

NIMS-EMC Materials Data for the Environment, No. 12

**Appraisal of a Sound-Material Society
from the Point of View
of Material Stock**



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March, 2006

Authors

Ichiro Daigo

Kiyoshi Ijima

Kohmei Halada

EcoMaterials Center
National Institute for Materials Science



EcoMaterials Center
National Institute for Materials Science

1-2-1 Sengen, Tsukuba, Ibaraki, 3050047 Japan
Tel: +81-29-859-2668
Fax: +81-29-859-2601
e-mail: emc@wotome.nims.go.jp
home page: <http://www.nims.go.jp/emc/>

Preface

The 21st century, which is being hailed as the "environment century," is becoming an age where the global environment is being considered from every possible aspect, such as daily and economic activities. Against this backdrop, raw and processed materials are being used to make all types of products. As resources, these materials are being extracted from the earth's environmental sphere, and returned to this sphere as waste, so they are very closely tied with the global environment. Therefore, not only the producers of materials, but also all the people who produce, use, and dispose of the products, have a vested interest in learning about the environmental load and recyclability of these materials to improve productivity and make the right choices for creating a sustainable society for the future.

Unfortunately, there is still relatively little processed information available regarding the environmental load and recyclability of these materials. Sometimes, information that has been "fleshed out" can be found here and there, but it is still often not sufficient to make informed decisions.

To address these issues, the EcoMaterials Center, as a core organization for the acquisition and processing of reliable information on substances and materials, is working hard to issue NIMS-EMC Data as a series. NIMS, it should be noted, is the acronym for the National Institute for Materials Science, and EMC refers to the EcoMaterials Center. While there may be slight differences in procedures for collecting data and creating databases, we would like to use detailed surveys by experts and other vehicles to provide essential material data which can be used to create product materials which cannot be derived from statistical data, and which includes data on such considerations as recyclability and LAC, or Life Cycle Assessment.

March, 2006



Dr. Kohmei Halada

Director of the EcoMaterials Center
National Institute for Materials Science

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Reference

The present report collects the results presented by the Working Group on "Appraisal of a Sound-Material Society from the Point of View of Material Stock" set by the Ecomaterials Forum, corresponding to year 2005. The members of this working group are as follows.

Members of the Working Group on Appraisal of a Sound-Material Society from the Point of View of Material Stock

Osamu Umezawa	Professor, Graduate School of Engineering, Yokohama National University
Wakana Tamaki	Market Survey Division, Japan Technical Information Services Corporation
○Ichiro Daigo	Research Associate, School of Engineering, The University of Tokyo
Ken'ichi Nakajima	Research Associate, Graduate School of Environmental Studies Tohoku University
Seiji Hashimoto	Senior Researcher, Research Center for Material Cycles and Waste Management, National Institute for Environmental Studies
Masaaki Fuse	Research Scientist, Research Center for Life Cycle Assessment, National Institute of Advanced Industrial Science and Technology
Shinsuke Murakami	NIES Postdoctoral Fellow, Research Center for Material Cycles and Waste Management, National Institute for Environmental Studies
Eiji Yamasue	Research Associate, Graduate School of Energy Science, Kyoto University
Kazuyo Yokoyama	Research Associate, Graduate School of Environmental Studies, Tohoku University

(○ : Leader of Survey)

1. Introduction

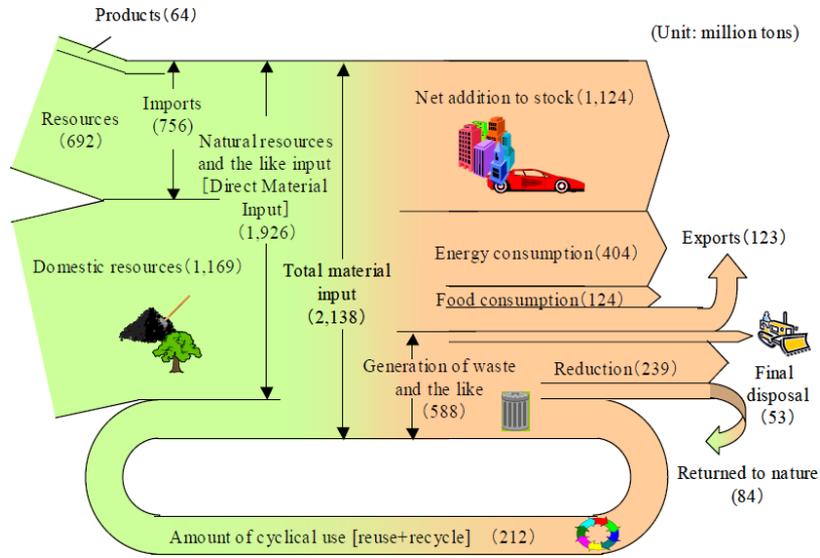
1.1 Ideal material flow

In order to establish a sustainable society, it is necessary to solve the problems of energy resource and mineral resource depletion as well as of waste disposal, to control the consumption of fossil energy, and to foster the recycling of materials. In Japan, the current status of material flow shows that approximately 2.1 billion tons of material was input during FY 2002 (see Fig. 1-1). Of this number, the amount of material that is recycled reaches approximately 200 million tons, which is one tenth of the total. As is shown in Figure 1-1, approximately half of the total amount of material input, that is 1.0 billion tons, is net additions to stock accumulated in the society (Ministry of Environment, 2005).

What should be the material flow in a society with an advanced degree of resource recycling? For example, Figure 1-2 shows a diagram of the material flow in a society omitting detailed discussion and assuming a society with a steady population. This is what we should aim at. To avoid misunderstanding, it is necessary to clarify that we do not recommend a large amount of material recycled and consumed though the quantity of material is not recorded in the figure. Taking material degradation by recycling into account, we start with the assumption that as consumption of some amount of natural resources is necessary, a perfect material flow with 100% of material recycling cannot be achieved, but the figure represents a society in which almost all material is recycled. The main points in this future image are that, in contrast to Figure 1-1, there are no net additions to stock. After society reaches a mature point, there is some degree of fluctuation, but the accumulation remains almost constant, and we assume that there become no net additions to stock.

Based on past experience, trends in the total amount of material input and in the net additions to stock are presented in Figure 1-3. During the two decades starting in 1980, the total amount of material input reached a peak in 1990, after a gradual increase during the previous 7 years, and after this peak there is a gradual decrease in the total amount of material input. On the other hand, the amount of natural resources input is also shown. The difference in relation to the total amount of material input corresponds to the amount recycled, and an increasing trend is evident. It is important to point out that changes in the total amount of material input and in the amount of net additions to stock show the same tendency. For the past 20 years, increase of net additions to stock shows an approximately constant ratio of the amount of resources input. If this trend continues, even when resource recycling advances, the amount of natural resources input cannot be lower than the amount of net additions to stock. That is, the amount of net additions to stock requires the additional natural resources input in the same proportion as shown in the concept image of material flow in Figure 1-4. Accordingly, to construct the ideal society as shown in Figure 1-2, it is necessary to decrease the amount of net additions to stock. Please note that to decrease the amount of net additions to stock does not mean to decrease the capital investment, but to achieve the highly efficient use of material. Next, we will discuss in detail about net additions to stock.

Figure 1-1 Schematic diagram of material flow in Japan (FY 2002)



Note: Due to intake of moisture, etc., total output shall be larger than total material input.

Source: Ministry of the Environment, Japan

Figure 1-2 Schematic diagram of ideal material flow assuming steady population

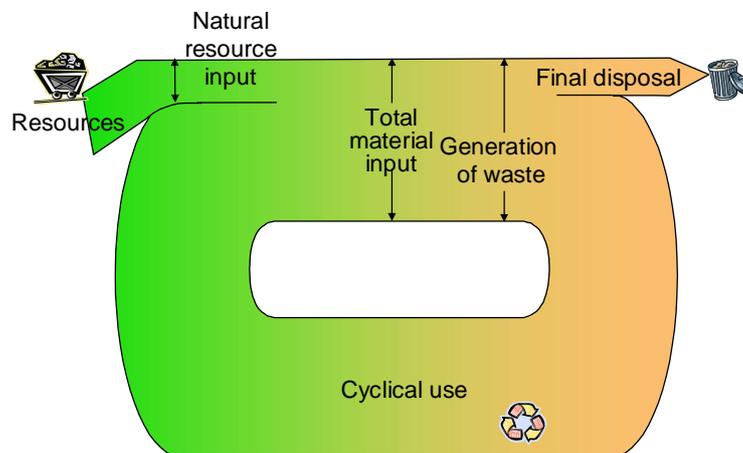
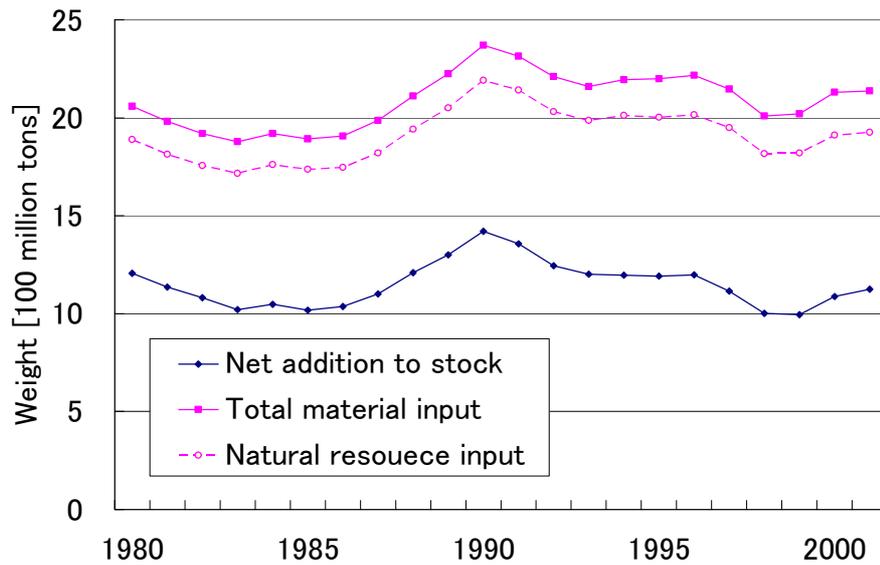
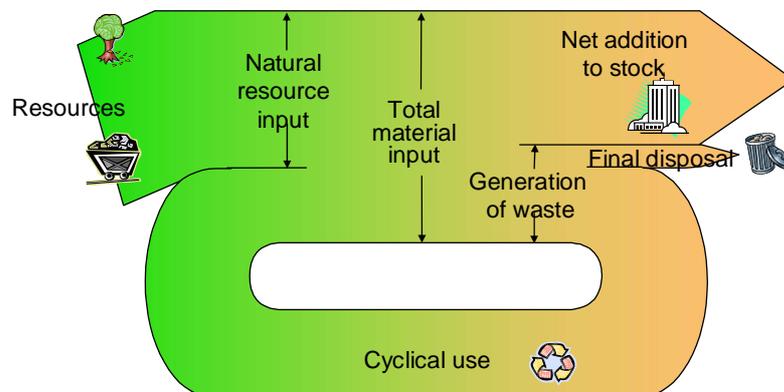


Figure 1-3 Japan's trends of total material input and net additions to stock



Source: Ministry of the Environment, Japan

Figure 1-4 Schematic diagram of material flow in the case of no decrease in net additions to stock



1.2 Net additions to stock and stock

In the material flow shown in Figure 1-1, the total amount of input material is defined as the total amount of imported products, imported resources, domestic resources, and recycled resources. On the other hand, the amount of output corresponds to the consumed energy, the amount of food consumed, exports, waste, etc. (the amounts of final disposal, reduction, returned to natural, and recycled materials). The amount presented above corresponds to the amount during one year. Here, the net additions to stock are calculated by subtracting the amount of output from the amount of input material described above. That is, not-accounted outputs, such as dissipated materials, are included in the net addition to stock.

Hashimoto and Terashima (1999) and Hashimoto et al. (2003) pointed out the discrepancy between the estimated outputs of demolition wastes and the statistical amount (from actual

measurements). They demonstrated a probability in which the outputs of demolition wastes have been underestimated. In other words, it is evident that there are waste materials not accounted for. Brunner (1999) pointed out that Today's emissions to the environment (including wastes) are small when compared to the input into the anthroposphere, which results in a rapidly growing stock of materials in urban areas. Most materials which have been exploited in the past centuries are still "hibernating" somewhere in the anthroposphere. Hashimoto et al. (2003) indicated that the difference between the amount of construction minerals input and the amount of waste is not counted as net addition to stock but as missing materials, or hidden flow, and that it has been almost emitted into the environment. Daigo et al. (2005a) pointed out the difference between the estimated amount and statistical amount (from actual measurements) of steel scrap generation, and developed a dynamic model by considering the recovery rate in collection processes from end-of-life products. Therefore, they imply the existence of disused products that are not accounted for as output. Umezawa and Okubo (2005) have pointed out the existence of an unaccounted amount of waste aluminum that has been left outside the material flow of aluminum in Japan. Fuse and Kashima (2005) focused on used automobiles that are exported but not included in the foreign trade statistics, and pointed out the existence of material that flows outside Japan. Murakami et al. (2005) also looked into the existence of non-ferrous metal scraps exported without being recognized as the specific metals.

As several research works have pointed out, there are used products and waste that are not being accounted for but are included into the figures for net additions to stock. Comparing estimated and statistical values, it can be inferred that a large amount of resources are laid underground (in hibernation status) or dissipated into the environment without being included into the statistics.

1.3 Problems faced by the recycling society

As shown in Figure 1-3, the fact that the net additions to stock have remained an almost constant proportion of the total amount of material input during the last 20 years indicates not only the trend of accumulation of materials in use in the society, but also probably compensates for the lost of materials. To reduce natural resource input to less than the amount of net additions to stock, it is necessary to determine accurate values within the current statistics of net additions to stock not being actually accounted for, that is hibernating or dissipated materials, and to subtract these amounts from the statistics.

However, the amount that has to be subtracted has not yet been identified or quantified. Firstly, it is necessary to identify the content of net additions to stock from observation of the material flow for one year and the content of in-use stock and hibernating stock from the past accumulated data. To this date, most of the research works focused on analyses of the flow of resources, but from now on high expectations will be posed on analyses of accumulated amounts.

In this article, the amount of accumulated materials in anthroposphere is determined as "social stock" (further details will be given in the next chapter). To prepare the analysis of the social stock, the Ecomaterials Forum set up this working group (hereinafter WG) for carrying out an "appraisal of a sound-material society from the point of view of material stock." The results corresponding to fiscal year 2005 have been summarized in the present book. In Chapter 2, the definition of social stock according to this WG will be discussed. In Chapter 3, the possible classification of social stock will be discussed from the point of view of highly efficient utilization of resources. The results obtained or achieved from analysis of social stock are summarized in Chapter 4. At the end of the book, each member of the WG will present his or her ideas on this topic.

2. Definition of Social Stock

2.1 Terminology

Social stock refers to the material accumulated in the anthroposphere, and the amount of material accumulated is also called the social stock. Examples of the social stock are materials used for buildings, public work construction, machinery, etc. We call the anthroposphere that part of the earth related to the human activities, and the remaining space is called the natural environment. It is

not easy to determine boundaries between the anthroposphere and the natural environment, so we deal with them in the following chapter.

To help to understand, we will discuss the statistics for current social stock. If the amount of things existing in the anthroposphere could be measured, it would be possible to determine the social stock. However, things in society are dissipated, and except for a limited number of special goods such as taxable goods, it is difficult to measure the social stock. As has been discussed in Chapter 1, in the case of "net additions to stock," deducting the amount from the material flow which is easier to determine is considered to be the most realistic approach (see discussions by Yamasue, Nakajima, and Daigo in the Appendices). On the other hand, past research works, facing the lack of data, have assumed the stock to be the accumulated variations (Brunner, 1999; Kleijn et al., 2000; Spatari et al., 2002; Van der Voet et al., 2002; Graedel et al., 2005). Other authors have established the need to carry out dynamic MFA (material flow analysis)/SFA (substance flow analysis) in order to analyze the stock (Kleijn et al., 2000; Van der Voet, 2002; Elshkaki et al., 2004).

In a similar way to the analysis based on existing material flows, it has been established that it is possible to analyze specific materials that are part of the social stock. These materials present in society can be classified according to two criteria. One criterion is to classify the materials according to the type of product, the other criterion calls for classification according to the composition (for example, steel, copper).

2.2 Social stock

(1) Boundary between the anthroposphere and the natural environment

Taking into consideration criteria already discussed, when thinking about the material accumulated in society, it is necessary to consider that the boundary between the anthroposphere and the natural environment remains unclear. Three unclear points can be summarized as follows:

(i) Separation between animal and plant activities and human activities

Regarding the classification between animal and plant activities and human activities, planted forests, agricultural land, livestock, and human bodies can be considered as part of a non-clear classification. These things are administered by human beings, but develop naturally so they can be included into the anthroposphere or in the natural environment. In Appendix IV, Hashimoto explains the guideline prepared by Eurostat (2001) on the material flow account (MFA).

(ii) Boundary determined by input processes

Regarding the boundaries determined by the input processes, there is an ongoing discussion on hidden flows. For certain materials, when it is not clear whether or not they have been transferred from the natural environment into the anthroposphere, they are under discussion as a case of material that has been purposefully transferred by human beings, but has not yet been used. For example, soil or rocks removed during excavation for construction purposes, sediments dredged from harbors, tailings resulting from mining and quarrying activities, biomass produced by harvesting activities, etc. Hashimoto (see Appendix IV) presents the guidelines prepared by Eurostat (2001), and the international joint research pursued by Matthews et al. (2000).

Hashimoto points out that there still remain several points that have not been clarified. Soil resulting from construction works is considered part of the hidden flows, but it can also be considered part of the accumulated materials. From the opinion stated by Matthews et al. (2000) in past research articles, as well as from estimates presented by Tanigawa and Murai (2001), soil removed for construction process is considered a hidden flow, but Hashimoto et al. (2003) think that a set amount of rocks is used for land preparation, or for harbor and airport construction, and therefore should be considered stock. Accordingly, the present situation is that for the same purposes of land preparation, soil is not considered as a stock, but rocks are considered as a stock.

(iii) Boundary determined by disposal processes

Regarding the boundaries determined by the disposal process, classification according to whether or not the used goods are discarded into the environment is not clear. For example, reclaimed land, hibernating materials and dissipative materials. In the guidelines prepared by Eurostat (2001),

reclaimed land under management is considered to be part of the environment, but researchers implementing MFA can determine whether it belongs to the anthroposphere or natural environment. In hibernating materials cables out of use that are left underground and other materials under the soil are included, prompted by Brunner (2004). Brunner pointed out the existence of large amounts of these materials. Regarding dissipative uses and dissipative losses of products, the Eurostat guidelines (2001) refer to materials that have been reverted into the environment as intended or unavoidable consequence of their use. For example, fertilizers, compost, antifreeze agents, etc. can be counted as dissipative uses, and automobile tires and road wearing, volatile component in solvents, etc. as dissipative losses.

Currently, hibernating materials can be considered accumulated materials. However, Hashimoto (see Appendix IV) says that instead of being in "hibernation," they are almost all reverted to nature without being collected, and as in the case of waste in landfill, they are dissipated or have been thrown away. Also, Murakami (see Appendix VI) says that the criterion to decide whether these materials are stock or not depends on whether they have been emitted to the environment by clear efforts or not. Daigo (see Appendix II) stresses the need for a clear boundary between the anthroposphere and natural environment in order to be able to consider a material as part of the social stock. Discussion on the boundary has the same meaning to the difference of flow and social stock. The next chapter will discuss the classification of social stock. For example, hibernating materials and landfilled materials being the result of human activities should be considered social stock, but among them, it is important to establish a proper classification.

(2) Stock and flow classification

In the present section, materials have been classified into accumulated material and flowing material. So far, there is not a clear agreement regarding this point, but in the guidelines prepared by Eurostat (2001) for the application of MFA (material flow accounts), the following items are mentioned pursuant to the national economic accounting.

- *Stocks of materials that belong to the economy are mainly man-made fixed assets as defined in the national accounts such as infrastructures, buildings, vehicles and machinery as well as inventories of finished products. Durable goods purchased by households for final consumption are not considered fixed assets in the national accounts but included in economy-wide MFA and balances. (Eurostat, March 15, 2001).*

Fuse (see Appendix V) gives detailed consideration to the relationship between social stock and national economic accounting, and proposes estimating social stock based on national economic accounting. Yokoyama (see Appendix VIII) has given detailed consideration to the relationship between social stock and the Input-Output Tables which are a statistic for national economic accounting. She assumes that those goods whose durable periods are less than one year are considered to be part of flowing materials.

As it has been described above, all the discussion start from premises that estimation of social stock is based on available statistics regarding material flow (the national economic accounting) and that the social stock is estimated as the accumulated stock increment obtained from analysis of the material flow. Based on these premises, regarding MFA/SFA in the existing literature, we obtained the following suggestion. Brunner and Rechberger (2004) assumed the system boundary for analysis must be determined by both time and space (temporal system boundary and spatial system boundary).

For the determined time and space, the accumulated stock increment obtained from analysis of the material flow does not include the amount of material that enters into and leaves the system within the determined time. For example, Yokoyama says that "a product whose period of use is less than one year is considered to be a flowing material," because the national economic accounting means statistics for one year. In the same fashion, Murakami (see Appendix VI) suggests that if at the time of estimation of social stock, an item that changes its shape into another shape within one year, the item should not be considered as part of the social stock. Umezawa (see Appendix I) says that flowing backlogs should not be included in the social stock. Yokoyama (see Appendix VIII) also considers dealing with stocks in the Input-Output Tables, and points out that it is necessary to make a more detailed classification of stocks.

In summary, classification of social stock and material flow may be strongly influenced by the availability of data. Also, it is important to give careful consideration to criteria for dealing with products with short useful life and backlogs.

3. Classification of Social Stock

In order to promote the recycling of resources it is necessary to analyze and classify the components of social stock. The members of the working group presented examples of classification derived from discussions from diverse points of view. Through analysis of the classification of social stock, it should be possible to estimate the amount of material that will become future recoverable materials. A detailed exposition of the proposal of each member of the working group has been summarized in the Appendices.

3.1 Classification according to using conditions

As has been discussed previously, besides material that is given effective use, it is possible to find dissipated material, remaining obsolete materials, materials disposed in landfill, etc. as part of the social stock. Classification according to conditions of existing materials or classification following the accounting criteria (see Appendix IV) can be considered. Yokoyama (see Appendix VIII) proposes as two classification criteria asking whether a material is used effectively or not, and whether a material still has useful lifetime or not. The two criteria have a little bit different points of view, but they make it possible to identify the extent of the buffer of resources in society that can immediately be recovered from the society as secondary resources.

- Social stock of goods with expired useful lifetime
 - Obsolete buildings without demolition
 - Goods not in use found inside homes and offices
 - Others
- Social stock not effectively used (accounted for)
 - Goods with expired useful lifetime mentioned above
 - Wheels of trains and automobile tires dissipated by wear
 - Materials remaining under the ground and the sea (including foundation pillars)
 - Others
- Social stock not effectively used (unaccounted for)
 - Materials disposed in landfill
 - Others

3.2 Classification according to recoverability

Proper classification of non-recoverable goods and materials could contribute to discouraging the consumption of this kind of goods and materials in society, making it possible to reduce resource input. Development of new systems for collecting these non-recoverable goods and materials or of new technologies to recover them could promote further efficient use of resources. We are sure that the analysis of social stock based on classification according to recoverability could also contribute to a sound-material society.

Each member of the working group has developed a classification system constituted of four categories, A, B, C, and D according to the recoverability of the diverse materials. For details of each category, please refer to the Appendices.

Table 3-1 Classification according to recoverability

Classification plan A	Classification plan B	Classification plan C	Classification plan D	Specific contents
Economically recoverable	Recyclable	Economic	Physically and socially recoverable	(1) Be recovered economically
Socially and economically recoverable	Recycling possible	Marginally economic	(Not applicable)	(2) Be recovered by regulations
Technically recoverable				(3) Lack of demands
	Recycling not possible (system)	Sub-economic	Physically recoverable but socially non-recoverable	(4) Recycling is possible according to the market conditions
	Recycling not possible (technically)			(5) Recycling is impossible economically and due to lack of systems
Non-recoverable	Unrecyclable	Other occurrences	Physically non-recoverable	(6) Recycling is impossible economically and due to lack of technology
				(7) Dissipated material

*Classification plan A (Hashimoto, attachment), Classification plan B (Nakajima, attachment, Yamasue, attachment), Classification plan C (Murakami, attachment), Classification plan D (Daigo, attachment)

Table 3-2 Examples of materials classified according to the classification

Classification plans	Examples
(1) Be recovered economically	Waste paper, iron and steel, and non-ferrous metal, etc.
(2) Be recovered by regulations	Wood, part of PVC, part of plasterboard, and ASR
(3) Lack of demands	Indium in ITO membrane
(4) Recycling is possible according to the market conditions	Some uncollectible waste paper, ferrous material, and non-ferrous metal
(5) Recycling is impossible economically and due to lack of systems	Roadbed material, foundation pillar, and other materials remaining on demolition site
(6) Recycling is impossible economically and due to lack of technology	Solder and obsolete building materials left on the ground
(7) Disappeared material	Pigment, paint, worn metal, splashed materials on demolition site, and emitted coolant

3.3 Classification according to ownership

In order to establish a link between results of analysis of social stock and establishment and implementation of policies to promote material recycling, it is necessary to establish a classification based on type of ownership (Fuse, see Appendix V). For example, three large categories can be established including private individual ownership, private institution ownership and public ownership. As another classification, two categories can be established as consumer goods and capital goods.

3.4 Classification according to region

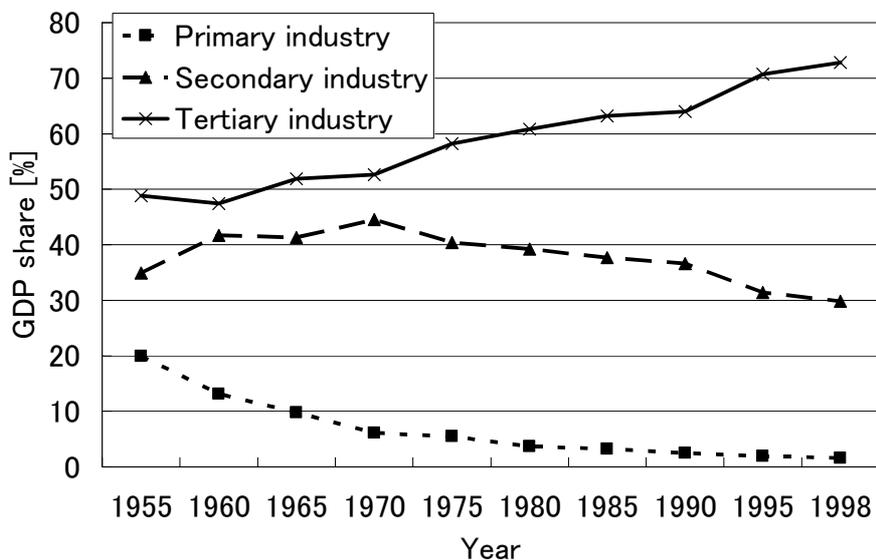
To recycle the materials discarded from social stock it is necessary to transport the scraps from the place of generation to the recycling factories. As the amount of generation is expected to increase, it will be necessary to build new recycling factories, making it of crucial importance to clearly prospect the region where waste is generated. To this end, it is necessary to understand the distribution of regions where scrap is generated (Umezawa, see Appendix I).

4. Concluding Remarks

4.1 Resource productivity index

In the resource productivity index presented as one of current governmental policy targets, GDP appears in the numerator and the amount of natural resources input appears in the denominator. That is, the goal is to decrease the amount of material input and increase the GDP. On the other hand, from the point of view of economics, they say that flow economics related to high growth has changed into stock based economics related to stable growth in developed countries. There is an evident shift from the secondary industry into the tertiary industry which has low intensity of material consumption. Therefore, not only a relationship between input of materials (amount of flow) and GDP, but also the social stock such as fixed capital has a large influence on GDP. However, no index based on stock has been proposed yet. Through the advance of the present research work, we expect to establish a new index by finding a new method for estimation of social stock, which will enable corroboration of the index used in stock based economics with the resource productivity index. Previous works have proposed several indices to present effective use of resources based on accounting of material flow. Among these proposed indices, six indices were proposed by Hashimoto and Moriguchi (2004), a high recycling capability index by the Ecomaterial Research Group (2004), and an average residence time of use in society by Daigo et al. (2005b).

Figure 4-1 Trends in GDP share by industry in Japan



Note: GDP is at current prices. GDP corresponds to nominal prices; 68 SNA from 1955 to 1985, and 93 SNA after 1990.
Source: Data from the national economic accounting published by Cabinet Office, Government of Japan (METI, 2002)

4.2 Future issues

As was discussed in Section 4.1, analysis of social stock is highly important for developing future strategies to promote resource recycling and to face resource depletion, and it has become one of the most pressing research issues in this field. Also, as was discussed in Chapters 2 and 3, the definition of social stock as well as clear criteria for its classification will be addressed as future research matters.

Appendix I (Umezawa)

(1) Definition of social stock

Spatial boundary is always equal to geographical boundary such as national border, since statistical data are usually provided as each country. However, it needs to discriminate production or waste data by region. The system taking into account social stock should be optimized by region. To calculate the amount of material flow, it needs to establish a sub-system in the spatial boundary and to construct the data for each sub-system.

Flow stocks comprise a large share of what has been defined as "(3) material flow that exceeds temporal boundary but not spatial boundary" in above. High-level assembly industry has streamlined stock management making use of the so-called "Toyota System" for online management, which reduces to a minimum the need for stocks during the manufacturing process. However, for the sub-contracting firm that receives the direct effect of the demand fluctuation, an increase in flow stock is expected, causing an overall increase in flow stocks. This flow stock circulates inside a certain process and it is not included in the "social stock".

(2) Classification of social stock

The proposal for classification according to recovery possibility shown in Table 3-1 may be suitable. For general and industrial wastes, PET, disposable plastics and similar materials close to our daily life, it would be better to indicate specifically which classification proposed is applied.

(3) Others

(a) Material flow concept and social stock

When comparing Figures 1-3 and 1-4, it is important to take into account the large ratio of imports and exports in Japan. As most of the produced goods are exported, the total amount of material input does not constitute net additions to stock or become waste. Exported products and waste materials that return to Japan to be recycled are a very small proportion of the total amount. Although there is much talk about recycling of resources taking place in many regions including East Asia, obtaining statistical data regarding used products and wastes as well as the resources input in their production is almost impossible. It is crucial, first, to carry out a survey of material flow in the region including East Asia, from the portion of recycled resources managed and statistical estimation of exports.

(b) Economic geography studies

From the viewpoint of economic geography, during the disposal and recycling of used automobiles, diverse technologies are required to meet the needs arising not only from the different processes and types of materials collected but also from regional differences in the processing approach of waste. Concretely, the total processing capacity of automobile shredding machines in each region can be compared to the number of automobiles in circulation to show the regional specialized factor. In the case of large city areas such as Kanto or Kinki, there are a large number of shredding machines, but if this factor is included in the analysis, this value is high for the Chubu, Kanto, Tohoku, and Hokkaido areas, whereas it is low for the Kinki, Chugoku, and Kyushu areas, and extremely low in the Shikoku area. In the near future, promoting of resource recycling in areas with high development potential including East Asia will require an accurate grasp of the required technologies

in the background. Therefore, material flow should not be considered just as statistics, it is necessary to extract and analyze the hidden meaning behind this figure.

Appendix II (Daigo)

(1) Definition of material stock in the society

Regarding the material stock, it can be said that "by dividing the Earth into anthroposphere and natural environment, material stock in the society is determined as the accumulated amount of material that exists within the spatial boundaries of the anthroposphere at a given point in time."

Here, the problem is to determine the boundary zone of a system, that is, the boundary line separating the anthroposphere and natural environment. There are two points that may confuse this line. The first one is the separation between animal and plant activities and human activities. For example, planted forests are the result of human activity, but they grow as result of plant activities. In addition, there is human intervention such as thinning to promote growth that must be also taken into account. Farm products bring the same difficulty, human beings carry out activities such as addition of fertilizer but growth is a natural activity. The second point is spatial division. Permanent or semi-permanent structures built mainly to protect the space for human activities can be considered to be on the boundary line. For example, they are filled grounds and concrete structures to prevent landslides. These are the result of human activities but remain outside the range of these human activities (surfaces or walls).

These two points can be included or left out of the definition of anthroposphere depending on analysis and evaluation purposes. In principle, it is more convenient to have clear definitions, but accountability is also important, so it is necessary to continue discussion on this topic.

There remains one discrepancy, the final disposal material. According to former flow (Ministry of the Environment, 2005), this material was handled as discharged from material stock in the society. Perhaps, as they should not be considered the same as material stock constituted of industrial machinery operating inside a factory, disposal material was not considered to be part of the material stock in the society. On the other hand, neither processing areas for final disposal material nor foreign countries can be considered part of the natural environment; therefore, from the definition we have been discussing, the final disposal material should be considered part of material stock in the society. In past research works, Yokoyama (2005) et al. included disposal areas in the accumulation system, taking them into account for resources circulation. Here, the argument within this WG becomes useful, and final disposal material is included into material stock in the society by the definition of material stock, by constituting the category of disposed materials. Precise discussion regarding this classification is presented in Chapter 3, but a clear classification method has not been yet proposed. In this section, discussion on anthroposphere and natural environment boundaries and on the classification should become future topics of discussion.

Discrepancies between material stock and flow were investigated. Actually, analyses of material stock consist of analyses of the variations accumulated in determined ranges of time and space, and analyses of special materials and products. Flow is the movement of materials beyond determined temporal and/or spatial system boundaries. That is, it is not decided unambiguously whether to count a material as accumulated material or as material in flow, rather this classification is varied by setting the system boundary. On the other hand, as most accumulation changes are determined from the difference between the amount of material input to the system and the amount output from the system, material that is not accounted as flow is assumed to be part of the stock. In the following, we will discuss the amount of flow which is difficult to estimate.

(i) Flow crossing over a spatial boundary that is difficult to estimate

Gas emitted from coolants, released into the atmosphere at the moment of disposal, or accidentally released into the atmosphere flows from the anthroposphere into natural environment, but it is difficult to measure. Also, flow of material into the atmosphere or into the sea as consequence of material corrosion or soil corrosion, which is an evident transition from the anthroposphere into the natural environment, is difficult to account for. When as a result of artificial processes, oxygen in the

atmosphere and other gases combine to form other compounds, the composed gases migrate from the natural environment into the anthroposphere, but there is also difficulty in computing the actual amount.

(ii) Flow crossing over a temporal boundary but not over a spatial boundary

When products staying in the same place in a time duration cross over a temporal boundary as stocks in the factory, they should be included into the flow statistics, but it is difficult to determine this amount due to difficulty in obtaining the pertinent data.

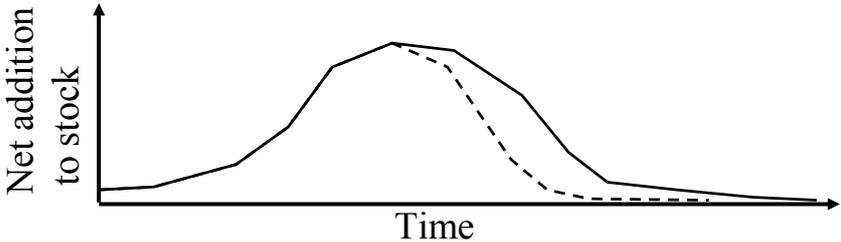
(2) Classification of social stock

We propose a classification based on the physical or the social possibility of collection. This classification differs from other classifications, as the physical point of view does not depend on regional and temporal characteristics. Three categories can be set as follows: (1) physically and socially recoverable, (2) physically recoverable but not socially recoverable, and (3) physically and socially non-recoverable. For example, material collected under legal directions belongs to the category (1), material that is not economically viable for collection belongs to category (2), and material scattered into the atmosphere belongs to category (3).

(3) Others

The net additions to stock increase with growing society. It is expected that when an ideal society matures, the material stock saturates, and the net additions to the stock begin to decrease. The solid line in Figure II represents this behavior. As time elapses, the variation follows a predicted slope, and the area under the curve corresponds to the required input of natural resource. Here we can discuss the dematerialization. To be dematerialized, it is implicitly necessary to reduce the investment of resources, or directly to decrease the required amount of natural resource. Namely, to be dematerialized, the curve shown by the solid line should be transferred to the curve shown by the broken line in Figure II, that is, the leapfrog. Current positions of industrialized countries are not clear in this schematic diagram, but they have probably reached the peak, whereas developing countries are still in a stage of growth of the curve. If Japan and other industrialized countries can establish a society with a low amount of material stock, this effect will not be limited only to each country, but also affect other developing countries. In summary, developing countries that have not yet reached the peak of social stock can make this peak smaller, and we can expect to mitigate resource depletion.

Figure II Schematic diagram for changes of net additions to stock



Appendix III (Nakajima)

(1) Definition of social stock

To define flow and stock, we propose a definition based on an input-output balance of the process. Figure III-1 corresponds to a conceptual diagram of this input-output balance, and Figure III-2 shows interrelation of processes. By classifying into techno-sphere and biosphere in the figure, we can consider separately manufactured goods, industrial byproducts, waste for disposal remaining in the techno-sphere, and emissions into the atmosphere, water and soil in the biosphere.

Figure III-1 Conceptual diagram of input-output balance of processes

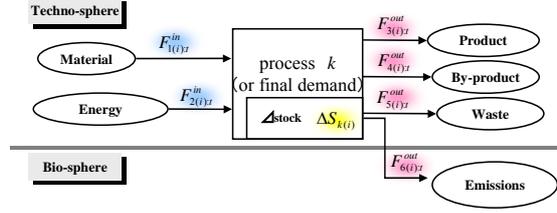
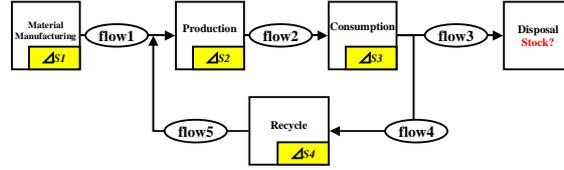


Figure III-2 Conceptual diagram of interrelationship between processes



Here, $F_{j(i):t}$ means the weight of a component i contained in a material j at a given time t . F^{in} corresponds to the weight of input material, F^{out} to the weight of output material, and ΔS the variation in accumulation. The input-output balance is represented by the following equation:

$$\begin{aligned} [F_{1(i):t}^{in} + F_{2(i):t}^{in}] &= [F_{3(i):t}^{out} + F_{4(i):t}^{out} + F_{5(i):t}^{out} + F_{6(i):t}^{out}] + \Delta S_{k(i):t} & \dots (1) \\ \Rightarrow \Delta S_{k(i):t} &= [F_{1(i):t}^{in} + F_{2(i):t}^{in}] - [F_{3(i):t}^{out} + F_{4(i):t}^{out} + F_{5(i):t}^{out} + F_{6(i):t}^{out}] & \dots (1)' \\ \Rightarrow \Delta S_{k(i):t} &= \sum_{j=1}^m F_{j(i):t}^{in} - \sum_{j=1}^m F_{j(i):t}^{out} & \dots (2) \end{aligned}$$

The total amount of a component i contained in a social stock material j at time t_f can be represented by the following equation:

$$S_{(i):t_f} = \sum_{t=t_0}^{t_f} \sum_{k=1}^l \Delta S_{k(i):t} \quad \dots (3)$$

(2) Classification of social stock

To identify social stock data which contribute to the promotion of an effective use of resources, we propose a classification method of social stock that gives careful consideration to the possibility of recycling of social stock. Table III shows the proposed classification of social stock that considers the recycling possibilities. This classification takes into account recycling technologies, social systems for collection and transport which support the recycling process, and economic efficiency. For these three elements, we present four categories for material recycling.

Table III Social stock classification based on recycling possibilities

		Technology	System (collecting, transporting, etc.)	Demands	Social stocks to be used efficiently	Unused social stocks	Notes
(1)Recyclable	Ongoing	○	○	○	Many products	Building component to be scrapped, illegally dumped cars	Economic - marginally economic
(2)Recycling possible	Lack of demand	○	○	×	In of ITO membrane		Marginally economic - sub-economic
(3)Recycling not possible	Lack of system	○	×		Roadbed material, foundation pillar	Buried materials	
	Technologically incapable	×					
(4)Unrecyclable	Physically incapable	-	-	-	Pigment, paint	Splashed and worn materials	

(3) Others

To further advance in the implementation of quantitative tools for analysis, it is necessary to discuss the following points based on an evaluation of results: (1) term definition, and (2) handling of resource quality.

Appendix IV (Hashimoto)

(1) Definition of material stock in the society

In order to define the material stock in the society, it is important to establish a system. The methodological guide prepared by Eurostat (2001) for Economy-Wide MFA establish the following concepts regarding stocks.

- Stocks of materials that belong to the economy are mainly man-made fixed assets as defined in the national accounts such as infrastructures, buildings, vehicles and machinery as well as inventories of finished products. Durable goods purchased by households for final consumption are not considered fixed assets in the national accounts but should be included in economy-wide MFA and balances. (3.15).
- In principle the stocks and changes in stocks of human bodies and livestock should also be recorded in economy-wide MFA and balances. However, experience suggests that these stocks are very small and also do not change much over time. In practice, therefore, the stocks of human bodies and livestock and their changes may be ignored unless there is evidence that these stocks change rapidly. (3.16)
- This Guide recommends to treat forests and agricultural plants as part of the environment in economy-wide MFA and the harvest of timber and other plants as material inputs. Treating forests and agricultural plants as part of the economy would require to include the bio-metabolism of these plants in the accounts. (3.19)
- In this Guide, waste landfilled is considered an output to the environment but compilers are free to choose the treatment they prefer. (3.20).

On setting the system, "hidden flow" is an important part of the flow. In the guide, it is divided into unused domestic extraction and indirect flows; the former is defined as follows:

- Unused domestic extraction are materials extracted or otherwise moved on a nation's territory on purpose and by means of technology which are not fit or intended for use. Examples are soil and rock excavated during construction, dredged sediments from harbours, overburden from mining and quarrying and unused biomass from harvest. Agricultural soil that is eroded is not moved on purpose but may be included as an optional memorandum item. (3.36)

- Unused domestic extraction comprises three major groups: unused extraction from mining and quarrying; unused extraction from biomass harvest; soil (and rock) excavation and dredged materials. (3.74).

Regarding this, international joint research by Matthews et al. (2000) presented the following explanation:

- Domestic hidden flows comprise two components: ancillary flows (for example, plant and forest biomass that is removed from the land along with logs and grain, but is later separated from the desired material before further processing), and excavated and/or disturbed material flows (for example, overburden that must be removed to permit access to an ore body, and soil erosion that results from agriculture). (p. 7).

Currently, the above-described classification is applied, but there remain some points that need clarification. A good example is the soil generated from construction activities. As this soil results from construction activities, but it has no intended use, it is considered to be a hidden flow. However, part of this soil can be used afterwards to prepare land, becoming then part of the stocks. Matthews et al. (2000) describe the following:

- Domestic hidden flows are dominated by mining overburden, earth moved during construction, and soil erosion from cultivated fields. (p. 13).

According to this statement, the soil moved during construction activities is considered part of the hidden flows. Tanikawa and Imura (2001) carried out a MFA of housing development, dealing with moved soil as part of hidden flows and not as part of the stocks. On the other hand, Hashimoto et al. (2003) argue that determined part of the rocks and stones are used for purposes of land preparation of housing, ports or airports, are input to the economy as DMI, and become part of the stocks. Therefore, in current situations, soil is not considered to be stock and rocks and stones to be stock as material for land preparation.

There are other ambiguous examples. Brunner (2004) pointed to obsolete underground cables and called these cables hibernating materials, but could they also be considered stocks? Dissipative flows are similar to this condition. In the guide prepared by Eurostat (2001), we found the following explanation regarding dissipative uses of products and dissipative losses.

- Dissipative uses of products and dissipative losses are defined as the quantity (weight) of materials which are dispersed into the environment as a deliberate, or unavoidable (with current technology) consequence of product use. These flows include dissipative uses such as fertilisers and manure spread on fields, or salt and other thawing materials spread on roads, and dissipative losses such as rubber worn away from car tires, abrasion from roads, losses due to evaporation. (3.80)

In the present framework, we can consider hibernating materials as stocks. However, instead of calling them "hibernating," we can consider that they are back into nature, and that they are material that has been disposed of. Instead of being collected in one place as waste in landfill sites, they are scattered in the environment.

To deal with the stock of materials in the society, it is crucial to clearly define the above points described.

(2) Classification of social stock

For example, it is possible to classify the materials according to the possibility of recovering them for use as resources. Considering the points discussed above, a classification may also take into account whether the material is being counted as stocks in the current MFA or not. Regarding the possibility of recovery for use as a resource, we have the following categories.

Economically recoverable	Having a value, recovery is cheaper than disposal.
Social-economically recoverable	Systematically operated (by regulation, agreement, social responsibility).
Technically recoverable	Technical recovery is possible for a cost.
Impossible to recover	Recovery is technically difficult. Includes used goods exported.

For example, in the case of construction related goods, the following classification can be made.

Table IV-1

	Materials regarded as stocks in existing MFA		Materials not regarded as stocks in existing MFA
	Materials to be scrapped	Materials not be scrapped	
Economically recoverable	- Metal such as iron - Concrete		
Socially and economically recoverable	- Wood - Part of vinyl chloride - Part of plasterboard		
Technically recoverable	- Mixed waste	- Materials used for land reclamation and foundation - Left materials when scrapped (including foundation pillar) - Unscrapped building materials left on the ground	- Earth and sand used for land reclamation - Materials buried on final waste disposal sites
Non-recoverable	- A small amount of material in mixed waste	- Splashed materials on scrapping yard	- A small amount of materials buried on final waste disposal sites

In the case of steel, the following classification can be applied.

Table IV-2

	Materials regarded as stocks in existing MFA		Not regarded as stocks in existing MFA
	Materials to be scrapped	Materials not be scrapped	
Economically recoverable	- Part of building, industrial machinery, etc.		
Socially and economically recoverable	- Part of automobile, electric appliances, etc.		
Technically recoverable	- Small amount of materials used in products	- Left materials when building scrapped (including foundation pillar) - Part of discarded products	- Materials reclaimed on final disposal sites
Non-recoverable	- Small amount of materials used in products	- Part of used industrial machinery, used automobiles, used electric appliances, etc. to be exported - Material to be sprayed	- Materials buried on final disposal sites

Appendix V (Fuse)

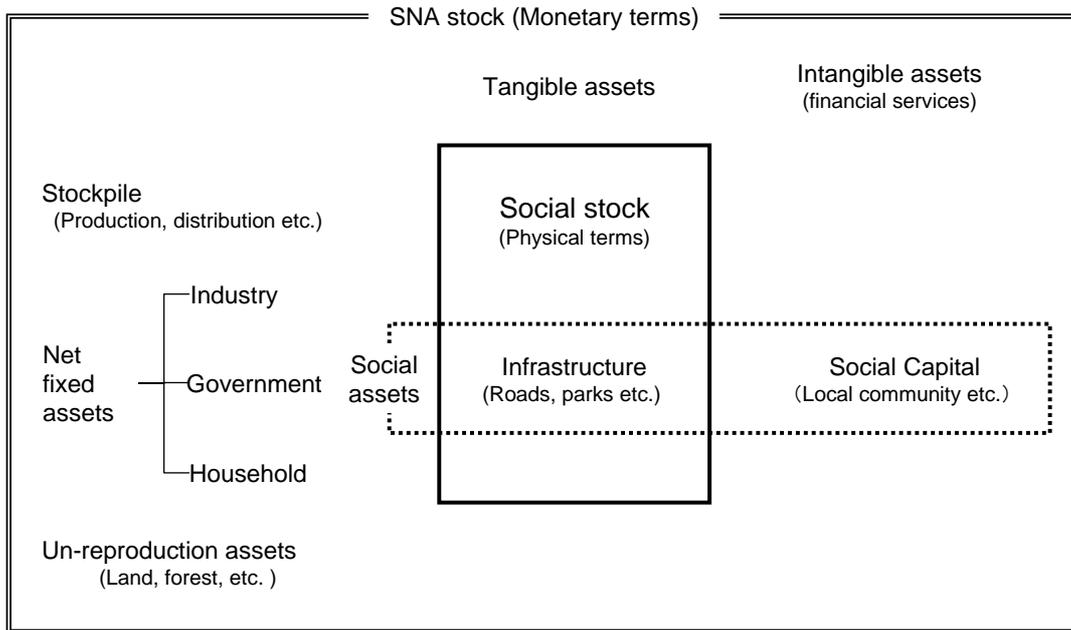
(1) Definition of social stock

Social stock is defined as the amount of physical stock in a society (the economic system consisting of production, consumption, waste and recycling activities) at a given time. In the following, social stock will be discussed based on (a) its relationship with other forms of existing stock and (b) its measurement.

(a) Relationship with existing stock

The relationship between social stock, the macroeconomic SNA (system of national accounts) stock, and the infrastructure and social capital of a defined area are shown in Figure V. In the figure, the production that exceeds a period of time set for flow measurement (for example, 1 year) and the flow with waste (for example, dealer's inventories and houses to be dismantled) are included in stocks for convenience. Assets impossible to reproduce refer to natural assets essential for production (for example, land). Intangible assets have no physical existence, but have a value (for example, financial services).

Figure V Relationship between social stock, SNA stock, and social capital



According to Figure V, social stock may be rearranged as follows:

- Social stock is included in SNA stock, and corresponds to stocks of tangible assets and net fixed assets.
- The SNA stock is measured in monetary terms, whereas social stocks are in terms of amount of goods.
- Social capital and social stock may have similar names, but they are different, except for infrastructure (for example, railroads, roads, parks, etc.) that is part of tangible and intangible assets involved in the administration of net fixed assets (public sector).

(b) Measurement of social stock

Measurement of social stock has two objectives. The first objective is to offer information in physical terms instead of monetary terms of the section represented by the bold line in Figure V (present condition evaluation). The second objective is to offer information (potential evaluation) necessary for the strategic management of stocks and net fixed assets that does not waste the non-renewable resources assets presented in Figure V. According to these two objectives, characteristics of to social stock can be described as follows:

- Qualitative information: Amount classified by type of material, service life, and others (sites, region).
- Gross stock and net stock: Net stock = gross stock – depreciation amount (wear and breakdown), and corresponds to the current amount described in the first objective. On the other hand, gross stock represents a latent amount (excluding the depreciation amount).
- Functional information (products, material, etc.): By classifying net fixed assets by their function, information on the amount of material available for potential recycling can be inferred.
- Classification of unused commodities (illegally disposed and abandoned) and landfilled material: Unused commodities and landfilled material can be also considered net fixed assets, and the latent amount for recycling is shown. This measure is not necessary for current condition evaluation.

(2) Classification of social stock

A classification of social stock based on (1) is presented in Table V. The columns represent the content of (a), and the lines the content of (b). Concerning the column for potential evaluation, more

realistic potential evaluation is expected by presenting a detailed account of recovery possibilities, existence of applicable corresponding recycling technologies, and data availability addition to this ideal potential evaluation.

Table V Example of classification of social stock

		Current situation appraisal: net stock	Potential appraisal: net stock, gross stock	
		Amount classified by type of material, service life, others	Amount classified by type of material, useful life, functions, others	
				Unutilized waste/ Landfill site
Stock	Arterial industry	Products, material stocks	Products, material stocks	Factory and building to be scrapped
	Venous industry	Recyclable stocks	Recyclable stocks	Machinery to be scrapped
	Government			Public facilities to be scrapped
	Household budget	Used product stocks	Used product stocks	Houses and automobiles to be scrapped
Net fixed assets	Arterial industry	Factory and building	Factory and building	Unused factories and buildings
		Machinery and equipment	Machinery and equipment	Unused machinery and equipment
	Venous industry	Processing facilities	Processing facilities	Unused processing facilities
		Processing machinery	Processing machinery	Unused processing machinery
				Landfill
				Industrial waste illegal dumping
	Government	Public facilities (roads, railroads, processing facilities)	Public facilities	Landfill
	Household budget	Houses	Houses	Unused houses
		Automobiles	Automobile	Unused automobiles
				General waste illegal dumping
				Derelict automobiles

(3) Others

The final section will discuss briefly the estimation of the amount of social stock. First, in the column corresponding to current situation evaluation of Table V, existing SNA stock statistics (monetary value, useful life) are multiplied by weight conversion coefficient and material composition ratios gained from other statistics to estimate the social stock. Also, direct estimation is possible for a portion of the goods with complete statistics. Finally, few statistics are expected to be available for the column of potential evaluation, which stresses the need for new methods for estimation and for the development of corresponding surveys.

Appendix VI (Murakami)

(1) Definition of social stock

In order to account the social stock of materials, it is important to first define the following three: materials, the scope of the society and stock.

The materials should be defined for each accounting; however, it is important to define whether they are considered according to their actual shape such as in the case of finished products existing in society, or according to their material species such as iron or copper. There are not absolute advantages or disadvantages regarding one of the two approaches, but for discussion purposes we will take the second one, namely to consider the material species. However, it is evident that most stocks acquire

determined shapes such as finished products. This situation is similar to the relationship between the substance in a deposit (for example, copper) and the actual deposit (for example, porphyry copper deposit).

When we talk about society, we are talking about the society composed of human beings. In the case of metals, their life cycle comprises mining of the ore, processing of the mineral to produce goods, use of these goods, and at the end of their useful life, recycling or disposal of these goods. That is, until the moment the mineral is purposely reverted into the environment, it is considered to be part of the social stock.

However, trying to estimate the amount of stocks actually means taking a snapshot at a certain point of time. Therefore, this amount must be defined in terms of time. This defines "stock." For example, by using statistical data to assess the amount, results will be obtained on a yearly base. If we attempt to compute the amount of stocks at the end of a given year, it is necessary to consider the amount of social stock of a certain item that has remained in the same shape for more than one year. That is, things that are present in a given moment but change into another shape within that year cannot be included. For example, as aluminum cans for beverages often do not remain in the same shape for one year in society, it is safer that they are not included into the social stock but are considered to be part of the flow.

Summarizing, we call social stock the amount of goods that during a set period of time remains in a determined shape in the human society.

(2) Classification of social stock

Now, we will discuss the classification method of social stock. There are many opinions concerning the methodology to use, but we will classify social stock as the amount of potential recyclable resources.

The term "recyclable resource" is not clearly defined¹, but we consider that the term refers not to natural resources but to resources that have been used or processed by human beings. There is the opinion that only things with realistic possibilities of use should be called resources, but as they depend on economic circumstances, this opinion shall not be adopted.

So, assuming that the social stock amount is the amount of potential recyclable resources, we will describe the categories most used for natural resource classification. The following are the most used criteria for definition of reserve of natural resources. There are two axes constituting this appraisal, first, the three categories of Economic, Marginally Economic, and Subeconomic of economic nature, and the category of things that have no economic utility, called Other Occurrences. Whether or not other appraisal axes are considered is established in the categories. Identified Resources and Unidentified Resources. These two categories are further divided according to the method to identify the material, but will not be discussed here.

In the case we decide to adopt the classification based on economic efficiency, we have the problem of "identification," as it is almost impossible to quantify the amount of social stock, so there is no meaning in adopting this classification. Instead, when social stock is equal to recyclable resources, time may become important. In the case of manufactured goods, usually they do not become recyclable resources until their useful life is concluded, but they are considered to be potential recyclable resources. These potential resources are turned out to be real resources only when their useful life has concluded, and those goods still in use or that have not been discharged are potential recyclable resources. In principle, natural resources can be used as soon as demanded (as a resource development project is, of course, a large project, it needs a certain lead time), and this is the main difference between recyclable and natural resources. Accordingly, when we incorporate the criteria of transition into recyclable resources as the moment when useful life is concluded, we can arrive at the classification shown in Table 1. Each classification criterion is described in the table.

¹ There is one definition in Japanese legislation. Unfortunately, their definition seems not widely accepted.

Table VI Classification of social stock as potential recyclable resources

	Currently recyclable stocks	Recyclable stocks in the future (Stocks in-use)
Economic	Used and economically recyclable materials	Economically recyclable stocks when discharged
Marginally Economic	Used and economically recyclable or unrecyclable materials (recyclability depends on market conditions)	Stocks which are recyclable or unrecyclable depending on market conditions when discharged
Sub-economic	Used materials which are unlikely to be recycled for economic reasons	Stocks which are unlikely to be recycled for economic reasons under current conditions even when discharged
Others	Used and unrecyclable materials	Stocks which are unrecyclable even when discharged

For “Stocks in-use,” it is possible to make a more detailed classification based on the expected time of the transition.

Appendix VII (Yamasue)

(1) Definition of social stock

The general definition for social stock consists of subtracting the amount of material discharged from the amount of material input. For example, in the White Book on Circulating Resources in Japan corresponding to FY 2002, the amount of material input in Japan was 2,100 million tons and the amount discharged was 1,100 million tons, which indicates that the increase in the amount of stocks reached 1,000 million tons. However, for detailed research on social stock, it is important to unify the concepts used. Here, we will discuss some concepts related to social stock.

First of all, the definition of variation in social stock and amount of social stock will be clarified. For a given period of time, both concepts present the same value, so it is important to differentiate them. Basically, the former concept refers to the difference between material input and material discharged during a given period of time, whereas the latter concept is based on the accumulated difference between material input and material discharged from a given point of time. For example, if we designate 1980 as the base year for a survey of social stock from year 1980 to year 2000, we can consider the difference between input material and discharged material for one year corresponding to 1985-1986, or for 10 years corresponding to the period 1990-2000 as the variation in social stock. On the other hand, in the period 1980-1981 or 1980-1985, the difference between input material and discharged material is the amount of social stock. The amount of social stock is often defined to be the amount accumulated since the dawn of history.

Based on this kind of definition, we can handle the amount of social stock as a quantity of state. There may be discussion about whether or not the quantity of state can be considered as entropy or energy of a system in thermodynamics, but at a given time t_f the social stock $S(t_f)$ can be expressed as follows:

$$S(t_f) = F_{in}(t_f) - F_{out}(t_f)$$

where, $F_{in}(t_f)$ and $F_{out}(t_f)$ represent the amount of material input and discharged from a standard time t_0 to a point of time t_f . The variation in social stock at a given time t is ΔS_m can be represented by

$$\Delta S(t) = f_{in}(t) - f_{out}(t).$$

Furthermore, it can be represented by

$$S(t_f) = \sum_{t=t_0}^{t_f} \Delta S(t) = \sum_{t=t_0}^{t_f} f_{in}(t) - \sum_{t=t_0}^{t_f} f_{out}(t),$$

where, $f_{in}(t)$ and $f_{out}(t)$ correspond to an amount of material input and an amount of material discharged at a given time t , respectively.

(2) Classification of social stock

There are several classification proposals for social stock, but here we will propose a classification based on recycling possibilities for goods.

1. Recyclable (from the physical and social point of view)
2. Recycling possible (currently the lack of demand makes recycling impossible, but it will be possible when this situation changes according to changes in the market)
3. Recycling not possible (not possible because of system or technological limitations)
4. Recycling not possible (physically impossible)

(3) Others

Future topics will include discussion regarding the handling of grade of material. In the case of collecting indium, for example, it is different for the same amount of indium when collected as a metallic indium or when collected as an oxide. The same situation is found in collecting nickel, which can be collected as a pure element or as an alloy element in stainless steels.

In these cases, for example, the required energy for the thermodynamic and social expenditures involved in using the collected material in the following process must be also computed to evaluate the advantages from processing such material and to decide the processing method. Further discussions on this topic are necessary.

Appendix VIII (Yokoyama)

(1) Definition of social stock

Regarding the social stock and the flow of goods, we will follow the definition established in the Input-Output Tables. The Input-Output Tables have a structure as shown in Figure VIII-1, and they reflect intermediate demand and final demand in the economic activities in Japan. Intermediate demand in a certain industry for a particular year corresponds to the input raw material, that is, it shows "Flow associated with industrial activities." Final demand is related to consumption items (household's expenditures – non-household's expenditures – private consumption expenditures – general government expenditures), that is, it is constituted of "Flow derived from consumption activities," items related to stocks (Gross domestic fixed capital formation (Private- Public)) "Stock increase," inventories, exports, etc.

Figure VIII-1 Input-Output Table

		Intermediate demand				Final demand						Total demand	(Deduction) Import	Domestic product
		Agriculture, forestry and fisheries industry	Mining industry	Manufacturing industry	...	Non-households expenditures	Private consumption expenditures	General government expenditures	Gross domestic fixed capital formation	Net increase in goods inventories	Export			
Intermediate input	Agriculture, forestry and fisheries industry	Flow associated with industrial activities				Flow derived from consumption activities				Stocks increase				
	Mining industry													
	Manufacturing industry													
	...													
Gross value added	Non-households expenditures													
	Compensation of employees													
	Operating surplus													
	Reserve for depletion													
	Indirect taxes (Deduction) subsidy													
Domestic product														

Table VIII Handling of inventories in IO table

		Intermediate demand	Final demand			
			Products	Semi-manufactured goods	Distribution	Raw material
Intermediate input	Material	Domestic			⑤	③
		Import		—	—	⑥
	Wooden furniture		①	②		

For the stock increase in the Input-Output Table, goods with a useful life longer than one year and with a value that is higher than 100,000 yen are considered capital assets and recorded under part of "National fixed capital formation." All goods with useful life shorter than 1 year are considered part of the flow. Inventories are different from flow and fixed assets (amount of stock increase). In the Input-Output Table, goods produced in a certain year that were not sold, were not consumed by the producer, and were not recycled as assets involving industrial activities as part of intermediate demand, are called "inventories." Inventories for a given year can be classified into the following four groups: goods produced during that year that have not been sold or consumed called "Net increase in producer inventories," goods related to the production of that year (end of year-beginning of year balance) called "Net increase in semi-manufactured goods inventories," raw material purchased during that year that was not used during that year and that is called "Net increase in raw material inventory," and merchandise distributed on wholesale or retail basis that has not been sold and is called "Net increase of dealer's inventory." In Table VIII, (1) corresponds to "Net increase in producer inventories," (2) to "Net increase in semi-manufactured goods inventories," (3) (4) to "Net increase in raw material inventory," (5) (6) to "Net increase of dealer's inventory."

(2) Classification of social stock

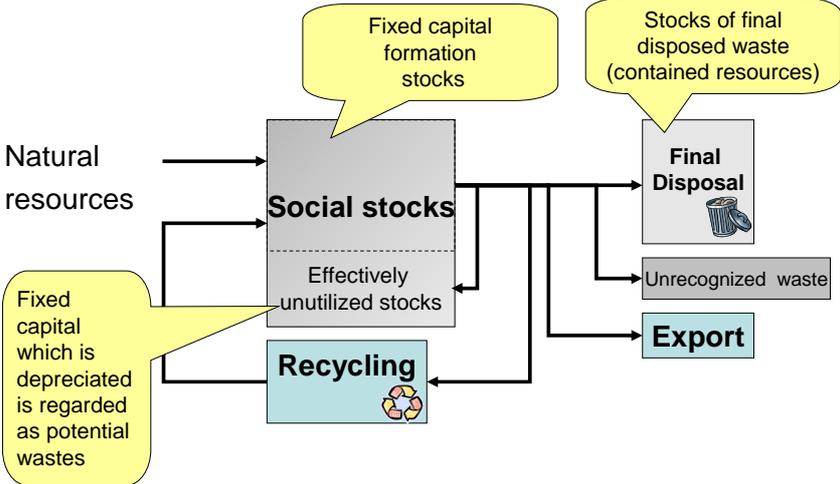
At this workshop, having as objective the formation of a recycling society, "social stock" was classified from the point of view of achieving an effective use of resources. When we evaluate the society from this point of view, we can see current social stock as the future source of a large flow of wastes. Proper management of resources (and wastes) includes a classification of goods present in the society into flow or stocks, and determines whether the useful life of these goods is over or not. The flow of goods in society can be classified into flow of manufactured goods and flow of waste, and in the same way stocks can be classified into stock of manufactured goods and stock of waste. Flow and stock of manufactured goods reflect the background of the accounting system that constitutes the Input-Output Tables framework. Regarding the flow of waste, the categories of waste as a byproduct of industrial activities (residues or scrap from manufacturing processes) and waste as a byproduct of consumption activities (household waste such as food residues or containers or packaging waste) must be added as well as a category for waste generated from durable products such as buildings and industrial machinery (superannuation waste and construction waste).

Accumulation of waste can be roughly divided into stocks which are not efficiently used and discharged goods that have reached a final disposal place. In stocks that are not being efficiently used, those goods whose useful life has expired are considered waste (or latent waste) from the point of view of resource (waste) management. The life cycle of a product is assessed from legal durable years, the fixed assets after this number of years, regardless of the conditions of use, are considered as waste (or latent waste). Taking into account actual condition of use, as there are a number of industrial machines and buildings that have exceeded their legal useful life, it may be not correct to call them "latent waste." Deserted houses, and bridges and industrial machinery out of use, can be considered as stock to become part of the waste flow depending on the market conditions. It is practically difficult that these goods are classified from stocks that are not being efficiently used as shown in Figure VIII-2, because a comprehensive survey that would identify the conditions of durable assets in Japan becomes

necessary. Classification based on the legal useful life becomes then one of the easiest methods.

This classification tends to include (a) deserted houses and unused bridges that will become part of the flow depending on the market conditions for dismantling-disposal, (b) inventory of electric appliances in the hands of recycling business (c) resources contained in material stored in final disposal places. Thus, this classification is useful for understanding "not recognized social stock" that was usually overlooked by conventional accounting systems.

Figure VIII-2 Classification of social stock



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