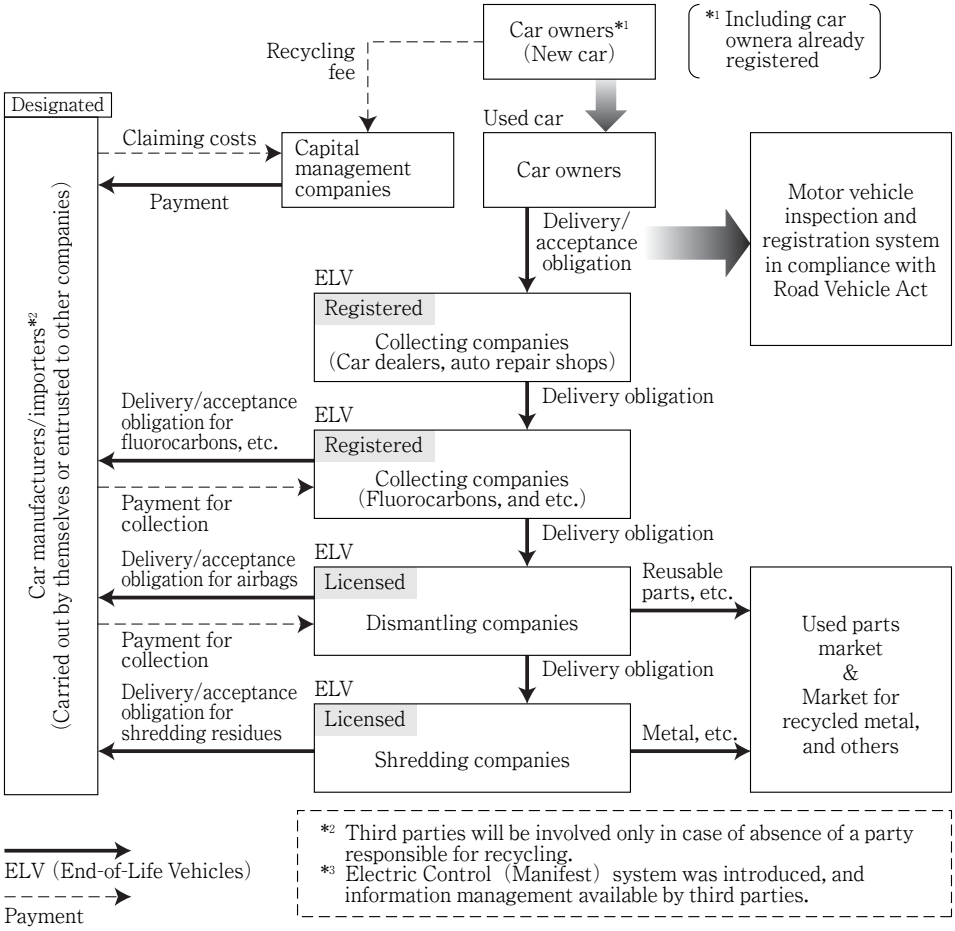
Japan's Automobile Recycling Law, which was passed in 2002 and took full effect in 2005, follows extended producer responsibility (EPR) by requiring that automakers and importers (both termed "manufacturers") take back and recycle fluorocarbons, airbags, and ASR. It also created a system that sets up rules for acceptance and delivery of ELVs by takeback businesses, dismantlers, and other such actors, and establishes recycling routes so that ASR is sure to find its way to manufacturers (Fig. 5.3).

The law requires vehicle owners to pay money to cover recycling as a recycling fee when a new vehicle is sold, or, in the case of a used vehicle, by the time of the first mandatory vehicle inspection. To prevent the loss of recycling funds due to the bankruptcy or dissolution of manufacturers, paid recycling fees are managed by a fund management corporation. Manufacturers and other actors can request payment when recycling ASR and other items. Payment of fees and their management are the two important features of the law.

Comparison with the EU's ELV Directive (promulgated in 2000) is useful to understand the characteristics of Japan's Automobile Recycling Law.[5)]

Scope of Cost Burden Although the EU directive seeks a new cost allocation arrangement for all parts of ELVs, Japan's Automobile Recycling Law narrows its scope to the three items of fluorocarbons, airbags, and ARS. As a result, it is assumed that dismantlers will bear the costs for disposal of other wastes—the parts other than those three items (such as batteries, tires, bumpers, and touch panels)—and so at issue is the question of whether users could be required to pay, something which cannot be done at present. To cover these costs, ELV businesses will for the time being probably recover and sell used parts for domestic use and export.

Resource Recovery Methods The EU directive limits the percentage of thermal recycling to 10% of all recycling by various methods, but, with the recycling of shredder dust in mind, Japan's Automobile Recycling Law puts thermal recycling on the same level as other recycling methods at processing facilities approved by manufacturers.



Source : The Industrial Structure Council.

Figure 5. 3 How the Automobile Recycling Law works

Cost Allocation The EU directive either requires manufacturers to take back ELVs, or makes them shoulder all or a considerable portion of their disposal costs. The specifics are left to individual countries. Germany uses internalization, in which manufacturers are required to accept ELVs brought to them by users.

Japan's law adopts the "separate-framework" system, in which manufacturers separately collect recycling costs from vehicle owners in advance. Criticism[6] of this system is that imposing the responsibility for payment on producers overlooks the provision of incentives to make products suited to recycling.

Cost Payment Methods Although the EU directive does not prescribe ways to manage and disburse funds, an example of how member states do this is Sweden's system, in which the recycling costs for vehicles put on the market prior to 1998 are paid out of a fund from the pooled fees charged on new vehicles. This is called the pension fund method because it does not have a one-to-one

correspondence between fees collected and money disbursed.

On the other hand, Japan's Automobile Recycling Law uses a self-payment system with a strict one-to-one correspondence, in which owners pay the fees for their own cars.

Japan's adoption of a separate-framework, self-payment system causes two problems. First, the one-to-one correspondence means that sometimes fees are paid back. A deposit can be returned if a vehicle is exported as a used automobile, but it cannot be gotten back if a vehicle is exported after partial dismantling and pressing in Japan. It is therefore anticipated that more vehicles about to be scrapped will be exported as used vehicles, and in fact there are increasing exports of used vehicles and pressed ELV scrap to answer demand created by China and other fast-growing economies.

The other problem is that the emergence of a corporation to manage the fund collected under the separate-framework arrangement signifies the birth of a huge investment institution that manages a fund of at least ¥1 trillion. Many people criticize this for bucking administrative reform, which aims to reform public-service corporations. The designated corporations relating to the Automobile Recycling Law are: (1)an information management center (receives reports from auto-related businesses about vehicles to be scrapped, and manages information on ELV takeback and delivery), (2)a fund management corporation (manages deposits, i.e., recycling fees), and (3)a designated recycling institution (takes care of recycling for small manufacturers that cannot do it themselves). The Automobile Recycling Promotion Center was designated as all three.

A certain portion of the 70 million currently registered vehicles will be scrapped instead of receiving the mandatory vehicle inspection, and a considerable portion of those scrapped vehicles is expected to emerge during the first two years after the Automobile Recycling Law becomes effective. It is possible that recycling fees cannot be received from the users who scrap those vehicles. Another problem in existence since before the law is the removal and recycling of abandoned vehicles.

Action on Hazardous Substances The EU directive considers reducing hazardous substances important, and sets forth a definite schedule for banning the use of certain substances. Japan's Automobile Recycling Law does not include any such definite provisions, and leaves the matter to voluntary industry initiatives.

Under the EU's ELV Directive, the general ban on the use of lead, mercury, cadmium, and hexavalent chrome became effective on new vehicles that are sold beginning in July 2003. In addition to batteries, at least 200g of lead are used in each of several applications including copper radiators, battery cable terminals, wheel weights, and fuel tanks. Mercury is found in light bulbs and instruments, cadmium in electronic circuits, and hexavalent chrome in the anti-corrosion coatings on parts. Owing to these restrictions, Japanese automakers too have started producing cars that comply for export to the EU.[7)]

More Transparency in Fluorocarbon Management

Fluorocarbons recovered under the Automobile Recycling Law are already being recovered and disposed beginning in October 2002 in accordance with a "fluorocarbon coupon" system based on the Fluorocarbon Recovery and Destruction Law, but this system does not necessarily work well. Users pay the cost for fluorocarbon recovery and disposal when scrapping their vehicles. In the system's first six months about 700,000 of the coupons were sold at a price of ¥2,580 each, one coupon per vehicle, yet only one half, or about 340,000 coupons were used to request disposal costs. One reason that comes to mind is that in many cases the fluorocarbons were removed and reused, giving rise to concerns of atmospheric releases.[8] Compared with the initial fluorocarbon charging amount in 2002 (half year), the estimated recovery rate was only 29% and the estimated destruction rate was just 12%.[9] Because the Automobile Recycling Law allows fluorocarbon reuse, after the law comes into force a system will be needed to eliminate the intransparency about fluorocarbon disposal and make sure that disposal is properly done.

Industry Reorganization Induced by the Automobile Recycling Law

The newly effective Automobile Recycling Law has not a little impact on not only (1)preexisting automotive dismantlers and shredders, but also (2)ASR recyclers and (3)the automobile industry itself. This section explores how the law's new system affects the various actors.

First, businesses that accept ELVs and that recover fluorocarbons must register with their prefectural governors, and dismantlers and shredders need permits from their governors. Businesses which already have permits under the Wastes Disposal and Public Cleansing Law are considered to have permits under the new law if they submit notifications within a certain period of time, and 74% of Japan's dismantlers had obtained permits by the end of 2002. Thus especially dismantlers will in fact need permits as waste management businesses in order to survive, and the requirement that dismantlers recover, separate, and recycle waste oil and waste liquids will likely force many small businesses which cannot make the grade to shut down. Additionally, some shredders are also getting into the dismantling business, leading to consideration of dismantlers working together or grouping.

Second, because this new law calls for recycling ASR, it led to the appearance of a new actor called ASR recyclers to whom automakers and importers pay fees when commissioning them to perform recycling. This more sophisticated ASR processing comprises roughly two types: (1)gasification-melting processing (steelmaking) and (2)nonferrous metal refining, and they are being developed by manufacturers in various industries. The latter suffers from siting limitations, but is considered to have the advantage because it generates stable income from processing and selling recycled resources. Because the government is seriously considering allowing shredder dust thermal recycling to a large degree when the law becomes effective, the technologies of ferrous and nonferrous metal refiners will probably take the mainstream in both types of ASR processing. Additionally, it is anticipated that other businesses

will be entering the automotive dismantling and recycling field, such as existing shredders and papermaking companies (which burn old tires).

Third, automakers are taking their own initiatives. The relationship between automobiles and the environment is multifaceted, and can be divided roughly into (1)the emission burden of automobiles themselves when in use, (2)the burden when being manufactured, and (3)the burden when being dismantled. The Automobile Recycling Law affects mainly(3). By requiring automakers to recycle fluorocarbons, airbags, and ASR, the law induces them to take action on ASR and to make their vehicles easier to dismantle and recycle. Through Toyota Metal, the Toyota Motor Corporation has entered the shredding business, by which it provides for the reuse of used parts and the increased use of recycled materials (Tab. 5.2). Nissan Motor Co., created a Recycling Promotion Office and is conducting demonstration research on ELV dismantling to assure the reliability of used parts and to pursue design for recycling. Honda Motor Co., is doing research on dismantling jointly with a venture-type recycling business that is a new entry in the field, and is providing for the use of rebuilt parts. It will be necessary to carefully watch trends with regard to efforts by automakers at "monopolizing" and "business grouping" the existing automotive dismantlers.[10)]

Recycling fees are supposed to be set and publicly announced by each automaker so as to assure competitiveness, and automakers are required to abide by and publicly announce the recycling standards for ASR and airbags, while dismantlers, shredders, and other businesses must follow more detailed provisions.

Area	Goals	Present status (in Japan)
Steady improvement in vehicle recovery rates in Japan and Europe	Japan:Early achievement of legal targets *1 Europe:Steady progress toward achieving legal targets *2	Vehicle recovery rate of 81% to 83%
Use of renewable resources and recyclable materials	Establishment of technologies for use in 20% of resin parts by 2015 (Total for Toyota eco-plastics and recyclable materials)	Began use of Toyota eco-plastics with the new Raum in May 2003
Expansion of reuse of parts	Tenfold increase in quantities sold by 2010 (compared with 2002)	Quantity sold in 2002: 23,000 parts/year
	Established the Toyota global standard in 2003	Creation of basic policies for global response
Reduction of substances of environmental concern	Introduction from 2006 of vehicles completely free of four substances *3 (in Japan and Europe) (Some parts exempted)	Average amount of lead in new vehicles in 2002 reduced to one-sixth or less the average amount in 1996

*1 ASR recovery rate of 30% (equivalent to a vehicle recovery rate of 88%) in fiscal 2005, of 50% (equivalent to a vehicle recovery rate of 92%) in fiscal 2010, and of 70% (equivalent to a vehicle recovery rate of 95%) in fiscal 2015.
*2 Vehicle recovery rate of 85% in 2006 and of 95% in 2015.
*3 Lead, mercury, cadmium, and hexavalent chromium; level for lead in Japan are one-tenth of less compared with 1996 values (similar values for the EU)

Table 5. 2 Toyota's "Recycling Vision" (released in June 2003)

Competition in Developing ASR Processing Technologies

The Automobile Recycling Law induced the appearance of ASR recyclers which are competing in the development of ASR processing technologies. Lead-

ing the pack are the nonferrous metal refiners, which already have such technologies.[11)]

Kosaka Smelting Company in Akita Prefecture is a smelter with a technology for processing "black ore" (kuroko), and it is already in full-fledged operation processing 4,000 tons of shredder dust monthly. The shredded material Kosaka accepts is a mixture of items including ASR, shredded electroscrap, and low-grade printed circuit boards. After shredding these items over again, the product is put in a fluidized bed incinerator to recover valuable metals and energy. The metals are put into the company's flash smelting furnace for refining. Kosaka has an advantage because it has a copper flash smelting furnace, a converter, and an electric furnace for lead. But recycling accounts for only about 20% of Kosaka's business, and it depends on the continuance of its copper (custom ore) refining business, which is the company's mainstay. Here one can see the waste management/recycling industry developing in tandem with the manufacturing industry.

The Onahama Refining Company in Fukushima Prefecture performs contract refining of copper ore. Because it has an old-type reverberatory furnace, after the oil shocks it tried different fuels, and in 1993 it started using ASR as fuel. It can also use shredder dust other than ASR (such as that from personal computers, cell phones, and pinball machines), and has an advantage in that it can use existing equipment such as its electrolysis process (10,000 t/month capacity).

The Naoshima Refining Company in Kagawa Prefecture uses the MI method, which can continuously process copper ore. In addition to the intermediate processing of the Teshima Island ASR, it also plans to recover metals from the bottom ash and fly ash from incinerated municipal solid waste (MSW), and from shredder dust.

Additional development competitors are the shredder dust processing furnaces that use steelmakers' melting furnaces (Nippon Steel Corporation, JFE, Sumitomo Metal Industries) and the furnaces of nonferrous metal processors (Mitsui Engineering & Shipbuilding, Takuma, Hitachi, etc.).

The direct melting furnace at the Eco Valley Utashinai facility in Hokkaido, which can process 100 tons of shredder dust daily and 70 tons of combustible MSW daily, burns coal and coke. Despite problems at first, the facility asked suppliers to perform thorough shredder preprocessing, adopted stricter acceptance standards, after shredding upped calories by using combustible MSW with no kitchen waste. Its processing cost for combustible waste is ¥150,000 per ton, and lower for shredder dust.

What is more, automakers themselves are developing ASR processing technologies. Nissan developed a technology which prevents the sticking of combustion residue by lowering the temperature of waste heat produced when incinerating shredder dust. Companies that have boilers which use the waste heat from existing incinerators need only change the material of the heat duct to one with high heat conductivity, getting by with 1／20 th of the cost of building a new facility of the same size.[12)]

Shredder dust processing is performed by two groups: one group of eight

companies including Nissan, Mitsubishi, and Mazda (foreign-owned), and another including Toyota and Honda.[13)]

Automakers must also take back and recycle airbags as well as ASR. They intend to contract with automotive dismantlers which will perform in-vehicle airbag deployment and bring all inflators to a central recovery point where they will be processed. The required airbag recycling rate (weight basis) is at least 85%.

Recycling Without Shredding

Work is also proceeding on developing methods that do not generate shredder dust. For example, West-Japan Auto Recycle Co., (in Kitakyushu Ecotown) recovers nonferrous parts such as harnesses with their copper content in its nonferrous recovery process, leaving a remainder that is mainly ferrous. This is formed into cubes with a triaxial press and provided as ferrous scrap for converters. Of the greatest significance here is the advance recovery of copper. If the government certifies that a processor "makes a major contribution to waste reduction and the effective use of resources" (Automobile Recycling Law, Article 31), that processor can receive payment for shredder dust disposal through the system.

Remaining Challenges

But the Automobile Recycling Law must still address many problems. Professor Katuya Nagata (Waseda University), who was involved in designing the law in the Ministry of Economy, Trade and Industry's Industrial Structure Council, notes that the law must still address these areas[14)]:

- Come into line with the Fluorocarbon Recovery and Destruction Law, which became effective first.
- Serve outlying islands (it is now possible to use some surplus funds from recycling fees).
- Dispose of abandoned automobiles.
- Determine the overall flow of vehicles, including used vehicle exports and recycled parts.
- Determine the place of ASR recycling technologies, especially chemical thermal recycling.
- Develop measures to encourage reuse (recycled and rebuilt parts).
- Take action on the approximately 130,000 already illegally dumped vehicles and those stored outdoors (it is now possible to use some surplus funds from recycling fees).
- Work toward an integrated solution by strengthening the linkage with current recycling systems for tires, batteries, and catalysts.

To solve these problems it is essential to build a system based on an automobile material cycle, to assign roles for each actor, and to have their cooperation.

Box 10 Recycling ELV Batteries

The underground cosmic ray observatory Kamiokande, which was the site of research that received the Nobel Prize in physics, was constructed in the Mozumi shaft of Kamioka Mine in Kamioka, Gifu Prefecture. Kamioka Mine (formerly operated by the Mitsui Mining & Smelting Co., currently owned by the Kamioka Mining Co.), also known as the source of the pollution that caused Itai-itai disease, was Japan's largest lead and zinc mine, but mining operations stopped in 2001. Since 1995 its lead refining division has been recycling lead of scrapped auto batteries from inside Japan, amounting to one-third of all that processed domestically. Each year this division processes 48,000 tons and produces 30,000 tons of recycled lead.

Refining to recycle lead works like this: The spent batteries are shredded and then put into a melting furnace with scrapped circuit boards to produce pig lead. This is subjected to electrolysis to obtain high-purity lead. The plastic battery containers are also reprocessed and used in factory pallets. The process also neutralizes the dilute sulfuric acid to render it harmless. Cadmium emissions from the mine now approach the background level. Applauded for its initiatives on zero emissions, in 2002 the company was awarded the Prime Minister's Prize for its efforts on the Three Rs: reduce, reuse, and recycle.

The company is covering the cost of recovering scrapped batteries with its earnings from precious metal recovery and self-produced hydropower, but problems it faces are that the LME market price of pure lead is lower than the market price of recycled lead, and the challenge of securing a recycled lead market.

Summation

Automobiles are sophisticated industrial products using ferrous metals, various plastics, and a large variety of other materials. Thus from the perspective of the material cycle, automobiles involve a very large number of actors if part manufacturers are included. Thus far ELV dismantling has relied on the sale of used parts and the market price of ferrous scrap to cover the costs of shredder dust disposal, but a depressed ferrous scrap market and demands for more advanced shredder dust processing brought pressure to drastically revamp the system. This led to passage of the Automobile Recycling Law, but this law requires the recovery and recycling of only three items: shredder dust, fluorocarbons, and airbags. Nevertheless, the law has a big impact on the ELV dismantling industry. Further, automakers are having to reconsider design for recycling and what materials to use.

Chapter 6 Recycling in the Construction and Food Industries

1 Recycling of Construction and Demolition Waste

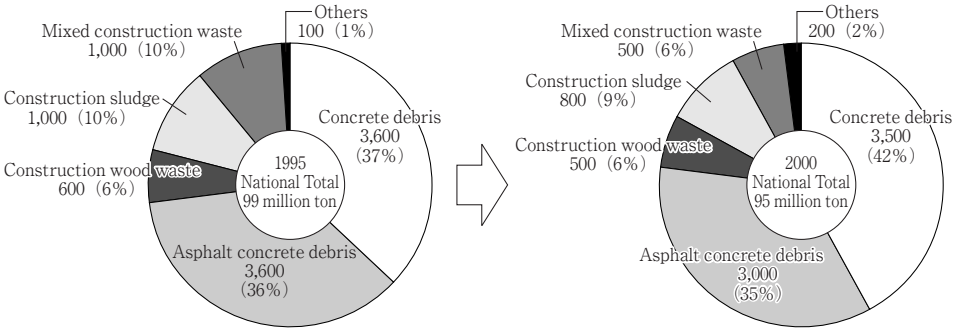
Large Quantities of Construction and Demolition Waste

A wooden house covering 100 square meters weighs about 40 tons if its concrete foundation is included. Since a home emits about a ton of waste each year, the house itself equals 40 years of waste, and this amount is generated all at once when demolishing a house. One can see how heavy and bulky demolition waste is.

Construction and demolition (C&D) waste is a category of industrial waste and comprises many types of waste including demolition waste (concrete and asphalt concrete debris), sludge (construction sludge), and wood waste (generated from construction), as well as waste plastic (waste PVC pipe, etc.), and glass and porcelain (broken glass, roof tiles, and wall/floor tiles, etc.). The construction industry uses half of all the natural resources used by all industries. In 2001 C&D waste accounted for about 19% (76 million tons) of the total approximately 400 million tons of industrial waste generated by Japanese industry, and about 30% of the approximately 50 million tons of industrial waste given final disposal. It also accounted for about 60% (240,000 tons) of the 400,000 tons of illegally dumped industrial waste.

Therefore from the perspective of the material cycle, C&D waste is a major portion of industrial waste, and qualitatively it includes hazardous wastes such as asbestos and waste PCBs.

Industrial waste types are ranked as follows by percentage of total emissions: concrete debris (42%), asphalt concrete debris (35%), construction sludge (9%), construction wood waste (6%), and mixed construction waste (6%). Meanwhile, the amounts of illegally dumped C&D waste are 40% each for demolition waste and wood waste. These percentages reflect the difference in recycling rates: while the recycling rate of asphalt concrete debris is be-



Source : Investigation of Ministry of Construction.

Source : Investigation of Ministry of Land, Infrastructure and Transport.

Figure 6. 1 Emissions of selected construction and demolition waste types

tween 96 and 98%, wood waste from construction is 61% (89% if one considers "volume reduction" achieved by incineration), construction sludge is 69%, and mixed construction waste is 36% (2002). (Fig. 6.1)

Behind the Increase in C&D Waste

Finding the reasons for the rising amount of C&D waste requires a look at the innovation in construction technologies since WWII.

First, in the field of architecture, for the construction of flexible-structure high-rise buildings engineers developed materials such as artificial aggregate and lightweight concrete, as well as high-strength steel and H-beams. In the field of civil engineering there was increased use of machinery and progress in switching to steel bridges, concrete bridges, and composite girder bridges. This resulted in high demand for metals, and spawned a source of ferrous scrap.

Second, housing production was industrialized, with builders making efforts at using new building materials (plywood, hardboard), componentization (aluminum window sashes, stainless steel sink/counter assemblies), and unitization (unit baths). Prefabricated housing construction also made strides. There was growing demand for aluminum and other new materials, which became a source of mixed C&D waste.

In connection with energy consumption, Japan's automobile fleet grew dramatically in tandem with road construction, and this naturally increased the use of concrete asphalt, and steel. It was indeed a trinity comprising automobiles, roads, and petroleum.

Additionally, urban planning in postwar Japan gave insufficient consideration to townscape preservation, which allowed cities to remake themselves in a scrap-and-build manner that generated vast amounts of C&D waste, another factor behind the increase in such waste.[1)]

The Reasons for C&D Waste

Using research[2)] that takes the most detailed look at the relationship between the construction industry and waste, this section will explore the mechanism which generates and increases C&D waste, and where the problems lie. The amount of C&D waste generated in 1995 by the construction industry as a whole was nearly three times that of 1980, rising to about 99 million tons, or almost twice the 50 million tons of municipal solid waste (MSW) generated annually. It appears the cause is not only the concrete and asphalt debris that are the largest portion of C&D waste, but also the large amounts of sludge, and broken and scrap wood, metal, glass, and porcelain that are now generated.

To begin with, 36.4 million tons (1995 data) of concrete debris are generated annually nationwide. Concrete civil engineering structures must be rebuilt after 50 years or at most 100 years, while buildings last about 40 years. As such, even if only about 10% of the concrete currently used has become concrete debris at this time, in the future the amount of debris generated will grow exponentially. An even more important point is that the floor space of demolished buildings, which is used to estimate the amount of concrete debris

generated, is increasing at a much faster rate than concrete use is, which indicates the great extent to which scrap-and-build has characterized urban development since 1965. Japan's construction market has an unusually high percentage of new buildings in comparison with other developed countries, while it has a low rate of maintenance and repair (15% in 1995). Britain, for example, has a maintenance and repair rate of about 50%.

With more roads being built, asphalt demand soared beginning in the second half of the 1950s, and demand fell temporarily during the oil shocks, but the five-to 10-year lifetime of asphalt pavement generated a massive amount of asphalt concrete debris that in 1995 was 36 million tons.

Excavation for civil engineering projects produces a muddy substance from the mixture of groundwater and the water and soil used in construction. Further, excavation methods and other procedures which use slurry that is artificially prepared generate a muddy type of industrial waste called construction sludge. Although technologies for the processing and reuse of construction sludge have been developed, the increase in subway, sewerage, and tunnel construction, and in building foundation construction, as well as innovation in technologies such as the slurry shield method, seem to be increasing the amount of construction sludge.

When demolishing buildings, demolition contractors first remove all they can of ancillary items such as concrete structures, pillars, beams, room partitions, roof files, wall/floor tiles, sanitary porcelain fixtures, electrical wiring, plumbing, and sinks/washbasins. Unwanted electrical appliances, furniture, carpeting, and other items are often left. Most demolition contractors would formerly machine-demolish buildings without separating these first, thereby generating C&D waste that mixed these in small pieces. Such waste contained waste plastics, PVC pipe, and other organic substances which in least-controlled landfill sites would often produce contaminated leachate and combustible gas.

As this discussion illustrates, the fact that public works expenditures by Japan's national and local governments, i.e., general government fixed capital formation, are two to three times higher than those of other countries is behind the large amount of C&D waste generated. With public works and the construction industry being used to stimulate the economy from time to time, one can see what a heavy burden scrap-and-build national development has imposed on the environment.[3)]

More Construction Byproducts in the Future

Buildings that went up during Japan's rapid-growth period will need replacement in the coming years, and it is anticipated that emissions of construction byproducts (surplus soil from construction and C&D waste) will surge. The Development Bank of Japan calculates[4)] that the total amount of construction byproducts generated (excluding surplus soil) will in 2010 be twice (313 million tons) the amount generated in 2000 and will in 2030 be 2.7 times (415 million tons) the 2000 amount. Especially between 2000 and 2010, when buildings from the 1970s must be replaced, construction byproducts will in-

crease at the high annual rate of 7.5%. At the same time, using civil engineering construction projects as the basis for estimating the amount of surplus soil generated yielded high results similar to those for construction byproducts: about 1.6 times higher than 2000 in 2010, and about twice as much in 2030.

Box 11 Reduction and Recycling of Excavated Soil from Gas Pipeline Construction

Formerly, the Road Law required that gas pipes be buried 1.2 meters deep, but a 1999 Ministry of Construction notification allowed them to be at a shallower depth, which also meant digging narrower trenches. This in turn provided for generating much less surplus soil, using less pit sand for backfill, causing less road traffic congestion because of construction, and shortening construction time.

Because laying gas pipes usually involves digging up roads, this generates excavation soil and asphalt debris. For that reason Osaka Gas Co., created an integrated system to reuse road debris, and developed a vehicle-mounted excavation soil regeneration plant and a simple screening separation method. In 2001 its recycling rate was 67%.[5)]

C&D Waste-Generating Mechanism

Let's examine the C&D waste-generating mechanism from the perspective of regime/actor analysis, which brings up a matter that is peculiar to the construction industry: its subcontracting system. There are large general contractors with a multi-tiered hierarchy of subcontractors below them. On a demolition site, for instance, one will find the demolition contractor, and the multi-tiered demolition subcontractors, collection and transport contractors, intermediate processing contractors, final disposal contractors, and other actors.

Demolition costs are often included in construction costs for new buildings, which works to hold demolition costs down.

The most troublesome C&D waste is said to be mixed C&D waste, whose recycling rate is about 36%, and much of which is illegally dumped or improperly disposed. Major reasons for this are that heavy equipment has developed to the point where buildings can be quickly and economically crushed into small pieces without sorting anything, and that it has been possible to perform demolition work without a construction business permit. If total costs for demolition and waste disposal are calculated assuming proper waste disposal, separating materials during demolition costs less than crushing everything into a mixture. However, when disposal costs are saved by illegal dumping or other improper disposal, the lowest price is achieved by combining this with crushing demolition.[6)] Over half of all illegal dumping is by waste generators.

What are the motives for improper disposal and illegal dumping? Data from the Metropolitan Police Department on the arrests made for illegal dumping of industrial wastes show motives (2000). The largest category, about 54%, is dumpers who "wanted to reduce disposal costs," followed by "planned

on illegal dumping from the outset" and "long distance from the disposal site."

As this shows, the main cause of illegal dumping is "reducing disposal costs," i.e., what in economics is known as profiting by economizing on invested constant capital. Therefore, the biggest cause of illegal dumping is a system which allows waste generators and waste management companies to profit from it. The industrial waste intermediate processing business, which is vital to recycling, currently has about 5,000 companies with combined annual sales of about ¥ 2 trillion. Most of the companies are small and medium enterprises, and each has an average of about 20 employees. A 1993 questionnaire survey of proprietors about C&D waste recycling found that only about three in 10 of these companies turn a profit.[7] As such, the causes of improper C&D waste disposal are economic pressure to cut demolition costs and the multi-tiered subcontracting structure.

C&D Waste and Illegal Dumping

The large amount of C&D waste is a primary cause of illegal dumping and improper disposal. According to Mr. Masayoshi Ishiwata, whose work I will discuss in detail in the next chapter, waste produced when demolishing wooden homes is the most problematic type of C&D waste. While crushing is not the main type of demolition, almost all the wood debris is incinerated even if separated. Much of it is burned in demolition contractors' own incinerators, while tougher restrictions on outdoor burning and small incinerators are actually increasing illegal dumping.[8]

Because it is individuals who request the demolition of wooden homes, those individuals and not just demolition contractors have considerable responsibility for industrial waste. A crucial step for solving the demolition waste problem is therefore raising demolition fees, which are already below the minimum for proper disposal. Additionally, there are not enough facilities capable of proper disposal.[9]

Construction sludge also has a low recycling rate. Forced to cut costs owing to the construction industry slump, big construction firms have developed several kinds of sludge recycling technologies, but although construction sludge is heavily regulated as industrial waste, surplus soil is entirely free of regulation thanks to a small difference in moisture content, and that translates into a big difference in disposal costs, an absurd situation.[10] Construction projects generate nearly 300 million cubic meters of surplus soil each year. About 30% of this immense amount gets recycled, and the other 70% goes into landfills. In terms of amount, this is far larger than the approximately 2 million tons of sludge that are disposed each year.[11] What is more, there is a danger that contaminated soil is being spread far and wide by calling it surplus soil. One local government to try and regulate this is Chiba Prefecture, which enacted a surplus soil regulation in 1998. Taiheiyo Cement Corporation developed a technology to detoxify contaminated surplus soil and put it to use as cement feedstock. This technology heats the soil to at least 1,000℃ in a special heating furnace and removes heavy metals and oil by vaporizing them. Start-

ing in 2004 the company installed heating furnaces at its plants around Japan, apparently investing ¥10 billion.[12)]

Construction Recycling Law (Fig. 6.2)

Primary features of the Construction Recycling Law (Building Construction Materials Recycling Law), which was promulgated in 2000, include: (1) the required sorting and recycling of demolition waste, (2)contracts between demolition customers and contractors, and (3)creation of a registration system for demolition contractors. Indeed, C&D waste is being handled better thanks to a ban on outdoor incineration, stricter regulation of small incinerators, establishment of the Special Measures Law on Dioxin Control and the Construction Recycling Law, and tougher regulations on C&D waste. But there is criticism of the Construction Recycling Law because the proviso of its Article 16.1 allows volume reduction (i.e., incineration) "when there is no recycling facility within 50km" and "when necessitated by geographical or transportation conditions even when there is a recycling facility within 50km." Because the law allows incineration by calling it volume reduction, the development of a recycling market which, for example, uses wood waste as raw material in blast furnaces and plastic as concrete forms will perhaps not progress as anticipated.[13)]

From the actor perspective, the Construction Recycling Law requires demolition contractors (waste generators) to sort demolition waste and recycle it, but there is no clear requirement to ensure that those who request demolition (customers) shoulder any costs. Further, demolition contractors are supposed to report to their customers on the completion of recycling, but it is quite possible that both actors will conspire to circumvent the law.[14)] This has led to proposals for linking proof of proper demolition with building certification, and for a security deposit system to assure proper demolition and recycling.[15)]

Initiatives by Major Construction Companies

The construction giant Obayashi Corporation started tackling environmental problems long ago. Let's use Obayashi's environmental report[16)] to examine the reduction of C&D waste. In 2001 the company generated close to 1.4 million tons of C&D waste, of which roughly half, or 690,000 tons, was from demolition. While the final disposal rate excluding sludge was 9%, Obayashi generated 800,000 tons of sludge, and subjected about 25% of that to final disposal.

Construction of the Marunouchi Building serves as an example of an effort toward 100% recycling of C&D waste.

Efficient waste sorting: Obayashi put recycling stations with sorting pallets on each floor of the building, and workers sorted wastes into 13 to 21 categories. An intermediate processing contractor was on site at all times for sorting guidance and processing.

Recycling: The approximately 5,400 pine piles that supported the former Maru Building's foundation went to a lumber mill and to a paper mill where they became kraft paper for envelopes and shopping bags. Polystyrene foam that had been used as packing material was compacted by equipment installed

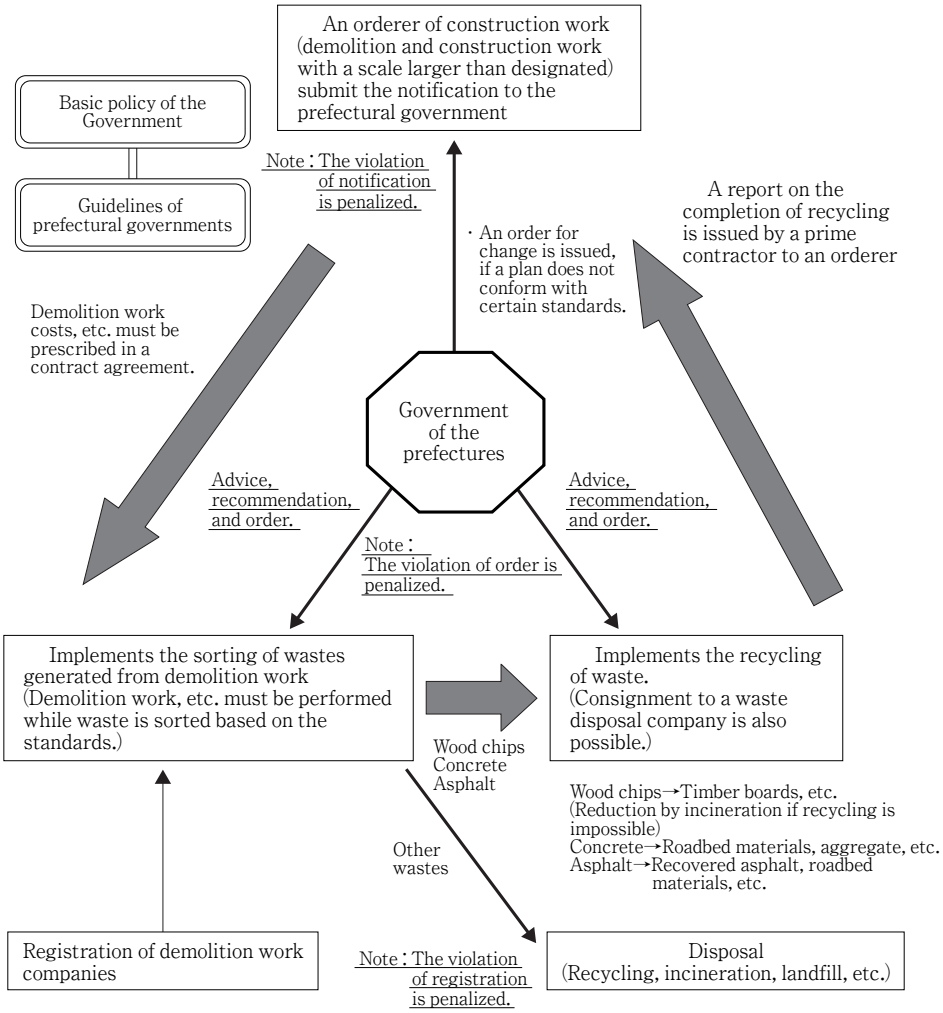


Figure 6. 2 Construction Material Recycling Law

on site, then went to a reprocessing facility where it was made into plastic flower pots.

Repair and Recycling of Office Furniture

Figuring out how to reduce the amount of discarded office furniture is an important part of dealing with C&D waste because such furniture is discarded when buildings are demolished. For that reason the office furniture manufacturer Okamura Corporation founded a company specializing in the maintenance, inspection, repair, cleaning, and refurbishing of office furniture to provide for its reuse. To recycle furniture, it recovers unwanted items and dismantles them into their constituent materials for recycling. Sixty percent of recovered furniture is reused or recycled, especially products made of steel.[17)]

2 Food Waste Recycling

Sixty Percent of Industrial Waste Is Biological Waste

Sewage sludge, livestock waste, wood waste, and other organic biological wastes account for the largest portion, 60%, of industrial waste. In terms of the material cycle, 280 million tons of these biological wastes are generated annually, an amount that, as the equivalent in fertilizer components, far exceeds the amount of chemical fertilizers used in a year (2.6 times that amount as nitrogen equivalent). If 1960 is the baseline year, the amount of nitrogen emitted into the environment with the flow of human food and animal feed in 1992 was about 1.5 fold.

Under 50% of the food waste discharged as industrial waste in food manufacturing processes (over 4 million tons) is recycled. By comparison, only about 800,000 tons of the food waste generated as ordinary business waste by supermarkets and restaurants (5.5 million tons) and that generated as MSW (12 million tons) are recycled (2000 data).

If all the biological waste currently generated were recycled by composting, Japan would have to make big changes in present agricultural production practices, such as using the compost for at least 50% of necessary plant and crop nutrients and raising cropland utilization by at least 30%.[18]

Examining biological waste recycling from the regime/actor perspective turns up the following problems. (1)Citizens/consumers tend toward a gluttonous lifestyle and depend too much on the public sector to deal with the waste. Needed actions include generating less kitchen waste, participation in separate collection, and networking their initiatives. (2)Businesses likewise have an over-dependence on the public sector, as well as on chemically synthesized materials. Their challenges are environmental management, collaboration with other businesses, and networking with consumers and farmers. (3)The administrative sector has the problem of inadequate institutions, and needs to remedy this through institutional design and coordination.

As an example, recycling wood waste requires the cooperation of many actors: (1)cooperation among waste generators to separate and recover wood during demolition, and compliance with acceptance standards; (2)choosing the best kind of recycling in line with waste characteristics; and (3)using the recycled materials. No material cycle will be established unless these three activities proceed in unison.[19]

The Environmental Burden of Fresh Food

What environmental burden is imposed by food production and distribution? The major supermarket chain Seiyu reported the results of a study that investigated ripe mandarin oranges from the perspective of waste and CO_2 emissions. Oranges harvested in the Omishima area of Ehime Prefecture are transported 790 km by large trucks from the fruit shipment center to distribution centers in the Tokyo area. Using rail transport instead of trucks reduces carbon emissions to one-tenth. Because oranges are left sitting for one week from harvest to shipping, they can take their time on the train.

In terms of waste, however, even if orange growers produce 120 tons of ripe mandarin oranges, only 82 tons of them will actually be eaten by consumers. Twenty tons are discarded at the shipping center after sorting for size and removing spoiled oranges. A decision was made to use some of the oranges for making juice. Also, running the oranges through a sizer breaks the oranges' capillaries, which can degrade taste.[20)]

Food Waste Recycling Law (Fig. 6.3)

This law, which entered into force in 2001, is meant to reduce the amount of food waste generated by food processing plants, restaurants, and other businesses. Behind the enactment of this law are the insufficiency of landfill space and dioxin from incineration facilities. The law sets a reduction target of 20% off the 2001 level by 2006.

Specifically, the law requires that businesses (1)generate less food waste, (2)reduce waste volume through drying and other means, and (3)reuse it as compost or animal feed, or in other ways. When initiatives by businesses generating at least 100 tons a year are seriously deficient, their names are made public or they are fined. Nevertheless, the system is not sufficient to induce ernest efforts because, for instance, a 20% volume reduction in food waste can be achieved by dewatering, and the disposal fees for business waste are inexpensive.

Initiatives by Major Supermarkets

According to Seiyu, its stores have achieved 100% recycling of fish waste, used cooking oil, and cardboard boxes, but the company recycles only 4% of the 23,400 tons kitchen waste generated at its stores and distribution centers each year. What's more, Seiyu is left with 4,600 tons of unsold food each year. One way the company deals with this food is to improve food ordering to cut excess, and to sell products that are past their shelf lives as "Eco-Value Products" to its employees.[21)]

In 1994 the Aeon Group installed a food waste composter in each of its locations. Each day the 68 machines reduce and compost 14 tons of food waste.[22)] However, in November 2003 a fire broke out at the company's Yamato Shopping Center apparently due to methane generated by the composter, which underscores the need for a system to safely use the machines.

Sapporo's Initiatives

In 1998 Sapporo launched a unique experiment coordinated by administrative authorities to make food waste from businesses into animal feed. Food waste and residue generated at 246 locations in the city including department stores, supermarkets, food processing plants, schools, and hospitals is collected by the Sapporo City Environmental Services Corporation using seven special food waste trucks and made into animal feed at the rate of 50 tons per day by an intermediate processor in the city, Sanzo (Mitsui Ship Building) Organic Recycling Company, using the oil heating decompression and dewatering processs. The resulting feed goes to a feed company, which sells it to pig and

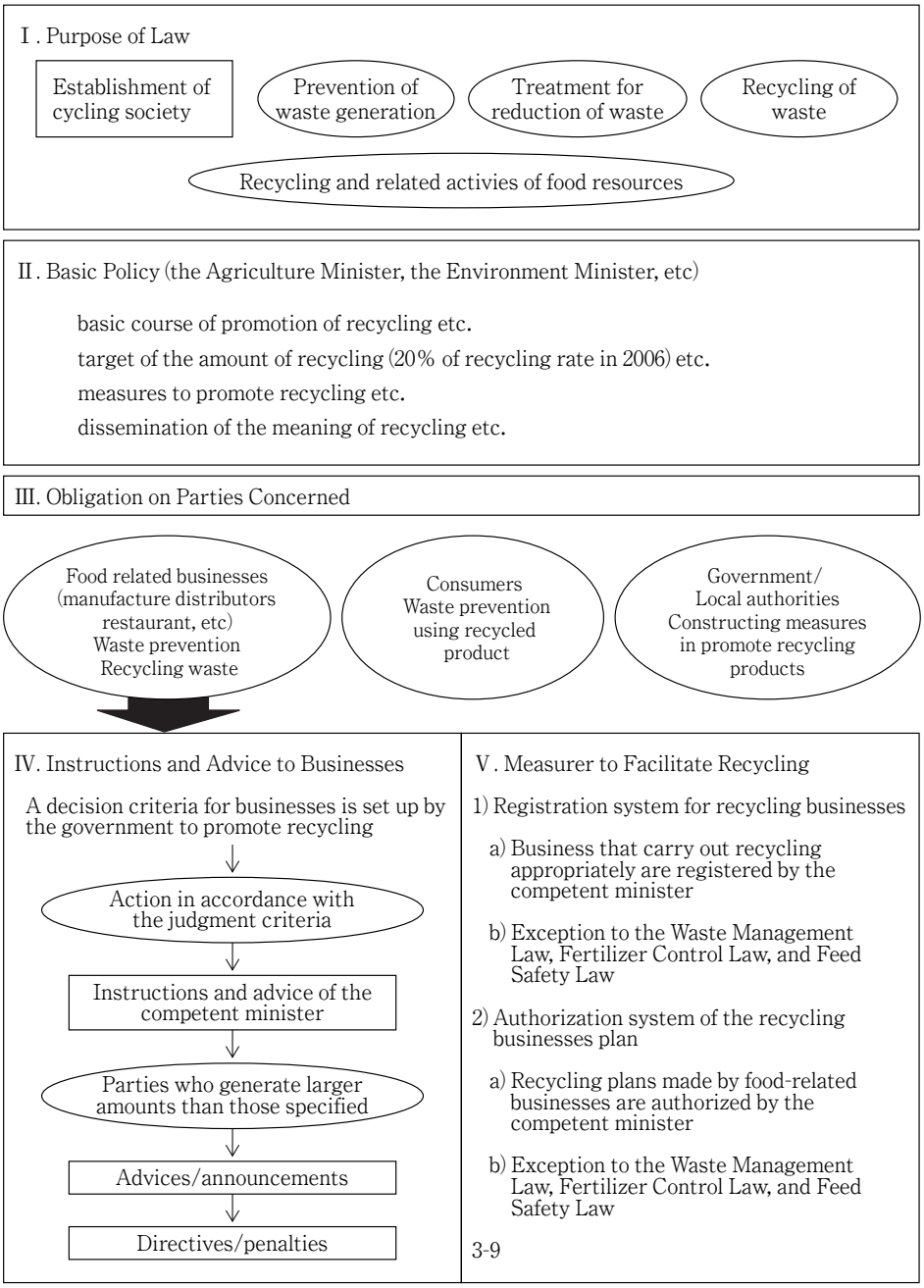


Figure 6. 3 How the Food Waste Recycling Law works

chicken farms in Hokkaido, resulting in a local food waste cycle.

An analysis was performed from the perspectives of the material cycle and regime/actors on the necessary conditions for such operations to work. Material cycle analysis with regard to food waste found conditions including: (1)information gathering to provide for the quantitative and qualitative stability of food waste, and selection of food waste generators; (2)guidance to keep impuri-

ties down to within 5% (however, a system was created to pre-process returned waste at the plant); and (3)provisions for environmental safety through the use of dedicated collection vehicles and the introduction of technologies. Regime/actor analysis found conditions including: (4)economic incentives for waste generators (lower fees than for collection as ordinary business waste: ¥66 per 20 liters instead of ¥78); (5)preferential treatment by administrative authorities to help with financing and taxes for initial investment and facility operation (fixed asset tax lowered to one-sixth); and (6)securing sales channels for the feed. Nevertheless, the plant is apparently barely making a profit.[23)]

With respect to condition(4), because general waste processing outside the city is allowed under the Food Waste Recycling Law, there is a possibility that processors outside of Sapporo will take advantage of processing fee differences and deprive Sanzo of part of its waste source.

Additionally, additive-free sewage sludge compost is used on farmland and green space in Sapporo, and this use is building a good track record. The cyclical use of organic waste is one noteworthy way of solving the sewage problems discussed in Chapter 1. A compost plant in Sapporo's Atsubetsu Ward dewaters sewage sludge and makes it into a cake-like form which is composted, producing 4,000 tons a year of completely fermented compost called "Sapporo Compost." Farmers are the biggest users, followed by golf courses, public works, and others. Sapporo Compost was launched in 1984 and has built a good reputation as a soil conditioner, but its biggest problem is that composting sewage sludge costs more than incineration. Even if the sale price of the compost is subtracted, it costs about ¥20,000 to produce a ton of compost, which cannot beat the ¥8,000／ton cost of incineration. Composting needs to be evaluated positively in terms of resource cycling.

Finally, one thing that must be emphasized regarding the cyclical use of biological waste is the problem of odors arising at the various stages of use (for example, 1,000 ppm ammonia). All the facilities I visited were expending great efforts to solve this problem. Recycling for cyclical use is the key to environmental conservation, but people involved in this work deserve recognition for what they endure, something that we must all keep in mind.

Biomass Use

Biological waste, including food waste, makes up about 60% of total waste, so in terms of the material cycle this can be seen as a matter of making cyclical use of biomass resources. But we can see this as not just managing waste, but also as the use of an alternative form of energy to substitute for fossil fuels. Because biomass is originally atmospheric CO_2 that was made into organic substances by photosynthesis, even if the CO_2 escapes when using biomass, the total balance is zero. For that reason it is highly effective as a fossil-fuel substitute. Instead of regarding biomass use as necessary to dispose of waste, we should see its potential for reducing the environmental burden of greenhouse gas emissions because calculations show that biomass equals about 5% of Japan's CO_2 emissions.[24)] Ways to use biomass energy include direct combustion, pyrolysis, gasification for liquid fuel, alcohol fermentation, methane fermenta-

tion, and the esterification of fats and oils (biodiesel), and biomass use is beginning to win support from government policy.

In terms of the regime/actor analysis framework, government policy includes the Guideline of Measures to Prevent Global Warming (2002), the Law on Special Measures for Facilitating the Use of New Energy Sources, the Japan Biomass Strategy, and other biomass support schemes, as well as the Livestock Waste Management Law (1999), the Construction Recycling Law, and others. Examples of equipment manufacturers getting into biomass gasification are Kajima Corporation, Kobelco Eco-Solutions, Meidensha Corporation, Obayashi Corporation, Nihon Eco Hatuden, and Kubota Corporation. There are also many companies producing methane gas from livestock waste.

But it is essential to pursue cost reduction, make operations more intensive, and provide policy support in a way that accommodates the characteristics of equipment users: they are small and medium companies and dairy farmers, who have geographically dispersed, comparatively small-scale operations. Further, an important condition when producing methane from livestock waste is that digester effluent can be used as fertilizer.

Particle Board from C&D Waste

Particle board is in the spotlight as a means of fixing carbon. It is made by grinding wood waste, mixing it with resin, and pressing the mixture into a board shape between platens. Material for particle board used to be obtained from log cores and lumber mill scraps, but now C&D wood waste and waste packing materials are ground for this purpose, which is a true recycling use of wood. There are of course many technical problems in using C&D waste, such as adulteration with metal, but solutions already exist. Breaking raw materials down into small pieces and re-forming them is a technology applicable not only to wood, but also to agricultural waste. An example is fiberboard made from bagasse.[25)]

Combined Treatment of Biomass Wastes

The composting toilets used in places like mountain cabins decompose human waste with wood waste. These toilets operate on the principle of the odorless decomposition and recycling of easily decomposed (readily putrefying) biomass waste types (such as kitchen waste, human waste, or livestock waste) by using difficult-to-decompose biomass (such as sawdust and wood shavings) as an artificial soil base. Easily decaying biomass such as food waste and livestock waste is turned into a resource without any odor by using wood waste, a forest resource, which is itself organic fertilizer and soil conditioner with added value. This solves the livestock waste problems and also makes effective use of otherwise wasted forest resources. The Hokkaido University Faculty of Agriculture is experimenting with this under the direction of Professor Minoru Terasawa.

Composting Banana Peels

One often hears jokes about falling after slipping on a banana peel, but a

banana-producing village in northern Thailand generates between 3 and 5 tons of banana peels a day in the process of making powdered, frozen, and canned bananas, and banana wine and juice. They would stink and attract insects if nothing were done, so villagers devised a method to compost them as a substitute for directly applied chemical fertilizers. With the cooperation of universities and other research institutions, an appropriate technology was developed to mix banana peels with animal waste and other substances and facilitate fermentation (the material cycle aspect). This project is succeeding thanks to the creation of a system and to the cooperation of actors, including these elements: (1)project cooperation and promotion, (2)compost production training and demonstrations in the village, (3)compost monitoring, (4)group management and training in marketing, and (5)assessments of both environmental and economic aspects.[26)]

Summation

Some C&D wastes and all food waste are biological organic wastes. As a characteristic of the material cycle, they have high moisture content and have therefore quantitatively been the biggest type of industrial waste. Further, the odor from their organic moisture content is an impediment to reuse. However, such wastes should be highlighted most when addressing the issues of raising Japan's food self-sufficiency rate, food safety, environmental conservation, and energy.

From the regime/actor aspect, the hierarchical subcontracting system for C&D disposal has been an inducement for illegal dumping, for which individual citizens also bear significant responsibility because they request the services of demolition contractors. In the recycling of food waste, it is very important to create networks of the actors who must deal with organic waste.

Chapter 7 Can Illegal Dumping Be Stopped?

1 Why Does Illegal Dumping Happen?

Ten Percent of Industrial Waste Is Illegally Dumped

Past discussion on the causes of and how to deal with the illegal dumping of industrial waste has not benefited from a sufficient analysis of the problem. Mr.Masayoshi Ishiwata made a splash with his book *The Industrial Waste Connection*,[1] which offers an extensive analysis and remedial measures based on the actual experiences of currently active Chiba Prefecture industrial waste investigators who uncovered illegal dumping. Because Mr.Ishiwata's area of expertise is financial analyses, he also probes the economic and business aspects of illegal dumping.

This chapter takes us through Mr.Ishiwata's analysis using both components of this book's two-pronged approach: (1)material cycle analysis and (2)regime/actor analysis. To begin with, Mr.Ishiwata poses a structural problem, noting that the supposed figure for the annual 400,000 tons of illegally dumped industrial waste is too low, as that would be only 0.1% of the 400 million tons generated; actually, he says, 40 million tons, representing 10%, are improperly disposed each year.[2]

If improperly disposed or illegally dumped industrial waste is an estimated 10% of the whole, it signifies systemic breakdown—a structural problem that cannot be solved just by cracking down on unprincipled businesses. Assuming it costs ¥20,000 per ton to dispose of 400 million tons a year, the market is worth ¥8 trillion annually. And if municipal solid waste (MSW) and waste management facilities are included, they create a colossal market of over ¥10 trillion annually. The illegal disposal of 10% translates into a ¥1 trillion black market.[3]

The basic problem is that because the capacity of processing facilities does not match the total amount of industrial waste generated, a stream of waste is directed toward illegal dumping and improper disposal at each stage from waste generators to intermediate processing facilities, transfer/storage facilities, and final disposal sites. There is an especially strong tendency toward illegal dumping of industrial waste that has been subcontracted and that exceeds processing capacity because of skyrocketing final disposal fees.[4] In terms of the material cycle, the two major types of illegally dumped waste are construction and demolition (C&D) waste and plastic. Although C&D waste is the larger by weight, plastic waste is prominent by volume. And while medical (infectious) waste is low by percentage, it is a major item among those illegally dumped.

The Anatomy of Illegal Dumping

In terms of my analysis framework, Mr.Ishiwata's excellent research paints a detailed picture of the regime and actors—especially the actors—in relation to the illegal dumping of industrial waste. To begin with, the industrial waste management system has a two-part structure comprising an aboveground structure and an underground structure. The former is the proper legal framework for industrial waste management, which has three types of businesses that are officially authorized actors : collection and transport, intermediate processing facilities, and final disposal sites. But the underground structure is a black market with illicit businesses that work in secret. From the economic aspect, Mr.Ishiwata has revealed the underground actors such as the one-hitters, who work alone and carry loads of industrial waste, the organizers who bring together the one-hitters, the hole-diggers who prepare illegal dumpsites, the land sharks who find suitable locations, the organized crime groups which take a percentage, the development racketeers who intervene in getting permits, and the financiers who manipulate black money (Fig. 7.1).

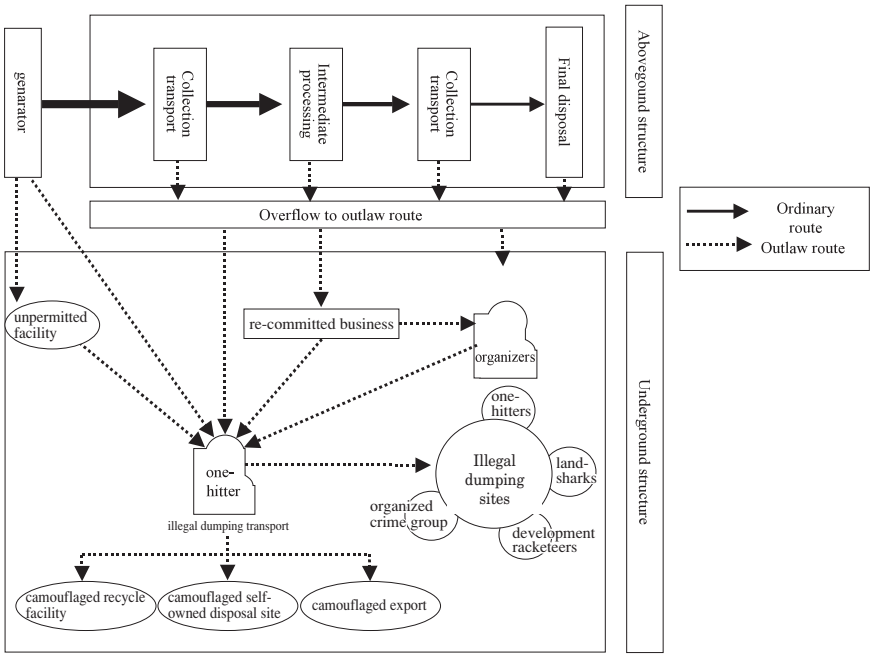


Figure 7. 1 Anatomy of illegal dumping

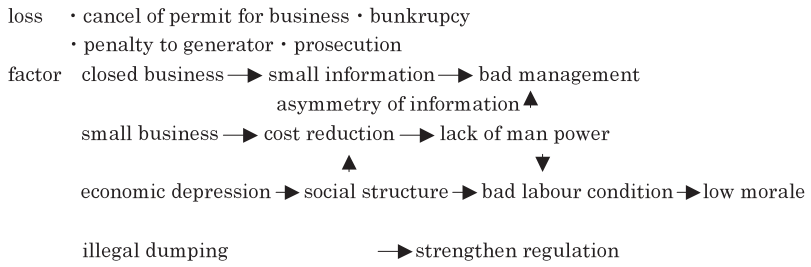
The industrial waste management system includes collection and transport, intermediate processing, and final disposal under the Wastes Disposal and Public Cleansing Law, and it functioned as a mass disposal system while there was still sufficient space left in final disposal sites. But as final disposal sites have approached their limits, the system is in imminent danger of collapse, and the illegal dumping problem is an indication of that. Ad hoc measures for stricter regulations are not a solution. Even the manifest system, for

which great hopes were entertained, is plagued with "blank tickets" (manifests that have only the stamp indicating disposal is completed). "E tickets" (tickets confirming final disposal) were added, but the situation is still not rectified.

Some companies, within the maze-like framework of the Wastes Disposal and Public Cleansing Law, would build substandard facilities with the claimed purpose of disposing of only their own waste, and start disposal work without permits to operate as waste management companies. Illegal dumping would be ramped up under the pretext of disposing of their own waste. Until 1997 disposal sites with volumes under 1,000 cubic meters were given permits even without seepage containments. As a consequence, even automobile shredder dust was virtually dumped illegally, and large volumes of it are still buried.[5)]

Risk to Businesses

In the midst of accelerated demands that waste generators too bear responsibility for illegal dumping, the management of industrial waste is now a special risk for businesses. The industrial waste-related risk flow for waste generators is described by an environmental report from Kinki Environmental Industry Co., (Fig. 7.2).



Source: R E M A T E C 2002 Environmental report, p.14.[6)]

Figure 7. 2 Risk posed by industrial waste

For this reason more and more companies are using a variety of self-defense means to reduce the risks associated with industrial waste. For example, Matsushita Electric keeps site photographs on file and closely tracks the flow of waste, while Kirin Beer has computerized its manifest system. Takenaka Komuten practices centralized waste management by generally using only one waste management contractor per prefecture. Fuji Xerox tries to curb illegal dumping by paying disposal fees after the job is done. It is vital that businesses use on-site inspections and financial statements to track the invisible flow of industrial waste.[7)]

Japan's Biggest Illegal Dumping Incident

At first glance the site looks like a verdant grassland (Fig. 7.3), but start walking through it and you see refuse-derived fuel (RDF) and compost sticking up through the ground, and detect ambient odors that include organic solvents. On the border between Aomori and Iwate prefectures, this site is where vari-

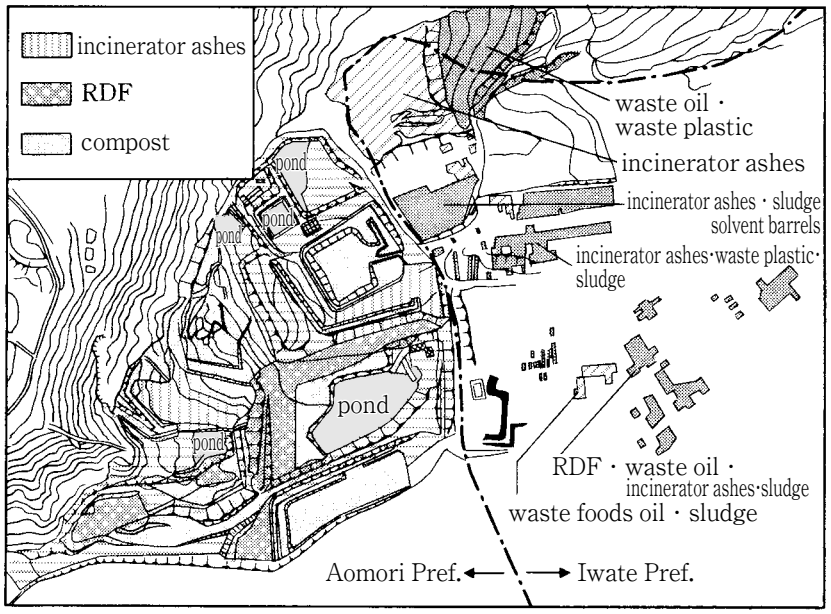


Figure 7. 3 Map of waste distribution

ous industrial wastes (including incinerator ashes, sludge, RDF, organic solvent barrels, and compost) from the Tokyo area were illegally dumped. The amount is about 870,000 cubic meters, which is twice that of the illegally dumped waste on Kagawa Prefecture's Teshima Island, making it Japan's biggest incident.[8] Because the dumpers, which were based in Aomori and Saitama prefectures, subsequently went bankrupt, Aomori and Iwate are working together to restore the site, while the Environment Ministry used a special law (Special Measures Law on the Removal of Impediments Caused by Certain Industrial Wastes) to subsidize 60% of the cost. Complete removal will cost an estimated ¥65.5 billion.

In this case the first issue is whether waste generators can be held accountable. They number 17,000, which is more than four times the originally anticipated number, and they comprise industries including dry cleaners, hospitals, and other services (5,500 companies); publishing, printing, chemical companies, and other manufacturers (2,600); wholesalers and retailers (600); and public institutions (300).[9] More than 60% of them are in the Tokyo area. Although an amendment of the Wastes Disposal and Public Cleansing Law made it possible to call waste generators to account, the law nevertheless requires a specific legal violation in the process by which wastes pass into the hands of waste management companies, such as "when appropriate compensation was not paid, or when [the waste generator] knew or could have known that waste would not be properly disposed." At the end of June 2003, therefore, Aomori and Iwate sent orders for industrial waste removal to four companies based in Tokyo, two of them being the large distribution company Hitachi Transport System and the major toy maker Takara. Aomori and Iwate prefectures claimed they had found that these companies' business sites in Tokyo

and Chiba Prefecture had asked unauthorized contractors to haul waste, which clearly violates the Wastes Disposal and Public Cleansing Law.

The second issue is the responsibility of Aomori Prefecture administrators because the incident was caused by contractors with permits granted by Aomori. Originally the matter arose in 1989 when San'ei Chemical Industries (currently being liquidated), an industrial waste management company based in Hachinohe City, brought a large volume of MSW from Chiba City to a mountainous area in Takko Town on the Aomori-Iwate border. In 1992 the company received permission, despite opposition from the Agriculture Commission, from Aomori Prefecture for a plan to compost sludge and cinders by mixing them with tree bark and fermenting them. This triggered large-scale illegal dumping. Even after illegal dumping came to light in 1996 and administrative dispositions by both prefectures suspended the company's business, Aomori continued granting permits. Both prefectures established investigative commissions to examine their administrative responsibility, and the commissions published reports in March 2003. Aomori's report in particular recognized the prefecture's administrative responsibility after San'ei Chemical refused to allow an on-site inspection in June 1996, and proposed measures to prevent a reoccurrence, having made six observations: (1)an indulgent view of San'ei Chemical, (2)a lax awareness of the facts, (3)indulgent treatment of San'ei, (4)the inadequacy of administrative investigations, (5)inadequate provision of information to and collaboration with the police, and (6)inadequate collaboration between offices responsible for waste and other offices. In view of the seriousness of this matter, in August 2003 Aomori Prefecture gave warnings to the people responsible for waste between 1996 and 1999,but the residents of Takko Town say the punishment was too lenient.

Third is the issue of the extent and cost of restoration. Aomori and Iwate agree on total removal(Aomori at first wanted to contain the waste, then switched its policy to specially managed waste removal, hazardous waste removal), but it is unclear if this includes material contaminated by the illegally dumped waste. The two prefectures must work in concert. After taking the emergency responses of curbing effluent contamination and providing moisture containment, the prefectures must determine the purpose and conditions for permanent measures, and then decide on specific methods after gaining consent from the local community. There is already some discussion on the possibilities of on-site treatment and using a melting furnace, but deciding on specific methods now is premature.

2 How Can Illegal Dumping Be Stopped?

Approach to Combatting Illegal Dumping

Mr.Ishiwata sums up the problems of measures against illegal dumping into the following four points.[10)]

(1) The causes and state of illegal dumping were not accurately analyzed.
(2) There was a lack of coordination in policy measures among government

ministries and between the national and local governments.

(3) Administrative authorities could not think outside the box.

(4) There was no growth of a foundation for the development of new environmental businesses.

(1) has already been discussed, while (2) is a matter of systemic coordination, and in (3) and (4) system regulations have not sufficiently taken economic conditions and methods into consideration, observes Mr.Ishiwata.

He therefore makes five urgent proposals.

(1) Simultaneously reduce final disposal and illegal dumping by building more intermediate treatment facilities (no more final disposal sites are needed).

(2) Protect local environments (municipalities' responsibilities and individuality).

(3) Establish a waste management system specific to each industry (a third way, which is neither a wide-area waste management system nor a local management system).

(4) Fully implement the market principle in recycling (competition in cost and sales channels).

(5) Regenerate polluted environments (pioneering new businesses).

Mr.Ishiwata is the first to come up with numbers (1) and (3). In his way of thinking, illegal dumping happens because there is not enough final disposal space; thus instead of the simplistic policy of building more final disposal sites, allow for the correct policy of building more intermediate treatment facilities, which will simultaneously reduce the amounts of waste landfilled and illegally dumped. He says this is because it is estimated that if the figures on manifests are added up, the intermediate processing facility overflow rate would exceed 200%, so if those facilities' processing capacity and recycling rates are raised, the final disposal amount could be reduced to one-tenth. It is necessary to switch from the current "collect, crush, and landfill" arrangement to a system architecture designed for a cyclical society that "sorts, picks, and uses."[11] The problem is how to make it happen, and a prerequisite for that is to correct information asymmetry (see Box 12), improve transparency, and clarify the cost structure of waste management.

Number (3), establishing waste management systems in each industry, would be occasioned by not only stiffer regulations for waste generator responsibility, but also the passage of various recycling laws, and would involve building industry-specific systems in the automotive, food, construction, and other industries, but without necessarily limiting waste management to within their own areas. This would be a "bypass operation" that would normalize the stalled industrial waste management system.

Regarding (4) and (5), acceptable methods are proposed as economic instruments to encourage recycling, such as levying taxes on virgin materials, interest rate subsidies and debt guarantees (instead of subsidies) for recycling

facilities, and having industrial waste taxes be national taxes used for environmental restoration.

Box 12 Information Asymmetry, Adverse Selection, and Illegal Dumping

Columbia University's Professor Joseph Stiglitz, who won the Nobel prize for economics in 2001, did excellent work in economic analysis of information asymmetry. The Japanese researcher Professor Eiji Hosoda explored illegal waste dumping from the perspective of information asymmetry and adverse selection.[12)]

Entities who contract out waste management do not have enough information to know what actually happens, and waste management firms use every way they can think of to cut costs (information asymmetry). The ultimate way to cut costs is illegal dumping. There is a manifest system to get around this problem by tracking waste management, but it is inadequate.

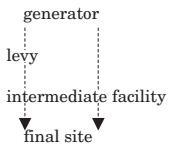
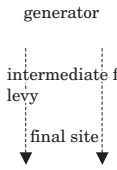
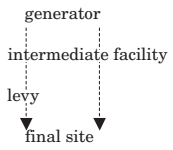
There is a saying that bad money chases away good money, and when there are good and bad things to choose from, the selection of the bad on the market, or the result of that choice, is called "adverse selection." In a world of asymmetric information, the phenomenon of adverse selection occurs often.

A well-known example are the deals made in the US used car market ("lemon" case). And in the management of waste, it is possible the good waste management contractors will be chased out. Because the cost is higher if one does the job right, management might not be done properly. It's hard for those who request the service to know exactly what's being done. If one is going discard an end-of-life vehicle, getting paid for your old car is better, so people will choose a cheaper dismantler. This is why good dismantlers are at a serious disadvantage in competition with cheaper dismantlers.

What should be done to prevent adverse selection? The answer is probably an approach that eliminates the cause, information asymmetry. This would entail creating a waste management information disclosure system that includes a manifest system, providing a verification system, and establishing the ultimate responsibility of businesses that contract out waste management.

Industrial Waste Taxes

Recently more local governments are instituting or thinking of instituting industrial waste taxes as non-statutory special-purpose taxes. Already more than half of all prefectural governments are among them. Mie Prefecture, which has had an industrial waste tax ordinance since April 2002, was the first local government in Japan to put a tax on industrial waste. This will be a touchstone for the future introduction of environmental taxes. Additionally, the three northern Tohoku district prefectures of Aomori, Iwate, and Akita have introduced a joint industrial waste tax (Fig. 7.4).

	A	B	C
Types	Emission tax	Landfill tax	
mechanism			
Object of tax	Intermediate facility, transport to final site	Transport to final site	Landfill at final site
Duty	generator	Generator, treatment	Landfill business
Method	Tax Report by generator	Tax collection by last treatment business	Tax report by last treatment business
Prefecture	Mie, Shiga	3 pref.(Chugoku), 3 pref(North-Tohoku), Nara	Kita-Kyushu city

Source : Morotomi.[14]

Figure 7. 4 Three types of industrial waste taxes

Three observations can be made on this trend.[13]

(1) The Law on Legislation for Government Decentralization, which became effective in April 2000, made it easy for municipalities to introduce non-statutory independent taxes (non-statutory general and special-purpose taxes).
(2) Local governments are beginning to perceive the importance of economic instruments in environmental policy because they can see the limitations to using existing regulatory instruments, as in the increases in CO_2 and waste.
(3) The deteriorating financial situations of municipalities. Local tax revenues are slumping badly due to the recession, making it urgent to secure stable revenue sources.

Mie Prefecture levies a tax of ¥1,000 per ton on businesses that annually generate 1,000 tons or more of industrial waste that undergoes intermediate processing and final disposal in the prefecture. This covers about 60% of industrial waste and the fee does not exceed the cost of transport outside the prefecture. Uses for the revenues include subsidizing the cost of developing technologies for decreasing business waste generation, infrastructure preparation around final disposal sites with public-sector involvement, and beefed-up monitoring of illegal dumping. Taxing industrial waste is an environmental good because it encourages, for example, waste reduction and recycling. There are also expectations that such taxes will discourage bringing waste from other prefectures, strengthen monitoring of illegal dumping, and provide funds for environmental restoration.

But introducing such taxes also faces many hurdles.

(1) At what stage and on whom are such taxes levied, and how does one create a system that does not hinder recycling? (Mie Prefecture taxes

waste generators, but exempts those whose emissions are below 1,000 tons. The three northern Tohoku prefectures tax at the landfilling stage.)

(2) Concerns about increased illegal dumping.

(3) The burden is on a certain industry (construction industry).

(4) Concerns about waste being shipped to other prefectures; the need to assure taxes mesh well with the systems of nearby regions.

Although industrial waste taxes provide little revenue, their greatest significance is that they are a form of taxation which substitutes for income and corporate taxes, and which reduces waste generation and the environmental burden. This created an opening for environmental taxes, which are used for environmental conservation. The exclusive use of administrative guidance and regulations until now did not offer enough incentive, but the exemption from this tax for businesses generating under 1,000 tons offers them an incentive to lower their tax liability by generating less waste. Till now (May 2005) already 23 prefectures have introduced industrial waste taxes.

We can summarize the points of the illegal dumping problem as follows.

In dealing with illegal dumping that has already happened, there are emergency responses and cost allocation. The US has a more or less functional system that covers both under the Superfund Law. Emergency responses must involve conducting an investigation, and establishing provisional remedial measures, permanent measures, an order of priority, and other means, as well as determining the actors in remedial measures. A different and separate matter is that of cost allocation. Responsibilities of the party who induced the dumping, of those involved in polluting, and of the waste generator, the cost recovery method, fund creation, how the national government and waste-origin prefecture are involved, and other matters must be determined. Japan has only the Wastes Disposal and Public Cleansing Law, whose recent amendment explicitly provides for a fund and the responsibility of waste generators, but in reality prefectures must deal with dumping through the subrogation of administrative acts. Even then, only a small percentage of costs is recovered from dumpers. In the case of Teshima Island, it was virtually impossible to make an issue of the financial responsibility of waste management contractors and waste generators, so the government has subsidized the cleanup.

Ways to address the causes of illegal dumping are encouraging waste reduction and recycling, enhanced monitoring, and stiffer fines. There are hopes that industrial waste taxes will induce waste reduction. Tax revenues could also be used to subsidize recycling and other efforts. Hence industrial waste taxes will be effective for addressing the cause of illegal dumping, i.e., reducing waste, but remedial measures for already dumped waste require different means.

In assigning roles to the national and local governments, there is an even greater need for national-level legal institutions on waste taxes and addressing illegal dumping.

Box 13 The Fate of Medical (Infections) Waste

Medical waste from a private university hospital in Tokyo was found in waste misrepresented as waste paper and illegally exported to the Philippines at the end of 1999.

Hypodermic and IV needles, bloody gauze, and other items from hospitals are disposed as infectious industrial waste, a category of specially controlled industrial waste (hazardous waste). Organs excised in operations are disposed as specially controlled general waste (infectious general waste). Both types are handled as infectious waste.

There used to be a danger that infectious waste could be mixed into MSW, presenting the danger that trash collectors would be injured and infected. Presently, however, infectious waste is managed with manifests as industrial waste.

As such, a characteristic of infectious waste is that infection can occur through the material cycle, and therefore in regime/actor terms the actors are medical care providers and waste management contractors.

It has been left to physicians and nurses to decide whether hospital waste is infectious waste, which makes it very important that medical care personnel are well-informed and educated in this respect. In 2003 the Environment Ministry issued new guidelines under which hypodermic needles, scalpels, glass shards, and other sharp objects are all treated as infectious waste, and the gauze, bandages, and other waste from infectious disease wards are all regarded as infectious waste.[15)]

Preventing the infection of medical staff is another important purpose of separating infectious waste. Waste management contractors say that even now the degree to which waste is separated differs from one healthcare provider to another.

The waste management flow begins with medical personnel sorting infectious industrial waste into specially made plastic boxes and coated cardboard boxes, which are then incinerated with the waste inside while controlling combustion and burning at 850℃ or higher to curb dioxin formation. Vinyl chloride IV bags and other non-infectious waste generated by healthcare providers ultimately are often burned in the same incinerators.

It is said that formerly the biggest source of dioxin in the US was infectious waste incinerators. Apparently the non-infectious waste from Japanese healthcare providers now contains many adult diapers, which is an indicator of Japan's aging population. Truly, wastes mirror a cross section of society.

According to a Sapporo vendor, the disposal cost for infectious waste is ¥60 per liter (containers cost about ¥13 per liter, ¥250 per kg), while the cost for non-infectious waste is ¥25 per liter (¥100 per kg). The difference arises from the difference in recovery cost because infectious waste requires special containers and vehicles.

Incinerator ashes include hypodermic needles and other objects, which are landfilled in controlled final disposal sites. Wide-area disposal spanning multiple municipalities is often used for these ashes. Burning 1 ton results in about 10 kg of ashes.

Many new contractors have entered the infectious waste management mar-

ket and are engaged in cost competition, but as regulations become gradually stricter, contractors that accept waste at low prices are finding that proper disposal is no longer possible. Accordingly, healthcare providers which try to save on infectious waste disposal costs must face the risk of illegal dumping and improper disposal.

The amended Wastes Disposal and Public Cleansing Law includes strict provisions on the responsibility of waste generators (in this case healthcare providers) when their waste is improperly disposed.

A problem now is how to handle hypodermic needles and other infectious waste items used at home. Because consumers cannot just put these in the trash, initiatives are underway to recover them at pharmacies and healthcare providers, but pharmacies would have to get permits as "specially controlled industrial waste managers."

For infectious waste the government should consider determining waste categories according to specific items, and add the disposal cost to the sale price, instead of classifying waste as "MSW" or "industrial" depending on the generator.[16)]

Box 14 Pollution by Primary Industries, and the "Coase Theorem"

Although people tend to think of farming and fishing as being close to nature, the agriculture and fisheries industries are major polluters. Hokkaido is the center of Japan's dairy industry, and its soil and rivers are heavily polluted with nitrate nitrogen by bovine waste.

Usually farmers accumulate and store this waste, which after decomposing is applied to pastureland as manure slurry. But in recent years farmers have enlarged their herds to raise profits, and cow waste has exceeded their capacity to deal with it.

Hokkaido's Nemuro area is not only a dairy farming zone, for it also has a big salmon fishery and accounts for one-third of Hokkaido's fish catch, but in recent years fewer salmon return to the rivers there, and river pollution by dairy farming is thought to be one of the reasons.

For that reason the Nemuro Area Salmon Breeders Association built a model plant to purify livestock waste, and has operated it since 1998 on a dairy farm upstream from a salmon hatchery. The association held discussions with the local municipality, the Hamanaka Agricultural Cooperative, and local dairy farmers, and paid the total cost of building the plant, about ¥6.5 million. This livestock waste purification system makes the waste into odorless slurry using soil microorganisms, and it is already being successfully used as a "natural purification system" in the Abashiri area.

It is unusual for a fisheries organization to try remediating dairy farming pollution, and this is one noteworthy instance of the "Coase theorem" in that two primary industries collaborated to conserve the environment, while not necessarily basing their actions on the polluter pays principle.

Well over a billion yen have been invested in salmon breeding programs, while a comparatively small amount is needed for livestock waste purification systems. If more salmon return to their rivers as a result, the fisheries industry

will also benefit financially. In other words, these points are also important: (1)it is possible this will minimize social costs and maximize the monetary value that can be produced, (2)if two primary industries operating in the same region can have a dialog on environmental conservation, little transaction cost is expended in making deals, and (3)inland waters fishing permission (to obtain salmon eggs), a kind of fishery right, is determined to an extent. These three points are among the Coase theorem's conditions.

Summation

If illegal dumping is analyzed in terms of the material cycle, the analysis will find an imbalance between processing facility capacity and the total amount of industrial waste generated, and that is where the insufficiency of intermediate processing facilities arises. With regard to the regime (system), the structure of industrial waste management is characterized by a two-tiered structure—an aboveground structure and an underground structure—with the former comprising three officially authorized actors: collection and transport, intermediate processing facilities, and final disposal sites, while the latter is a black-market world populated by illegal operators. The one-hitters, who work alone and carry loads of industrial waste, the organizers who bring together the one-hitters, the hole-diggers who prepare illegal dumpsites, the land sharks who find suitable locations, the organized crime groups which take a percentage, the development racketeers who intervene in getting permits, and the financiers who manipulate black money—these underground actors exist because of economic reasons. As such, steps to combat illegal dumping will be effective only if their means address these root concerns. The government should give consideration to intermediate processing facilities, industry-specific waste management systems, taxing the use of virgin materials through a tax system to encourage recycling, and other means.

For illegal dumping that has already occurred, the issues include the responsibilities of waste generators and administrative authorities, the scope of environmental restoration and cost allocation, and emergency and permanent measures. Industrial waste taxes hold down waste generation, but different means are needed to deal with illegal dumping that has already occurred.

Concluding Chapter The Path to an Affluent Life and Low Environmental Burden

Proposal for a Millennium Sustainable Society

I sensed something really new in the proposal for the "millennium sustainability studies" proposed at the 19th Science and Technology Forum hosted by the Japan Science Technology Agency at Lake Hamana in January 2000. Dujiang Weir in China's Sichuan Province has continued to provide irrigation water in the Sichuan basin for over 2,300 years. In Japan the Shingen Dike on the upper reaches of the Fuji River has been protecting Kofu City for more than 400 years. As these examples show, we have millennium science and technology that underpin millennium sustainability despite the feeling that they have often been forgotten amid the fast-paced scientific development in recent years.[1)]

In the natural world we are discovering the powers of insects, such as the more than 100 thousand species that make silk ; bacteriostasis, which suppresses the proliferation of bacteria; and new functions such as shutting out UV radiation. As this shows, biological resources that take advantage of the powers of plants, insects, and microorganisms are technologies that have been refined through the 4 billion years of evolution since the dawn of life. This is because the process of evolution eliminated those things lacking in safety and functionality, so the products and technologies of presently existing organisms are superb.[2)] Some examples for which there are expectations are the substances with medicinal functions produced by insect wax (beeswax) and insects, organic compost using houseflies, snake poison with anticancer effects, and immunity-enhancing proteins which are extracted from mackerel.[3)]

Such soft materials deserve our attention as the foundation that supports the material cycle in a sustainable cyclical society. The sustainable development of ecological resources is a strategy that might be regarded as making a business of ecology.[4)] True structural reform away from the growth society is building the millennium society.

Reform for Happiness with Less Money and Real Happiness

At its annual meeting in 2002 at Hokkaido University, the Society for Environment Economics and Policy Studies held an public citizens' symposium called "Public Works and Environmental Conservation." We invited Mr.Yasuo Tanaka, the governor of Nagano Prefecture, and under my moderation conducted a discussion with researchers.[5)] Of particular note with regard to regime/actor analysis was the public works reform fostered by Governor Tanaka. Especially significant is a suite of reforms called the "five revampings," with specific examples being the "rice paddy revamping" and "road revamping" in Nagano Prefecture's Sakae Village. As the village's population is quite aged, and the elderly need village roads in their daily lives more than national or

prefectural roads, the prefecture is building village roads far more cheaply than those of the standard that the government subsidizes. Village residents were asked where they want roads, then the prefecture purchased idle rice paddies cheaply and build village roads wide enough for small delivery trucks. Further, the village hired four contract workers to make improvements to terraced rice fields at only about one-fifth the cost required by land improvement associations. These are public works created by the citizens, or what could be called "citizen works" that make it possible to obtain real happiness with less money.

In "forest revamping" projects, instead of reducing the usual number of public works, the prefecture switches construction workers to thinning and other forestry work. For this purpose the prefecture held lumberjack classes in various locations to have workers learn about thinning from instruction in the classroom and forest. Thinning is performed by construction companies which have employees who qualified. Forestry cooperatives do not lose work because of the growing amount of thinning work.

This Nagano Prefecture example illustrates how changing the system and giving actors better roles reduces costs and burdens, and provides citizens with true well-being while working for environmental conservation.

Citizen Windmill Initiative

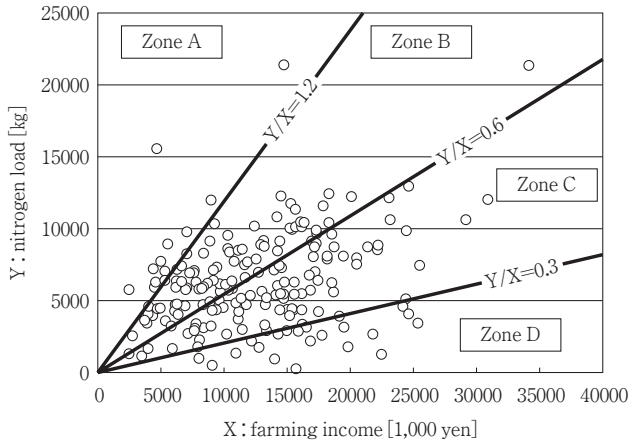
Here I shall discuss a citizen project that I myself was involved in, the citizen windmill initiative. How does one on a daily basis bring together the power of citizens who want to conserve the environment, and achieve a certain result ? One answer to that is the NPO Hokkaido Green Fund campaign, in which citizens pooled their money to build a wind farm as a source of renewable energy. The first such facility in the country was "Hamakazechan, " which was built in Hokkaido's Hamatonbetsu Town and has a maximum output of 1 MW. Behind this one can find the prefectural referendum on nuclear power plant construction and the movement opposing more nuclear plants, but originally the Seikatsu Club Livelihood Collective served as the nucleus in forming the Hokkaido Green Fund with green electricity fees that are 5% of electricity payments, and the public could also contribute through a bank account. Participants grew to about 1,300. It was decided to use the fund to build a citizens' community power station and install wind generators. Members of the public, mainly Hokkaido residents, covered 70% of the approximately ¥200 million construction cost by investing ¥500,000 per share. There is an agreement with Hokkaido Electric for purchase of the power. Investors receive dividends. To expand this effort throughout the country, a Citizens Renewable Energy Fund was created, and public investment is being sought for citizens' wind farms operating in Ajigasawa Town, Aomori Prefecture and Tenno Town, Akita Prefecture. This is a citizens' network operating through a new business model.[6] By proposing new value that takes the place of opposing nuclear power plant construction, the movement offers a message and vision for re-evaluating lifestyles by means of conserving electricity and providing for change in lifestyles, as well as creating a community business which takes ad-

vantage of the local strong winds.[7] In other words, it uses a network of people to create new value and a new business model.

Lowering the Environmental Burden While Increasing Human Satisfaction

Chapter 1 mentioned pollution by livestock waste and stated that dairy farmers must hold their operations down to appropriate scale and eliminate their dependence on imported feed concentrate. In connection with this, a study on income and human satisfaction conducted in Hamanaka Town, a dairy farming area in eastern Hokkaido, is very interesting.

The study evaluated the relationships among income, energy use, nitrogen load, livestock health, and satisfaction, and found that among farms with the same ¥15 million income, some had very low environmental nitrogen loads of 2 or 3 tons, while one had the extremely high load of 19 tons (Fig. C. 1). It was also found that fossil energy input and nitrogen load are not determined by differences in how farms are run, but rather the amounts of feed and fertilizer purchased. The study also uncovered a tendency for frequent livestock illness if animals are fed much concentrate. Further, the study confirmed the absence of a significant correlation between farming income and satisfaction.[8] In other words, income level does not determine satisfaction or the environmental burden.



Source : Hoshiba.[8]

Figure C. 1 Relationship between farming income and nitrogen load

Recovery of "Human Power"

Here we come to the matter of the social aspect of humans, which is what supports the possibility of achieving the aforementioned millennium sustainable society. This concerns the preferable state of systems and the human actors as seen in this book's regime/actor analysis. In the 21st century there is a very fast increase in the environmental burden of human society, which is depressing the possibility of achieving a sustainable society, while at the same time there is stagnation and decline in the beneficial human activities that would increase that possibility. Further, there are glaring disparities among

societies in energy use. If the per capita CO_2 emissions of Indians are given a value of 1, then the emissions of the Japanese are 10, and those of Americans are 20.

A vision for future society emerges from the self-awareness and hopes of those who wish to recover and develop atrophied "human power." The Indian economist Amartya Sen, who won the Nobel prize for economics in 1998, says that the purpose of economics is the well-being of people, not income. Human well-being has often been sacrificed because societies aim to raise incomes. Pollution during Japan's rapid-growth years was typical of this.

But how do we measure human well-being ? Sen tells us it is "capability,"[9] which is the sum of human functionings, literacy, physical strength, scholastic ability, the ability to be involved with others, and other qualities, as well as the latitude to choose them freely, i.e., freedom for living. Specifically, the United Nations Development Programme has proposed "human development indicators" that include literacy, average life expectancy, income, degree of freedom, and gender equality. Some countries have high incomes, but short average life expectancies.

At present China and India are at quite high levels with respect to average life expectancy, but while the Republic of South Africa, Brazil, and other countries have high per capita GNPs, they have far lower average life expectancies. And although African American men living in New York's Harlem have incomes far above those of people in developing countries, their probability of reaching age 40 is lower than that of Bangladeshi adult males. These facts show that income, per capita GNP, and other indicators play only a very limited role with respect to average life expectancy and well-being. Reasons for this are that healthcare, environment, and other public health policies, public safety, social security (for example, accidental death is common in societies with rampant violence), and elements of public policy other than income

Figure C. 2 Relationships among human welfare, public policy, and income

play a major role in people's welfare, and also that even when income is the same, the extent of the role that public policy plays in welfare differs according to the conditions for each individual (for example, a person prone to illness has more healthcare expenses) (Fig. C. 2).

Thus in creating a sustainable society—a millennium sustainable society, it is imperative to improve human well-being while decreasing environmental burden. In other words, we must simultaneously recover nature power and human power, which are the ultimate source of wealth.

Finally, to go over the keywords once more, the millennium sustainable society, citizen projects, people networks, the simultaneous recovery of nature power and human power, capability, and sustainability without a doubt are the foundation to build a 21st-century society with a sound environment and citizen well-being.

Professor, Hokkaido University

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References

Introduction

1 Environment Ministry: *Cyclical Society White Paper*, 2004 Edition, May 2004.
2 Yoshioka, Kanji, Sumihiko Ohira, Hitoshi Hayami, Ariyoshi Washizu, and Ryuji Matsuhashi: *Interindustry Analysis of the Environment*, Nippon Hyoronsha, June 2003.
3 According to Nagano Prefecture Governor Yasuo Tanaka.
4 World Economic Forum: *Environmental Sustainability Index*, An Initiative of the Global Leaders of Tomorrow Environment Task Force, 2005.
5 Prescott-Allen, Robert: *The Wellbeing of Nations*, Island Press, 2001.

Chapter 1

1 Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, Planning Working Group: *Enhancing the Cyclical Society System,* February 2002.
2 Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, International Resources Cycle Working Group, *Toward a Sustainable Asian Cyclical Economic Society*, October, 2004.
3 Japan Environmental Council, "State of the Environment in Asia" Editing Committee: *State of the Environment in Asia 2000/01,* Toyo Keizai Inc., November 2000, Chapter 3.
4 *Nihon Keizai Shimbun,* December 1, 2002.
5 Ibid., Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, Planning Working Group. Association for Home Electric Appliance, *Handbook of Home Electric Appliance*, 2004.
6 Kojima, Michikazu: Aya Yoshida "Waste Exports from Japan and Recycling in China," Consumers' Life Institute, *Research Assistance for a Sustainable Society and the Global Environment (2002)*, 2003.
7 Ministry of Economy, Trade and Industry, Commercial Information and Policy Bureau: *Report on Study of Measures for Creating a Transportation System that Helps Provide Smooth Distribution for a Cyclical Society,* March 2002. For an interview study on the international movement of recycled resources, see Wada, Naohisa: "International Movement of Recycled Resources," in Japan Society of Public Utility Economics, *Journal of Public Utility Economics*, 52 (1), October 2000.
8 Ministry of Finance: *Trade Statistics*, 2003.
9 Ibid., Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, Planning Working Group; Tasaki, Tomohiro: "Questionnaire Survey on the Ownership and Discarding of Consumer Appliances and Personal Computers," in Japan Waste Management Association, *Papers at the 24th National Conference on Waste Management Research and Case Studies,* 2003.
10 *Nikkei Ecology,* 32, Nikkei BP Publishing, February 2002.
11 Ishikawa, Masanori: "How Should Risk Analysis Be Used to Advantage in Comprehensive Environmental Management?" *Kagaku (Science),* 72(10), Iwanami Shoten, October 2002.
12 Takahashi, Yutaka: *Earth's Water at Risk*, Iwanami Shoten, February 2003.
13 According to Professor Daikan Oki.
14 Okai, Takeshi, et al.: "How Animals Are Raised and the Environment Protected in Grassland Dairy Farming Regions," Hokkaido Veterinarians Society, *Hokkaido Veterinarians Society Journal*, 37(11), November 1993.
15 Matsui, Teruo: "History of Hokkaido Grasslands and a Scenario for Sustainable Development," Hokkaido Grassland Research Society, *Hokkaido Grassland Research Society Journal*, 36, 2002.
16 Yoshino, Nobuhiko: "Profitability and Developmental Possibilities of Low-Input Dairy Farming in Full-Time Dairy Farming Areas of Hokkaido," *Rakuno Gakuen University Bulletin, Humanities and Social Sciences Section*, 22(1), October 1997.
17 Hoshiba, Shinji, et al.: "A Proposal for Composite Indicators to Assess Dairy Production Systems," The Society of Agricultural Structures, Japan, *Journal of the Society of Agricultural Structures, Japan*, 32(3), December 2001.

18 Mitomo, Moriyuki: *Slow Farming*, Nobunkyo, March 2000, p. 71.
19 Mitomo, ibid., p. 102.
20 International comparative research by Yuichi Moriguchi, et al. World Resources Institute: *Weight of Nations*, 2000.
21 Murota, Takeshi: "The Economics of Recycling as Seen from the Material Cycle," in Hosoda, Eiji and T. Murota, eds., *Iwanami Lectures in Environmental Economics and Policy Studies, Volume 7: Institutions and Policies of the Cyclical Society*, Iwanami Shoten, 2003.
22 IPCC: *Special Report on Land Use, Land-Use Change and Forestry*, 2000.
23 Referred to by Article 3. 3 of the Kyoto Protocol.
24 Referred to by Article 3. 4 of the Kyoto Protocol.
25 Hata, Akio: *Soil and Groundwater Contamination*, Yuhikaku, October 2001, p. 159; Asami, Teruo: *Hazardous Metal Contamination of Soil in Japan*, Agne Gijutsu Center, March 2001, Part 2.
26 Hata, ibid., p. 167.
27 Sakai, Shin'ichi: *Waste and Chemicals*, Iwanami Shoten, June 1998, p. 19.
28 Stigliani, W.: "Industrial metabolism at the regional level: The Rhine Basin," in Ayres, R. U., ed., *Industrial Metabolism: Restructuring for Sustainable Development*, United Nations University Press, 1994.
29 Nishimura, Hajime and Tatsuaki Okamoto: *The Science of Minamata Disease*, Nippon Hyoronsha, 2001, Chapter 3.
30 For details, see Martin Jänicke, "The Political System's Capacity for Environmental Policy," Forschungsstelle für Umweltpolitik (FFU) Freie Universität Berlin 1995, Japanese edition, Hokkaido Graduate School of Economics, *Economic Research*, 46(3), December 1996.
31 Porter, G. and J. W. Brown: *Global Environmental Politics*, Westview Press, 2000.
32 Nakaso, Toshio, ed. and trans.: *Report on the Ground Reality of the Cyclical Economy and Waste Management Act of Germany*, NTS, November 1999.
33 I thank Professor Yu Matsuno for this information.
34 Yagishita, Masaharu: "Assessing Waste Policy in Nagoya," *Toward the Reform of Environmental Management*, Japan Science and Technology Agency, Interdisciplinary Research Exchange Workshop, 2003.
35 Sasaki, So: "Municipal Solid Waste Management in Bangkok," Master's thesis for the Hokkaido University Graduate School of Economics, 2003.
36 Environment Ministry: *Cyclical Society White Paper*, 2003 Edition, May 2003, p. 99.
37 Japan Waste Management Association: *Report on a National Study about Fee-Based Waste Management,* March 1998.
38 Japan Waste Management Association: *Report on a Study about Fee-Based Waste Management,* 2002 Report Commissioned by the Environment Ministry, 2003.
39 Yoshida, Fumikazu: "The Environment and Sci-Tech," in Teranishi, Shun'ichi and Eiji Hosoda, eds., *Iwanami Lectures in Environmental Economics and Policy Studies, Volume 5*: Policy Integration for Environmental Conservation, Iwanami Shoten, February 2003.
40 Tanaka, Nobutoshi, et al.: *Research on the Effect of Fee-Based Waste Collection on Conservation Lifestyles among Consumers*, Report on 1995 Scientific Research Grant Results, 1996.
41 Yamakawa, Hajime and Kazuhiro Ueta: "Research on Fee-Based Waste Collection: Results and Challenges," Japan Society of Waste Management Experts, *Journal of the Japan Society of Waste Management Experts*, 12(4), July 2001.
42 Usui, Takehiro: "Elasticity Forecast on the Effectiveness of Instituting Fee-Based Waste Collectiion in 3,230 Municipalities," Society for Environmental Economics and Policy Studies, *Proceedings of the 2002 SEEPS Congress*, 2002.
43 Yamakawa, Hajime, Kazuhiro Ueta, and Yasushi Terajima: "Illegal Dumping in Municipalities with Fee-Based Waste Disposal, and Influencing Factors," *Journal of the Japan Society of Waste Management Experts*, 13(6), November 2002.
44 Yamakawa and Ueta, ibid.

Chapter 2
1 Sueishi, Tomitaro: *Reviving the Urban Environment*, Chukoshinsho, August 1975.
2 *Nihon Keizai Shimbun,* May 3, 2003.

3 Hosoda, Eiji: *The Economy of Goods and Bads*, Toyo Keizai Inc., November 1999.
4 Porter, R.: *The Economics of Waste*, Resources for the Future, 2002, p. 178.
5 Porter, Michael and and Claas van der Linde: "Green and Competitive: Ending the Stalemate," *Harvard Business Review*, September-October 1995.
6 Development Bank of Japan, *Studies*, 55, "Developments in the Resource-Cycling Sector, Primarily the Materials Industries," July 2003.
7 *Nihon Keizai Shimbun*, August 14, 2003.
8 Asakawa, Masami: "On the Socialization of Waste Management Costs," Japan Society of Political Economy, *Journal of the Japan Society of Political Economy*, 38, September 2001.
9 Porter, 2002, p. 3.
10 Sekisui Chemical Co., Ltd., *Environmental Report 2002*, July 2002, p. 11.
11 Canon, Inc., *Canon Environmental Report 2002*, June 2002, p. 24.
12 Kansai Electric Power Co., *Global Environment Action Report 2002*, July 2002, p. 67.
13 East Japan Railway Company, *Social and Environmental Report 2003*, September 2003, p. 33.
14 Suga, Mikio and Masanori Ishikawa: "Application of Input-Output Tables for Environmental Analyses(6)," Pan Pacific Association of Input-Output Studies, *Journal of Applied Input-Output Analysis*, 6(1), June 1995.
15 Oji Paper Co., Ltd.: *Oji Paper Group Environment Report 2002*, December 2002, p. 21.
16 Fuji Photo Film Co., Ltd.: *Fuji Film Environment Report 2002*, June 2002.
17 Otsuka, Tadashi: *Environmental Law*, Yuhikaku, November 2002, pp. 386-387.
18 Hosoda, ibid.,, p. 143.
19 Lifeset, R.: "Extended Producer Responsibility and Leasing: Some Preliminary Thoughts, in Extended Producer Responsibility as a Policy Instrument," Seminar, May 8-9, 1998.
20 Otsuka, ibid., pp. 427-428.
21 Ministry of Health and Welfare, Notification by Environmental Enhancement Section Chief: "Conversion to Wide-Area Waste Management," May 1997.
22 Here I referred to: Yatsugi, Shin'ichi: "An Historical Analysis of Policy on Conversion to Wide-Area Waste Management(2)," Kyoto Economic Forum, *Keizai Ronso (Discourses on Economics)*, 167(2), February 2001.
23 Ministry of Health and Welfare: "'Waste Management Facility Performance Guidelines' Pertaining to Government-Subsidized Construction of Waste Management Facilities," October 1998.
24 Yatsugi, Shin'ichi: "Administrative and Financial systems of Operations for Waste Management Facilities and Equipment," Society for Environmental Economics and Policy Studies, ed., *Public Works and Environmental Conservation*, Toyo Keizai Inc., December 2003.
25 Japan Waste Management Association, October 2002.
26 *Asahi Shimbun*, December 23, 2002.
27 *Hokkaido Shimbun*, May 9, 2003.
28 Tsugawa, Takashi: *A Close Look at Gas Melting Furnaces*, Ryokufu Publishing, November 2000; Yamamoto, Setsuko: *Plans for Wide-Area Waste Management*, Tsukiji Shokan, October 2001.
29 Kishimoto, A., et al.: "Cost Effectiveness of Reducing Dioxin Emissions from Municipal Solid Waste Incinerators in Japan," *Environmental Science and Technology,* vol. 35(14), 2001, pp. 2861-2866.
30 Kishimoto, Atsuo: "Assessment of Costs for Dioxin Control Measures in Municipal Solid Waste Incineration Facilities," Society for Environmental Economics and Policy Studies, *Proceedings of the 2003 Society for Environmental Economics and Policy Studies Congress*, 2003.
31 Watanabe, Tadashi and Toshiro Hayashi: *Dioxin*, Nippon Hyoronsha, January 2003.

Chapter 3
1 Japan Environmental Council, "State of the Environment in Asia" Editing Committee: *State of the Environment in Asia 2000/01*, Toyo Keizai Inc., November 2000, pp. 64-66.
2 Yasui, Itaru: *Recycling*, Nippon Hyoronsha., June 2003, pp. 76-77.
3 *Nikkei Business*, June 16, 2003, Nikkei BP Publishing.
4 Hosoda Eiji: "Retrospective on the First Three Years of the Container and Packaging Waste Recycling Law," Japan Waste Management Association, *Journal of Japan Waste Management Association*, 53(237), September 2000.

5 *Nihon Keizai Shimbun*, July 4, 2003.
6 *Nihon Keizai Shimbun*, July 13, 2003.
7 *Monthly The Waste*, 28(1), Nippo Publishing, January 2002.
8 *Nihon Keizai Shimbun*, April 18, 2002.
9 Ueta, K., et al.: "International comparative analysis of household waste composition with special reference to packaging waste," *Environmental Economics and Policy Studies*, 4(4), 2001.
10 Kirin Brewery Co., Ltd.: *Kirin Beer Environmental Report 2003*, August 2003, p. 21.
11 Shinshu Committee for Research on Combatting Global Warming: *"Nagano Model" for Combatting Global Warming (First Proposal)*, March 2002.
12 Sueishi, Tomitaro: *Reviving the Urban Environment*, Chukoshinsho, August 1975, p. 214.
13 The following information is based on Environment Ministry: *Cyclical Society White Paper*, 2004 Edition, May 2003.
14 Thanks to Professor Masanori Ishikawa for this.
15 Calculated from various years of the Japanese government's *Quality of the Environment in Japan*.
16 Ministry of Public Management, Home Affairs, Posts and Telecommunications: *Evaluation of Policy Facilitating the Recycling of Containers and Packaging*, January 2003.
17 Ministry of Health and Welfare, Department of Water Utilities and Environment: "Calculations on the Cost Imposed on Municipalities by the Packaging and Container Waste Recycling Law (1998)," materials submitted by the Ministry of Health and Welfare, Living Environment Council, Waste Subcommittee.
18 Japan Waste Management Association, "Investigation of Cost Imposed on Municipalities by the Packaging and Container Waste Recycling Law," *Journal of Japan Waste Management Association*, 55(250), October 2002.
19 According to the Ministry of Economy, Trade and Industry.
20 Matsuto, Toshihiko: "Estimation of Metal Flow in Municipal Solid Waste Facilities," Japan Society of Waste Management Experts, *Papers Presented at the 14 th Japan Society of Waste Management Experts Congress*, 2003.
21 According to waste accounting.
22 Shoji, Hajime and the Waste Research Society Seeking Revision of the Container and Packaging Waste Recycling Law, *Let's Develop Waste Accounting*, Nippo Publishing, May 2003.
23 In 66 municipalities for which ratios could be calculated, the cost burden ratios for municipalities and waste management companies (for recycling into new products) were calculated assuming that the total recycling cost (for collection, storage, sorting, and recycling) for PET bottles, glass bottles, other plastics, and other paper collected separately by municipalities is 100.
24 Yorimoto, Katsumi: *How to Become a Recycling Society*, Iwanami, October 2003, p. 140.
25 According to Mr.Toshio Nakaso.
26 Dai Nippon Printing Co., Ltd., *DNP Group Environmental Report 2002*, September 2002, pp. 42-43.
27 Kitagawa, Susumu: "Germany's Container and Packaging Recycling System," in Ueta, Kazuhiro and Susumu Kitagawa, eds., *Handbook for the Cyclical Society*, Yuhikaku, April 2001; Quoden, J.: "Effects of the Introduction of an EPR Management system on the Economy," OECD Workshop on "Economics of Extended Producer Responsibility," Tokyo, 2002; Institute for Policy Sciences, *Research on the Recycling of Plastic Films and Sheets*, research commissioned by the Kurorin Chemical Co., 2001.
28 Container Comparison Research Group (led by Itaru Yasui): *Report on Comparison of Containers with the LCA Method*, Revised Edition, August 2001.
29 Institute for Policy Sciences: *Study and Business Report on Container and Packaging Life Cycle Assessment (2002)*, June 2003.
30 Citizens Forum for a Cyclical Society: "Initiatives to Reduce Waste in Nagoya," materials distributed by the Stakeholders Conference, August 2003.
31 Ishikawa, Masanori: "Recycling and LCA," in Nakanishi, Junko, Shigeki Masunaga, and Hiroyuki Matsuda, eds., *Practice in Calculating Environmental Risk*, Iwanami Shoten, December 2003.
32 *Asahi Shimbun*, June 26, 2003.
33 Citizens Initiatives: *From Recycling to Reuse*, 1999.

34 Doi, Takakazu: "Status of Implementation of the Container and Packaging Waste Recycling Law," Japan Society of Waste Management Experts, *Journal of the Japan Society of Waste Management Experts*, 13(2), March 2002.
35 Nakamura, Shuji: "For a Cyclical Society that Gives Priority to Reuse," *Monthly The Waste*, 28(8), Nippo Publishing, August 2002.
36 Citizens Initiatives, ibid.
37 Cabinet Office, Socioeconomic Research Institute, ed.: *Recycling Model for Glass Bottles and Ferrous Metals*, Ministry of Finance, Bureau of Engraving and Printing, June 2002, p. 112.
38 Otsuka, Tadashi: *Environmental Law*, Yuhikaku, November 2002, pp. 398-399.

Chapter 4
1 Association for Electric Home Appliances, *Report on Facilitating the Management and Recycling of Waste (Creating a System to Facilitate the Recycling of Specified Consumer Appliances)*, 2001.
2 *Nikkei Ecology*, 32, Nikkei BP Publishing, February 2002, p. 48.
3 *Nikkei Ecology*, 38, Nikkei BP Publishing, August 2002, p. 43.
4 January 23, 2004, 2,930 municipalities.
5 Annually, Fukuoka City is ¥37 million, Sapporo City is ¥13.8 million, Kyoto City is ¥11.5 million, and Sendai City is ¥4.8 million.
6 Ueno, Kiyoshi: "Influence and Effectiveness of the Appliance Recycling Law," *Toward the Reform of Environmental Management*, Japan Science and Technology Agency, Interdisciplinary Research Exchange Workshop, 2003.
7 Materials distributed by the Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, Planning Working Group, September 2001.
8 Fuji Research Institute Corporation, *Mizuho Report,* "Current Status of the Appliance Recycling Law, and Future Challenges," September 2002.
9 Development Bank of Japan, *Studies*, 20, "Impact of the Introduction of the Appliance Recycling System, and Future Prognosis," March 2001.
10 Mitsubishi Research Institute, Inc.: *Report on Promoting the Management and Recycling of Waste (Implementation of system to Recycle Specified Consumer Appliances: An Exploration of the Appliance Recycling Law's Effectiveness in Alleviating the Burden on Municipalities)*, research commissioned by the Ministry of Economy, Trade and Industry, 2002.
11 Sony Corporation: *Social and Environmental Report 2002*, June 2002, p. 18.
12 Mitsubishi Research Institute, Inc.: *Study on Trends in Technologies Addressing Environmental Impacts by Chemicals in Conjunction with the Production and Discarding of IT Equipment (Research Commissioned by the New Energy and Industrial Technology Development Organization)*, 2002.
13 Williams, E., ed.: *Computers and the Environment*, United Nations University, 2003.
14 Nakamaru, Yoichi, et al.: "Estimating the Number of Discarded Electronic Circuit Boards from Consumer Electronics," Japan Society of Waste Management Experts, *Papers Presented at the 12th Japan Society of Waste Management Experts Congress*, 2001.
15 Sakai, Shin'ichi, et al.: "An Exploration of Info-Communications Products: Materials and Their Recycling," Japan Society of Waste Management Experts, *Papers Presented at the 11 th Japan Society of Waste Management Experts Congress*, 2000.
16 Sharp Corporation: *2002 Sharp Environmental Report*, September 2002, p. 35.
17 According to the Japan Paper Association.
18 According to the Sapporo City Environment Department.
19 Ministry of Economy, Trade and Industry, Industrial Structure Council, Environmental Committee, Waste and Recycling Subcommittee, Planning Working Group: *Enhancing the Cyclical Society System*, February 2002, p. 15.
20 Basel Network Action and Silicon Valley Toxics Coalition (2001): *Exporting Harm*.
21 *Indust*. 20(3), 2005, p. 102.
22 *Asahi Shimbun*, July 28, 2003.
23 Hosoda, Eiji: "Challenges of the Cyclical Society System," Japan Society of Waste Management Experts, ed., *A Waste Reader*, New Edition, Chuo Hoki Publishing, July 2003; Ministry of

Economy, Trade and Industry, Kyushu Bureau of Economy, Trade and Industry: *Report on Study of the Possibilities of Building an Asian Resource Cycling Network*, March 2002.

24 Re-Tem Co., Ltd.: *2002 Environmental Report*, 2002, pp. 4-5.

25 Kojima Michikazu, Aya Yoshida.: "Waste Exports from Japan and Recycling in China," Consumers' Life Institute, *Research Assistance for a Sustainable Society and the Global Environment (2002)*, 2003.

Chapter 5

1 Kurasaka, Hidefumi: "An Economic Analysis of the Automobile Recycling Law," *Jurist*, 1234, Yuhikaku, November 15, 2002; Honda, Daisaku, et al.: "Flow Study on the Recycling and Processing of End-of-Life Vehicles," Japan Society of Waste Management Experts, *Papers Presented at the 14 th Japan Society of Waste Management Experts Congress*, 2003.

2 *Asahi Shimbun*, October 1, 2003, evening edition.

3 *Report by the Hokkaido Council for Proper Automobile Recycling*, 2002.

4 Nissan Motor Co., Ltd.: *Environment and Social Report 2002*, March 2003, pp. 33-34.

5 Kurasaka, ibid.

6 Otsuka, Tadashi: "Automobile Recycling Law: Assessment and Problems," Japan Center for Human Environmental Problems, *Research on Environmental Law*, no. 28, Yuhikaku, October 2003.

7 Daihatsu Motor Co., Ltd.: *Environment Report 2003*, September 2003, p. 23.

8 *Yomiuri Shimbun*, May 11, 2003.

9 Released on December 3, 2003 by the Ministry of Economy, Trade and Industry.

10 Togawa, Ken'ichi: *Automobiles and Recycling*, Nikkan Jidosha Shimbunsha, September 2001; Development Bank of Japan, *Studies*, 36, "Recycling End-of-Life Vehicles: Outlook and Challenges," March 2002.

11 Development Bank of Japan, *Studies*, 55, "Developments in the Resource-Cycling Sector, Primarily the Materials Industries," July 2003.

12 *Nihon Keizai Shimbun*, June 26, 2003.

13 *Asahi Shimbun*, December 5, 2003.

14 Tsukio, Yoshio, ed., *Grand Design for an Ecological Society*, NTT Publishing, April 2003, p. 220.

Chapter 6

1 Yoshida, Fumikazu: *The Political Economy of Waste and Pollution*, Iwanami Shoten, September 1998.

2 Honda, Atsuhiro and Masaru Yamada: *Management and Reuse of Construction Waste*, Energy Conservation Center, Japan, July 1990; Honda, Atsuhiro and Masaru Yamada: *Recycling of Construction Byproducts and Waste*, Energy Conservation Center, Japan, August 1994.

3 Yoshida, ibid.

4 Development Bank of Japan: Studies, 33, "Urban Renewal and Resource Recycling," February 2002.

5 Osaka Gas Co., Ltd.: *Environmental Action Report 2002*, July 2002, pp. 19-20.

6 Society for Research on Managing Building Demolition Waste, ed.: *Report on the Demolition and Recycling* System, Taisei Publishing, November 1998, p. 13.

7 Ministry of Construction, Economic Affairs Bureau, Project Coordinator's Office, and Ministry of Construction, Economic Affairs Bureau, Construction Industry Section, eds., *Report of Research Group on Recycling Facilities and the Proper Siting of Final Disposal Sites*, Taisei Publishing, July 1999, p. 17.

8 Ishiwata, Masayoshi: *The Industrial Waste Connection*, WAVE Publishing, December 2002, pp. 117-118.

9 Ishiwata, idid., p. 122.

10 Ishiwata, ibid., p. 200.

11 Hosoda, Eiji: "Latent Resource Value and the Possibilities of Recycling," Japanese Geotechnical Society, *Soils and Foundations*, 51(5), May 2003.

12 *Yomiuri Shimbun*, July 6, 2003.

13 Ishiwata, ibid., p. 190.

14 Otsuka, Tadashi: *Environmental Law*, Yuhikaku, November 2002, pp. 420-421.
15 Kitamura, Yoshinobu: *The Changing Industrial Waste Legal System*, Daiichi Hoki Publishing, February 2003, p. 65.
16 Obayashi Corporation: *Environmental Report 2002*, August 2002.
17 Okamura Corporation: *2002 Environmental Report*, July 2002, pp. 25-26.
18 Biological Waste Recycling Research Group, *Biological Waste Recycling Research Group Report*, February 1999.
19 According to Professor Minoru Terasawa.
20 The Seiyu Co., Ltd.: *Seiyu Sustainability Report 2002*, May 2002, p. 50.
21 Seiyu, ibid., pp. 52-53.
22 Aeon Co., Ltd., *Aeon Environmental Report 2002*, May 2002, p. 45.
23 Mori, Hisatsuna: "Use of Food Waste as Animal Feed," Hokkaido University Graduate School of Economics, *Economic Research*, 51(3), December 2001.
24 Yamaji, Kenji, written and ed., *Bioenergy,* Mioshin Publishing, December 2000; Development Bank of Japan, *Studies,* 48, "Food Recycling and Biomass," December 2002.
25 Hayashi, Tomoyuki: *Considerable Change in Lumber and Wooden Buildings*, Maruzen Library, March 2003, pp. 132-133.
26 Kasemset, C.: "Management of Technology Transfer on Banana Peel Waste Composting," *2003 International Symposium on Environmental Management: Policy, Research and Education*, Chiang Mai, 2003.

Chapter 7
1 Ishiwata, Masayoshi: *The Industrial Waste Connection*, WAVE Publishing, December 2002.
2 Ishiwata, ibid., p. 20.
3 Ishiwata, ibid., p. 33.
4 Ishiwata, ibid., pp. 34-35.
5 Ishiwata, ibid., p. 109.
6 Kinki Environmental Industry Co., Ltd.: *REMATEC 2002 Environmental Report*, November 2002.
7 *Nikkei Ecology*, no. 48, Nikkei BP Publishing, June 2003.
8 Takasugi, Shingo: *Foundering Industrial Waste Policy*, Nippon Hyoronsha, April 2003; *The To-o Nippo*, "Investigating Heavy Illegal Dumping on the Prefectural Border," series of eight articles published between September 1, 2002 and February 15, 2004.
9 *Yomiuri Shimbun*, April 22, 2003.
10 Ishiwata, ibid., pp. 232-233.
11 Ishiwata, Masayoshi: *How to Eliminate Illegal Dumping*, Iwanami Booklet, July 2003, p. 10.
12 Hosoda, Eiji: *The Economy of Goods and Bads*, Toyo Keizai Inc., November 1999, Chapter 5.
13 Kurasaka, Hidefumi: "Local Environmental Tax Developments and Industrial Waste," National Federation of Industrial Waste Management Associations, *Indust*, 16(5), May 2001.
14 Morotomi, Toru: "Theoretical Basis and Institutional Design of Industrial Waste Taxes," Japan Society of Waste Management Experts, *Journal of the Japan Society of Waste Management Experts*, 14(4), July 2003.
15 *Asahi Shimbun*, May 24, 2003.
16 *Asahi Shimbun*, January 13, 2003.

Concluding Chapter
1 According to Professor Daikan Oki.
2 According to Mr.Manabu Akaike.
3 Japan Resources Association, ed.: *Millennium Sustainable Society*, Japan Institute for Community Affairs, January 2003.
4 According to Mr. Manabu Akaike.
5 Tanaka, Yasuo, et al.: *Public Works by the Citizens*, Iwanami Booklet, February 2003.
6 According to Mr. Tetsunari Iida.
7 Hasegawa, Koichi: *The Environmental Movement and the New Public Sphere*, Yuhikaku, April 2003, p. 175.
8 Hoshiba, Shinji, et al.: "A Proposal for Composite Indicators to Assess Dairy Production Sys-

tems," The Society of Agricultural Structures, Japan, *Journal of the Society of Agricultural Structures, Japan*, 32(3), December 2001.

9 Sen, Amartya: *Development as Freedom*, Oxford University Press, 1999.