Chapter 10

Utilization of Material Flow Analysis in 3R Policy in Japan

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1. Introduction

Utilization of material flow analysis in 3R policy is expected toward establishing a Sound Material-Cycle (SMC) Society. In Japan, the “Basic Law for Establishing an SMC Society” and other various individual recycling laws have their own targets for recycling depending on their objectives. In this paper, the targets for each recycling law are reviewed and the utilization of the material flow analysis is discussed.

2. Basic Plan for Establishing an SMC Society in Japan

2.1 Material Flow Indicators in the First Basic Plan for Establishing an SMC Society

Japan has the “Basic Environment Law” and the “Basic Law for Establishing an SMC Society” which came into force in 1994 and 2001 respectively. The Second Basic Environment Plan of 2000 based on the Basic Environment Law described the need for quantitative indicators (or targets) in the Basic Plan for Establishing an SMC Society.

The Central Environment Council from the Ministry of the Environment (MOE) provided their opinion in the formulation of concrete guidelines for the Basic Plan for Establishing an SMC Society in 2002. That opinion illustrated various indicators such as total material input, reused amount, recycled amount, waste generation, collected/recycled rate for major recyclable resources for each year, based on the material flow. As a result, the First Basic Plan for Establishing an SMC Society was formulated on March 2003. Three phases were set for material flow indicators of this plan; inlet, cycle and outlet.

As inlet indicator, resource productivity was adopted, that is defined such as Gross Domestic Product (GDP) divided by Direct Material Input (DMI). It expresses dematerialization of total economy in the country.

For cycle, the cyclical use rate in the input basis was utilized with recycled amount divided

by material input (DMI and recycled amount). Although either input- or output-based cyclical use rate has merit and demerit, the former can negatively evaluate improper recycling with larger input of energy and material. Currently, recovered amount in the output phase can be used in many cases due to the statistical constraints, but how to measure the “replaced” input would be the future task.

As outlet indicator, final disposal amount was adopted simply. Comprehensive environmental indicators with weighted multiple impacts using Life Cycle Impact Assessment is not used for policy at this moment.

2.2 Material Flow Indicators in the Second Basic Plan for Establishing an SMC Society

As the material flow indicators, the same three indicators with revised targets are used in the Second Basic Plan for Establishing an SMC Society which was formulated in March 2008. The resource productivity excluding earth and rock input, and the coordination toward low-carbon society were added as supplementary indicators. In addition, indicators to monitor changes, for example, resource productivity of fossil resources, biomass resource input rate, and Total Material Requirement (TMR), were also set without targets. In the Second Basic Plan, the following issues to be examined are shown; material flow in each region, material flow indicators that allow international comparisons, primary resource equivalence conversion weight, environmental efficiency and resource productivity, establishment of a standardized conversion factor that can be used internationally, and 3R indicators based on the amount of reuse, material flow by individual items, and a common calculation method.

Besides the above material flow indicators, various effort indices were set both with and without targets. As the indices with target, “Reducing the quantity of wastes”, “Changes in thoughts and actions to establishing an SMC Society”, “Promoting SMC society business”, and “Steady implementation of individual recycling laws” were set. Also, indices to monitor changes are adopted without targets, such as the size of rental and lease business market and the shipping rate for refill

products.

2.3 Quantitative Targets and Evaluation

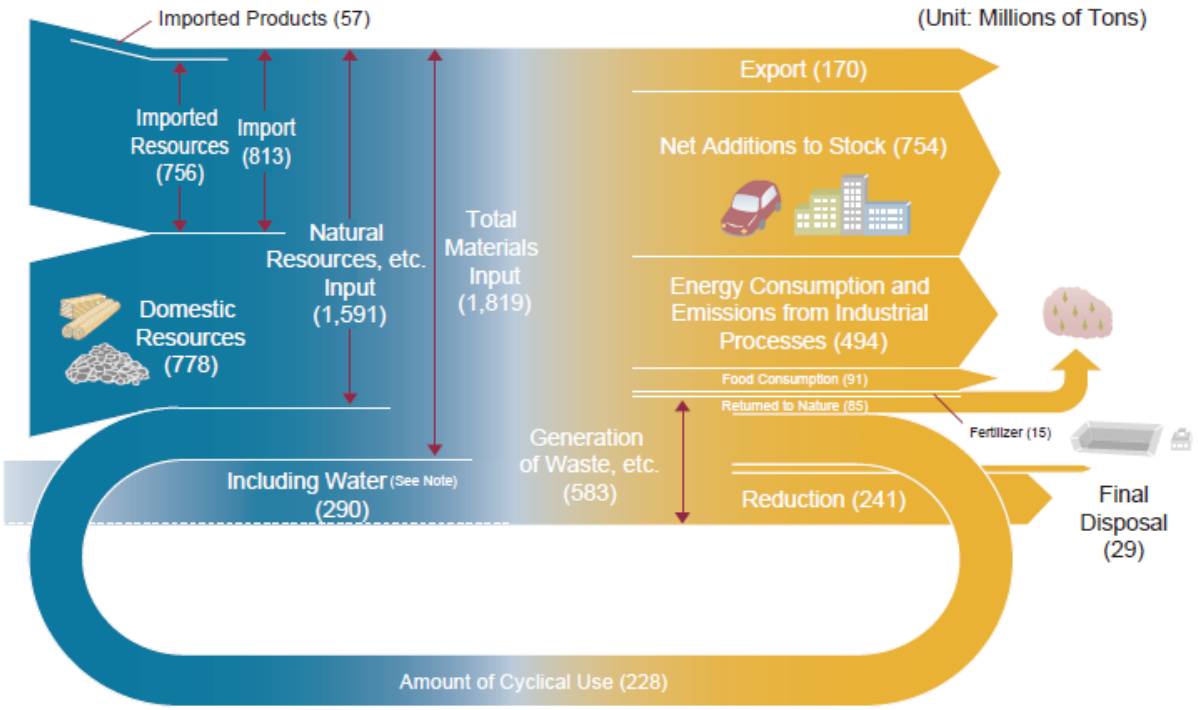
The Japan's Ministry of the Environment illustrates the total material flow in the country used as reference in the Second Basic Plan for Establishing an SMC in 2008 (Figure 1). Quantitative targets for the three material flow indicators are shown in Table 1 and in Figures 2 to 4.

The First Basic Plan requested the Central Environment Council to evaluate and review the progress of policies based on the plan every year. According to the evaluation by the Council, three indicators of recent years have been improved to achieve the targets. At the same time, the needs for supplemental indicators and the consideration of international trade of recyclable resources were indicated. Some of the improvement has been realized in the Second Basic Plan.

Furthermore, the Council indicated that relationship between micro information for individual policy and macro information with these indicators should be linked properly. This issue still remains at the Second Basic Plan. Since various recycling laws and plans in the individual fields such as packaging and home appliances have set various individual targets prior to the First Basic Plan, those individual targets and macro material flow targets are not directly linked each other. Those indicators for micro and macro targets should be harmonized for future consistency.

The detail of above process and discussion on material flow indicators in the Basic Plan for Establishing an SMC is presented well by Moriguchi (2009).

Figure 1. Total Material Flow in Japan in Fiscal Year 2006



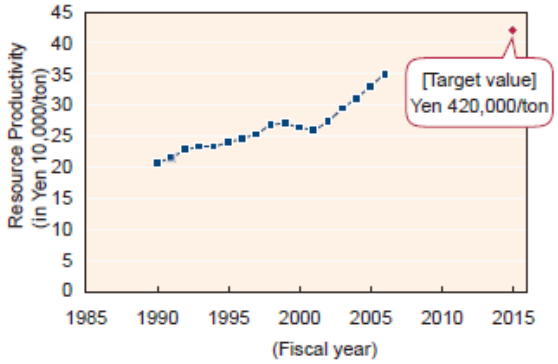
(Note) Including water: Input of water included in waste and the like (sludge, animal manure, human waste, waste acid, and waste alkali) and sediment and the like associated with economic activities (sludge from mining, building and water works and tailing from mining).

Source: MOE, "Material Flow in Japan 2006", 2009, http://www.env.go.jp/en/recycle/smcs/material_flow/2006_en.pdf

Table 1 Quantitative Targets for Material Flow Indicators

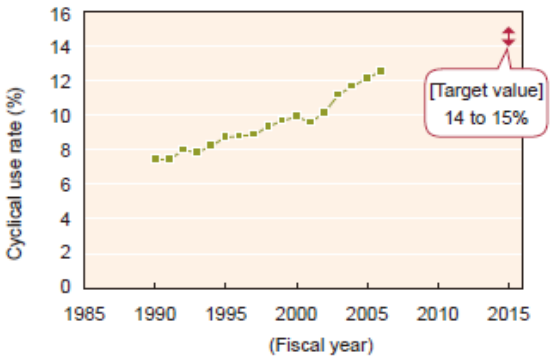
Indicators	Targets		Base year: 2000
	First Basic Plan (Target year: 2010)	Second Basic Plan (Target year: 2015)	
Resource productivity	app. 390,000 JPY/ton (40% up)	app. 420,000 JPY/ton (60% up)	app. 280,000 JPY/ton
Cyclical use rate	app. 14%	app. 14-15%	app. 10%
Final disposal amount	app. 28 million tons (50% down)	app. 23 million tons (60% down)	app. 56 million tons

Figure 2. Trend of Resource Productivity



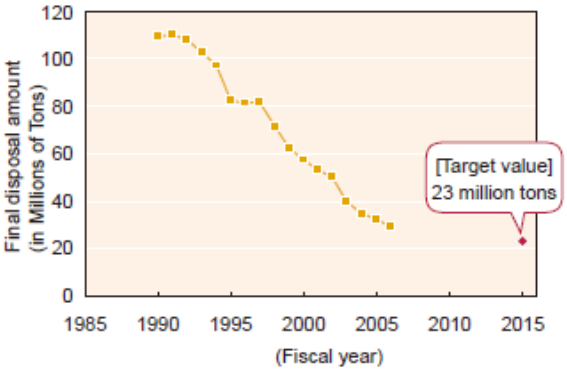
Source: MOE, "Material Flow in Japan 2006", 2009

Figure 3. Trends of Cyclical Use Rate



Source: MOE, "Material Flow in Japan 2006", 2009

Figure 4. Trends of Final Disposal Amount

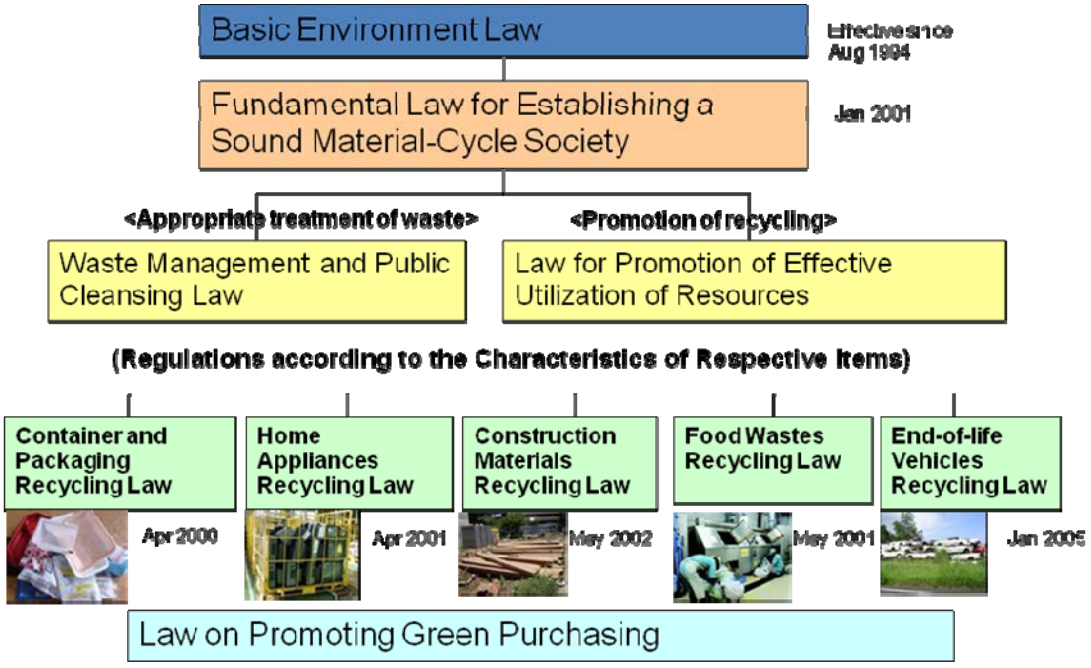


Source: MOE, "Material Flow in Japan 2006", 2009

3. Individual Recycling Laws

Legislative framework to establish an SMC Society in Japan is shown in Figure 5. This paragraph discusses the recycling targets of the four recycling laws for packaging, home appliances, personal computers and vehicles, considering the objectives described in each law.

Figure 5. Legislative Framework to Establish a Sound Material-Cycle Society in Japan



3.1 Container and Packaging Recycling Law

3.1.1 Objectives

The Container and Packaging Recycling Law for PET bottles, glass bottles, and steel and aluminum cans went into force in 1997, and for all packaging including paper and plastic in 2000. The objectives of this law include the reduction of municipal waste to be landfilledand efficient use of recyclable resources.

3.1.2 Definition of Recycling and Roles of Stakeholders

The definition of recycling ("*Sai-shohin-ka*" in Japanese) under this law is to make economically valuable (0 or more) materials that can be used by themselves or others. With regards to the roles of stakeholders, municipalities are in charge of the collection and transportation. On the other hand, the producers and retailers have monetary responsibility for recycling. They provide the

recycling fee and the designated business body consigns the recycling to appropriate recyclers for each municipality using the fee.

3.1.3 Recycling Rate

This law has no target of recycling rate. Material flow (collected and recycled amount), and monetary flow are, however, reported annually to the Ministry of Economy, Trade and Industry (METI) and MOE.

3.2 Home Appliance Recycling Law

3.2.1 Objectives

Home Appliance Recycling Law went into force in 2001. This law aims to contribute in the reduction of municipal waste to be landfilled and the efficient use of recyclable resources. Previously, iron and steel was only recovered at municipal facilities. However, due to the content of valuable resources in the product, copper, aluminum and recently plastic as well were expected to be recovered and recycled.

3.2.2 Definition of Recycling and Roles of Stakeholders

The definition of recycling ("*Sai-shohin-ka*" in Japanese) under this law is to make economically valuable (positive, or at least zero) materials that can be used by themselves or others. Energy recovery is recognized as one of "broad" sense of recycling, but not as the recycling with target.

Regarding roles of stakeholders, the collection and transportation are entrusted to retailers and producers. Producers have the physical responsibility for recycling at their recycling plants. But the cost is paid at discharging by final consumers, for collection (from retailers to designated stock yard) to retailers and for recycling to producers.

3.2.3 Recycling Rate

Recycling rate is set as the rate of recycled amount, i.e., derived amount with economically valuable materials that can be used by themselves or others, divided by collected amount at recycling plants under this law. Targets and trends of recycling rate are shown in Table 2. These targets have been achieved since 2001, and recent recycling rates are gradually increasing due to the efficient separation and the value of materials. Thus, targets were elevated with 5 to 10% for air conditioners, refrigerators and washing machines, while that remains with 55% for CRT TV because of the difficulty of CRT recycling.

The material flow of collected and recycled amount and monetary flow are reported annually to METI and MOE.

Table 2. Targets and Trends of Recycling Rate

	Target	**FY2006**	**FY2007**	**FY2008**	**Remarks**
Air conditioners	70% (60% until Mar 2009)	86%	87%	89%	
TVs	50% (LCD, PDP) 55% (CRT)	77%	87%	89%	FY2009, LCD and PDP added
Refrigerators and freezers	60% (50% until Mar 2009)	71%	73%	74%	
Washing machines	55% (washing machines, 50% until Mar 2009) 65% (clothing dryers)	79%	82%	84%	FY2009, clothing dryers added

3.3 Law for Promotion of Effective Utilization of Resources (Personal computers)

3.3.1 Objectives

The Law for Promotion of Effective Utilization of Resources went into force in 2001 for business-use personal computers (PC), and in 2003 for home-use PC. This law covers various sectors and products. PC and small-type secondary batteries are set as designated products to be recycled.

The objectives of this law include the reduction of municipal waste to be treated and landfilled, efficient use of recyclable resources, and environmental preservation considering toxic substances.

3.3.2 Definition of Recycling and Roles of Stakeholders

The definition of recycling ("*Sai-shigen-ka*" in Japanese) under this law is to make use as parts or secondary materials. This law does not necessarily request economical value of recovered materials, unlike the above two laws.

Concerning the roles of stakeholders, collection and transportation are entrusted to producers. Producers have the physical responsibility for recycling at their recycling plants. The cost for collection and recycling is paid by final consumers. This cost is incorporated in the product price since the enforcement of this law.

3.3.3 Recycling Rate

Recycling rate is set as the rate of recycled amount divided by treated (almost the same as collected) amount under this law. The target recycling rates are 50%, 20%, 55% and 55% for desk-top PC, notebook PC, CRT display and LCD display, respectively. Recycling rates (treated and recycled amount) and collected amount are disclosed.

3.4 Law for Promotion of Effective Utilization of Resources (Small-type Secondary Batteries)

3.4.1 Objectives

Law for Promotion of Effective Utilization of Resources went into force in 2001 for small-sized secondary batteries (Pb, Ni-Cd, Ni-MH, Li-ion). The objectives of this law are the same as that with PC.

3.4.2 Definition of Recycling and Roles of Stakeholders

The definition of recycling is to make use as parts or secondary materials. Regarding the roles of stakeholders, collection and transportation are entrusted to producers. Recycling is also charged to producers but implemented by Japan portable rechargeable Battery Recycling Center (JBRC), Mobile Recycling Network (MRN) and other producers. The cost for recycling is incorporated in the product price.

3.4.3 Recycling Rate

Recycling rate is set as the rate of recovered metal content divided by treated (or collected) amount under this law. The targets recycling rates are 50%, 60%, 55% and 30% for Pb, Ni-Cd, Ni-MH, Li-ion, respectively. Collected, treated and recycled amount, and calculated recycled rate are disclosed.

Collected rate representing collected amount divided by sold amount is not set under the law. The Industry Structure Council of METI had set the target of collection rate with 75% and 45% for Pb and Ni-Cd, respectively, in their guideline for waste management and recycling before. However, there seemed the difficulty of data availability and the recent revised guideline of 2005 did not set that target.

3.5 End-of-Life Vehicles Recycling Law

3.5.1 Objectives

End-of-Life Vehicles Recycling Law went into force in 2005. The objectives of this law include the reduction of (industrial) waste, efficient use of recyclable resources and reusable parts. Previously, iron and steel was only recovered at conventional recycling facilities. However, due to the content of valuable resources in the product, copper and aluminum were also expected to be recovered and recycled.

3.5.2 Definition of Recycling and Roles of Stakeholders

The definition of recycling ("*Sai-shigen-ka*" in Japanese) is to make use as parts or secondary materials. Energy recovery is recognized as recycling for automobile shredder residue (ASR). With regards to the roles of stakeholders, dismantlers and recyclers (with shredding facilities or electric furnace) have physical responsibility, while consumers pay the fee for appropriate treatment of Chlorofluorocarbons (CFCs), airbags and ASR during purchasing.

3.5.3 Recycling rate

Recycling rate is set as the rate of recycled amount divided by collected amount under this law. The target recycling rates are 50% (2005), 70% (2010) for ASR, and 85% (year not specified) for airbag. In case of ASR, thermal recycling and amount of residue is considered. Recycling rates are disclosed by producers.

4. Discussion

4.1 Overall Material Flow Including Non-legislative scheme

The flows of material, monetary and information are interactively linked. But in general,

material flow is concerned when it is linked with monetary flow. It is hard to estimate overall material flow. Exception is automobiles (All the vehicles are registered and recycling fee is paid at purchasing). For containers and packaging (short life products), shipping amount to the market is estimated as discarded amount. For long life products such as home appliances and PCs, estimation of discarded amount is not easy due to the need for life time and the storage at home. Collected and recycled amount only under the legislative scheme is officially reported.

Government (MOE and METI) have tried to understand the overall material flows including the flows not covered by the legislative schemes, using questionnaires for the case of home appliances. Especially, invisible flow for export from Japan is of high concern. But the main approach is implemented with research basis.

4.2 Relationship between individual recycling and SMC Society

Individual recycling laws have their background and objectives for municipal and industrial waste. To achieve those objectives, the laws have their own definitions and targets of recycling. At this moment, the relationship between micro information for individual policy and macro information with these indicators should be linked properly, as described above. Since various recycling laws and plans in the individual fields such as packaging and home appliances have set various individual targets prior to the First Basic Plan for Establishing an SMC Society, those individual targets and macro material flow targets are not directly linked to each other. Those indicators for micro and macro targets should be harmonized for future consistency.

4.3 Toward the Promotion of 3R

Basic Law for establishing an SMC Society stipulated the priority of 3R (reduce, reuse, recycle). Reduced amount, however, may be hard to estimate. Reuse is less focused under individual laws. Recycling and proper disposal are reported officially. How to monitor the overall material flow

and to promote 3R with material flow analysis would be the future challenge.

5. Conclusion

Various individual recycling laws in Japan set recycling target for each item. This reflects the individual background and objectives for municipal and industrial waste. This does not have direct link with the Basic Plan for Establishing an SMC Society. The objectives of individual recycling laws are mainly waste reduction and cyclic use of materials. Targets of recycling rate are mainly set as recycled (utilized) amount divided by collected amount in the legislative scheme, in general. Current monitoring is applied for evaluation of legislative scheme. But with the increasing international trade of recyclable resources, material flow analysis is expected for understanding overall flows and improvement of legislation. Furthermore, those indicators for micro and macro targets should be harmonized for future consistency.

Reference

Y. Moriguchi. 2009. “3rd Chapter: Introduction and expansion of indicators and quantitative targets at Basic Plan for Establishing an SMC,” in Y. Sakita and S. Sakai, eds. *Establishing an SMC*. pp.51-84. Tokyo: Chuo-Shoseki. (in Japanese).