Economic Aspects of Public Policy for Promoting a Materials-cycle Sustainable Society*

Kazuhiro Ueta**

<Contents>

I. Introduction

We are seeking a transformation from a "mass-waste society" to a "materials-cycle sustainable society." The present mass-waste society came about through the toleration of huge quantities of waste to the point that the sheer amount far exceeds the capacity of local governments to deal with it. In order to process this excess waste, additional incinerators and landfills have become necessary. These, in turn, become the sources, both immediate and potential, of further pollution and environmental disruption. However, the contemporary strategy of constructing new disposal facilities to cope with the rapid increase in the volume of waste is presently approaching its physical and social limits.

There is a fair amount of awareness within society on this point, and recent years have seen a growing consensus in favor of waste reduction, reuse and recycling. But when the question turns to what extent we should push these three goals, who will do it, and how it should be done, opinions diverge and it is clear that waste policy remains in a continuing state of trial and error. Furthermore, the speed of technological change continues to far outpace the capacity of sanitation and recycling engineers to

---

* This is a slightly modified version of the paper which was delivered at the seminar in commemoration of the opening of Environmental Studies Building in Seoul National University, 17 May, 2000.

** Professor of Environmental Economics and Public Finance, Graduate School of Economics, Kyoto University Kyoto 606-8501, Japan/e-mail ueta@econ.kyoto-u.ac.jp

develop new methods of disposal. One new material after another is developed and introduced without considering how it will affect the waste situation, how the cost of its disposal will be covered and what sort of social apparatus will be necessary to carry this out. Will conventional methods work? Can it be recycled? Or should society directly or indirectly limit its production and sale in some way? These are some of the issues confronted by modern society and are ones that demand difficult choices.

Recovery of resources from waste through recycling is a specific principle incorporated in the general waste management policy adopted by an OECD committee in September of 1976. Accordingly, attempts at recycling integrated with overall waste management, at least in the more industrialized nations, might be expected to have become more refined over the last 15 years. In fact, however, discrepancies remain not only over the organization and aims of recycling efforts,but also over the desirability of recycling itself.

For example, setting aside ideology and concentrating on actual recycling experience, the following two criticisms of waste, it can lead to a loss of incentive to reduce the amount of waste produced, and that recycling should be fundamentally reevaluated as a possible cause of the tendency towards increasing amounts of waste. Second, that because of limitations on the market for recycling thus tends to merely gloss over the seriousness of problems associated with waste, and that there is hence a danger of using to sweep the real problem under the rug.

The purpose of recycling efforts varies with the sponsoring organization. While local governments often motivated to undertake recycling efforts in order to extend the life of landfills by reducing the amounts of waste that must eventually be disposed of, citizens groups often approach recycling from the standpoint of a group activity that will contribute to a cleaner environment through a reassessment of member's lifestyles. Regardless of initial motivation, however, recycling activities require the input of resources and manpower, and in not a few cases the sustainability of these efforts is jeopardized by relatively small gains from recycling posed by economic viability has yet to be surmounted.

This paper will consider the measure that should be used in determining the desirability of recycling from the standpoint of economic viability. Some additional consideration will also be given to the social systems that should be formed in order to bring about the level of recycling desired.

II. Municipal waste as a potential resource

The resource potential of just the municipal waste collected in Japan's cities is far from negligible. Although there are no coordinated statistics on the composition of municipal waste, results of studies in some large cities in Japan before Packaging Law was enacted indicate that municipal waste is composed

of 33-39% paper, 15-22% plastic, 6-21% garbage, 6-14% glass, 4-7% metals,all on a dry weight basis. These studies did not include bulky waste (electric appliances, etc.), so the metals content is probably higher. These figures would also vary depending on whether or not the process of extracting resources from waste is included, and on the extent of recycling activities in each city.

As is clear from the studies mentioned above, the amount of municipal waste consisting of potentially recyclable paper, glass, metals, cloth, and plastic is quite large. Because of the presence of other materials many items and losses in processing, however, the full amount of each material cannot be recovered. Still, it is technically possible to recycle about 90% of glass, 70-80% of textiles and metals, and 60% of paper. Were recycling to be pursued to the technical limit, municipal waste would undoubtedly be a huge storehouse of potential resources.

At the same time, however, the paucity of actual recycling in comparison with the huge potential resources of municipal waste is surprising. Why does such a discrepancy arise?

III. Social benefit of recycling

Generally, in order for recycling to become established, the following four conditions must be met.[1)]

(1) Large amounts of waste exist.

(2) There are useful attributes contained in the waste.

(3) Technology exists to process the waste into usable form.

(4) There is a demand for the reprocessed material or product

In addition, these conditions must be met simultaneously.

If, with these conditions met, the price of the recycled material is less than the price of virgin material, and if this price differential continues for some length of time, then recycling activity can be expected to occur in the market. In reality, however, a variety of factors that affect economic viability of recycling, such as the physical characteristics of the waste (amount, composition, consistency, location of source, etc.), the location and scale of the reprocessing industry, and the stability of the market for recycled materials tend, under the current market mechanism, to mitigate against price competitiveness of reprocessed materials.

Let us look at an actual example. Because the collection of waste paper requires inputs of land, for stockyards, and labor, the waste paper collection/recycling industry can be said to be both labor and land intensive. Because Japanese cities are characterized by a shortage of labor and high land prices, it has

1) Ueta (1992).

become more and more difficult to participate in the industry, and market-based recycling is not expanding.

The standard for recycling, based on the above-mentioned price differential between reprocessed and virgin materials, is evaluated from the standpoint of the market efficiency of waste as a potential resource. This standard has, under current market structure, a tendency to put reprocessed materials at a comparative disadvantage, meaning that the level of recycling does not increase. In other words, having been filtered by the market, what should have been recyclable resources must then be disposed of as municipal waste.

Under current waste management legislation, that is to say the 1970 Law Concerning Waste Disposal and Cleansing (hereafter, Waste Management Law, or WML), local government bears responsibility for the disposal and/or processing of municipal waste. If this waste, consisting of potential resources, is not recycled, then local government must make the expenditure required to dispose of it. As is generally known, location of final sites for waste disposal, especially in larger cities, is becoming increasingly difficult, and per capita expenditures on waste disposal are continuing to rise. Thus, reduction in the amounts of waste generated has become a topic of debate within local government, with recycling taken up as one method of achieving this goal.

In this case, recycling is seen as an alternative to the existing system of disposal, namely collection, followed by landfill of the remainder. Thus, the proliferation of this kind of recycling effort has come about with the realization that waste management policy heretofore, which has taken the mass waste society as a given and sought to increase municipal capacity to dispose of waste through incineration and landfill, is insufficient to provide an effective solution to the waste problem. While many local governments have been directly influenced by the difficulties associated with the location of final disposal sites, we can refer to any recycling activity undertaken by government as public recycling, which comes about in quite a wide variety of forms.

The question arises, then, as to the economic viability of the various recycling systems that local governments are experimenting with. Market recycling uses profitability as a clear measure of market efficiency, but how is public recycling to be evaluated?

Public recycling, or recycling activity undertaken by local government, differs from the profitability standard used by private firms. The rationality of public recycling cannot be demonstrated simply through a direct comparison of recycling costs versus revenues from sales of recovered materials. In addition to these revenues, recycling has a large number of external benefits which include the following:[2)]

1) Reduction of waste disposal costs, which will be highly dependent on the kind of disposal service

employed; that is, on the organization of collection, treatment, and disposal, and on treatment and disposal technology.

2) The reuse of recycled materials in the production process will serve to lessen the total impact of pollution and environmental destruction that occurs in the process beginning with production and ending with disposal. This is dependent, however, on the negative environmental impact of the recycling process itself.

3) Extension of the lives of disposal sites and reduction of demand for new disposal sites (overlaps somewhat with 1 and 2).

4) Reduction, through the use of recycled materials, of the use of virgin materials which require mining, harvesting, or processing. This consequently shifts the nature of the production system towards using less energy and fewer resources.

5) The use of domestically recycled resources reduces raw materials imports and has a positive effect on the balance of trade, increases self-sufficiency, and contributes to the stable supply of resources.

6) In cases of high unemployment, there is an employment effect due to the creation of jobs.

7) People are encouraged to value things more, to care more for their community, and to take better care of the environment in general.

Economic consideration of recycling activities undertaken by local governments should take into account the above-listed seven external benefits. That is, evaluation should take place not in the dimension of private efficiency, but rather on the plane of social efficiency.

IV. Social Cost/Benefit Analysis of Recycling

4.1 Analytical framework[3)]

Here, let us use the actual example of paper recycling to consider a standard within the realm of social efficiency that might be used to decide whether or not recycling should be carried out

In order to simplify the problem and to focus on economic viability of recycling, let us assume that, aside from materials costs and external costs, a ton of paper of the same quality can be manufactured at the same cost using either waste paper or virgin pulp.

Generally, the net benefit gained from the recycling of waste paper to make an additional ton of (new) paper can be expressed by Formula (1) as follows:

2) Turner (1981).

3) This framework is extended from Turner (1981).

$$NBR = SCV + SCD - SCS \quad (1)$$

where *NBR* is the net benefit of recycling (: social benefit - social cost),

SCV is the social cost when virgin materials are used,

SCD is the social cost of waste processing and disposal, and

SCS is the social cost when recycled materials are used.

In short, the net benefit of recycling is calculated to be the sum of the costs saved by recycling.

Formula (2) represents the social costs *SCV* if virgin materials are used.

$$SCV = VC + VP + VF \quad (2)$$

where *VC* is the cost of one ton of virgin materials,

VP is the impact of environmental pollution caused by the processing of one ton of virgin materials, and *VF* is the loss of resource and amenity value from the cutting down of enough forest to yield one ton of virgin pulp.

The social cost of the processing and disposal (as waste or rubbish) of waste paper, SCD is indicated by Formula (3).

$$SCD = SC + ST + SP + SD + SA \quad (3)$$

where *SC* is the cost of collection for subsequent processing and disposal,

ST is the cost of incineration or other processing,

SP is the impact of environmental pollution caused during processing,

SD is the cost of disposal or dumping, and

SA is the environmental damage and pollution and loss at the dumping site caused during the process of disposal.

Formula (4) represents the social cost, SCS, when recycled materials are used.

$$SCS = SCR + SS + SPR \quad (4)$$

where *SCR* is the cost of collection for subsequent recycling,

SS is the cost of separation and processing, and the cost of transport to the paper factory, and

SPR is the impact of environmental pollution caused by the processing of one ton of recycled materials.

When Formulae (2), (3), and (4) are Substituted into Formula (1), and the external benefits of

recycling that have not been included in these formulae are added, the result is Formula (5).

$$NBR = (VC - SS) + (VP + VF + SP + SA - SPR) + (SC - SCR) + ST + SD + A \quad (5)$$

where A includes the additional external benefits of recycling.

Formula (5) provides a framework for the calculation of the net benefit of recycling,which essentially consists of the sum of (a) social costs that would have occurred had virgin materials been used but which are saved due to recycling, and (b) the social costs of waste paper disposal that have also been saved by recycling, minus (c) the social costs of the recycling process itself. When these are restructured in the form of components of an equation like Formula (5), the factors that influence the movement of social benefit become easier to understand. Let us consider the various components individually.

($SC - SCR$) represents the difference between the costs of collection of waste for disposal and the costs of collection of the same waste for recycling. $SC - SCR$, or whether or not recycling adds to collection costs, depends on the nature of the collection system.

Compared to the other components, ($VP + VF + SP + SA - SPR$) is more difficult to express in monetary terms. As more recycling is carried out, of course, VP, VF, SP, arid SA will decline. Depending on the technology used, however, it is possible for SPR to rise so much as to offset this gain. Tools to accurately measure this kind of environmental loss in monetary terms are now being developed, but are not yet ready for reliable use . An alternative method is to measure by using the cost of preventing the environmental damage as a substitute variable.

($VC - SS$) is the difference in cost to a paper factory of a ton of virgin material versus that of a ton of usable waste paper. This can be seen as the difference between the cost of a ton of pulp and the costs of collection, separation, and processing, as well as transport costs to the factory, of a ton of waste paper.

4.2 Some consideration

Given the framework provided by Formula(5) for the analysis of social costs and benefits, we should now be able to calculate the net social benefit of expanded recycling , and to make a decision as to whether or not recycling should be implemented more widely. In fact, however, there are many cases of recycling projects which departed from the original plan and projections and which were subsequently suspended. The causes of these failures vary somewhat in each case, but there are several consistencies relating to economic viability which deserve attention.

The first is the economic motivation for the understanding of recycling in the public sector. When recycling is taken up in the public sector as an alternative to the landfill of waste, judgment will almost certainly be made depending on whether the cost to the public sponsor is "cheaper" than the cost of

disposal by landfill. That is, Formula(6) must be valid.

$$SCD - SCS = (SC - SCR) + (SP + SA - SPR) + (ST + SD - SS) > 0 \quad (6)$$

$(SC - SCR)$, as previously mentioned, depends on the collection systems, but will generally be such that $SC - SCR \leq 0$. $(SP + SA - SPR)$ indicates the effect on the environment, but determination of the correct value is far from simple. If the environmental impact of the recycling process is comparatively very large, then the value could be negative. The more common problem, however, is that countermeasures against SP (specially, anti-pollution measures implemented at incineration facilities) are being introduced. This means that, as SP is increasingly being internalized within ST, and as environmental countermeasures against SA are inherently hard to put into effect, evaluation in monetary terms is made even more difficult, leading to a tendency to underestimation, and resulting in the insufficiently proper internalization of SD. In spite of the fact that in such cases $SP + SA - SPR > 0$, there is a possibility of calculating that $SP + SA - SPR < 0$, jeopardizing justification of the recycling project. In cases where the paper factory that is to use waste paper as a substitute for pulp is located far away from the location where the waste paper is collected, SS would be very high, making it possible for a situation to arise in which $(ST + SD - SS) < 0$. This value will also be affected by the relative efficiencies of the process of waste disposal and the process of separation and processing of waste paper to be recycled.

Thus, the validity of Formula(6) depends on the following four factors : First, the extent to which collection costs in the recycling system can be suppressed; second, improvement of recycling technology in order to reduce environmental pollution caused by recycling itself, and the manner of evaluation of the environmental destruction caused by disposal; third, the comparative efficiencies of the technologies and systems used in the separation and processing of materials to be recycled, and in the treatment and disposal of waste ; and fourth, distance from the paper factory at which recycled materials would be used. Accordingly, the more the public sector can improve these factors, the more merit recycling will have over disposal.

The next consideration has to do with the market for recycling. In order for recycled materials to be used instead of virgin materials in a given production process, assuming that the same quality output can be produced for the same cost from either input, a ton of recycled material must be cheaper than a ton of virgin material. That is, Formula(7) must hold.

$$SCV - SCS = (VC - SCR - SS) + (VP + VF - SPR) > 0 \quad (7)$$

Within Formula(7) , unless environmental damage is valued highly enough, as seen in the case of

waste paper recycling, $VC < SCR + SS$, often resulting in a situation where $SCV - SCS < 0$. In this case, where price is the only factor determining the material used, recycled material will not be used and will consequently have to be disposed of.

When Formula(7) does not hold, it is only natural that market recycling will not take place. Even if Formula(7) does not hold, however, as long as Formula(6) does hold, then the net benefit *NBR* of recycling can still be positive. That is, even if $SCV - SCS < 0$, if $SCD - SCS > 0$, then under certain conditions, the following formula will be valid:

$$NBR = SCV + SCD - SCS > 0 \tag{8}$$

The implication here is important. According to Formula(8), even when the net benefit of recycling is positive and, socially, recycling should be carried out, it may not be undertaken because the cost of recycled materials will be higher than that of virgin materials. To put it simply, recycling is cheaper than landfill but, because the value of the recovered materials is insufficient as a resource, recycling does not occur.

The reason that recycling does not expand in spite of the fact it is socially desirable is because, as indicated by Formula(8), there is no overarching body which can recognize and judge social costs and benefits in their entirety, and because there is no social system formed for such a purpose. The public sector makes decisions based only on comparisons of *SCD* and SCS, while the private sector makes decisions based only on comparisons of *SCV* and *SCS* or of *VC* and (*SCR* + *SC*). In effect, even though there is an obvious chain consisting of production, consumption, waste, and disposal, decision-making at each link along the way is carried out in isolation from the other links. This is termed by the author an "isolationist social system,"[4] which interferes with the recycling of the potential resources contained in waste. The barrier of economic viability, which we have now examined, continues to hamper public recycling efforts throughout Japan.

V. Conclusion: Issues for a Materials-cycle Sustainable Society

In order to overcome and reintegrate isolationist social systems with regard to recycling, policy goals will have to be established and policy instruments will have to be chosen for each individual type of waste item. In addition, the swift pace of technological progress means that new products are leading to varieties of waste with entirely new characteristics that stand to further complicate disposal and

4) Ueta (1992).

recycling. There are some choices and decisions now faced by modern society.

In forming a partnership among citizens, companies and governments in support of a recycling society, there is a need to create a forum for cooperation concerning the formation of social systems that will control the flow of goods (future waste) from an environmentally sensitive standpoint through the stages of manufacture, distribution, consumption, waste, and finally disposal or recycling. The first step will be for local government which has responsibility for waste disposal, to take a leadership role. The problem of waste cannot possibly be solved without the active presence of local government.

Government at the national level will also need to provide support and funds. Although the years have seen expansion of assistance for recycling facilities, overall assistance from the national treasury has been declining due to revenue "shortages," meaning that there is a growing gap between the need for funds for waste management and the availability of assistance. Limitations on local sources of funding are damping down enthusiasm for implementing solutions to the waste problem.

Another important question is to what extent passage by the Diet of some recent Recycling Law, and revisions to the Waste Management Law will have an impact on solutions to the waste problem and on the formation of a materials-cycle sustainable society. A number of difficulties have already been brought forward and, depending on how these are resolved, the effect of this legislation could be dramatically influenced.

Solutions to the waste problem depend heavily on the extent to which participation and public release of information become integrated into the social fabric, and the extent to which progress is made, including the revision of legislation and the creation of overarching bodies to supervise waste management, away from the mass waste society paradigm. In this sense, then, the future of recycling can be said to hang largely on the willingness of citizens to take initiative within a forum for social cooperation concerning the waste problem and possible countermeasures.

Finally, then let us briefly consider the role played by citizens in the so-called recycling movement.

There is a large variety of possible role, all of which lead to reduction of the costs of collection, separation and processing that accompany recycling efforts. As in Formula(4), when SCR and SS are reduced, SCS is also reduced, and the price of recycled materials is made more competitive vis a vis virgin materials, thereby increasing the economic viability of recycling.

References

Turner (1981), An Economic Evaluation of Recycling Scheme, in O'Riordan, T. and Turner, R. K., (eds.), *Progress in Resource Management and Environmental Planning*, Vol. 3, John-Wiley and

Sons, pp. 109-159.

Ueta (1992), Economics of Recycling for Solid Waste Managewent. Yuhikaku. pp. 249 (in Japanese)