Discussion Paper

3R Policy Indicator Factsheets

Ver. 1

Asia Resource Circulation Policy Research Group

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This report is based on a background paper of the 4th Regional 3R Forum in Asia and the Pacific from March 18 to March 20 2013, Hanoi, Viet Nam and Factsheets Series of 3R Policy Indicators developed by Asia Resource Circulation Policy Research Group.

The report is based on a research project of the Asia Resource Circulation Policy Research Group, coordinated by Institute for Global Environmental Strategies and funded by the FY 2012 and FY 2013 Asia Resource Circulation Research Project commissioned by Ministry of the Environment of Japan (MOEJ). The Asia Resource Circulation Policy Research Group is a collaborative research group focused on policy research on 3R promotion in Asia, with contributions from researchers at Institute for Global Environmental Strategies (IGES), Institute of Developing Economies – Japan External Trade Organization (IDE-JETRO), National Institute for Environmental Studies (NIES), University of Malaya (UM), Asia Institute of Technology (AIT), Institut Teknologi Bandung (ITB), Tokyo Institute of Technology (TOKYO TECH) and United Nations Centre for Regional Development (UNCRD).

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Performance Indicators in 3Rs and Resource Efficiency: Monitoring the Progress of 3R Efforts Towards a Green Economy

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01 Introduction

In developing Asia, policies and legislations to promote *reduce, reuse and recycling* (3Rs) of waste have gained much traction over the last 10 years. Henceforth, the focus of governmental efforts on the 3Rs should be to improve policy implementation and manage policy progress. To these ends it is essential to set clear policy targets and review them regularly, which necessitates a set of policy and performance indicators for monitoring their efficacy.

In recognition of the importance of "adopting a life cycle approach and of further development and implementation of policies for resource efficiency and environmentally sound waste management", RIO+20 outcome document "Future We Want" places emphasis on "goals, targets and indicators…. are valuable in measuring and accelerating progress" towards implementation efforts of sustainable development and a green economy.

Along these lines, Hanoi 3R declaration, discussed and adopted at the 4th Regional 3R Forum in Asia and the Pacific in Hanoi held from March 18–20, proposes a set of priority goals for thematic areas related to waste management and the 3Rs. And as an annex document, it has listed sample indicators which can be useful in monitoring these goals.

This discussion paper was prepared by experts of the Asia Resource Circulation Policy Research Group to facilitate discussions on policy and performance indicators on the 3Rs and resource efficiency. It discusses why the indicators are useful in monitoring progress in 3R efforts, existing good practices, opportunities for improving the capacity related to indicator and target-setting and information availability in Asia. To aid in comprehending performance indicators on the 3Rs, factsheets on selected sample indicators corresponding to priority theme areas of policy goals of the Hanoi 3R Declaration are presented as annex documents to this discussion paper.

02 Asia Resource Circulation Policy Research Group and 3R Indicator Working Group

This is a collaborative research group focused on policy research on 3R promotion in Asia. The group is contributed to by researchers from Institute for Global Environmental Strategies (IGES), Institute of Developing Economies – Japan External Trade Organization (IDE-JETRO), National Institute for Environmental Studies (NIES), University of Malaya (UM), Asia Institute of Technology (AIT), Institut Teknologi Bandung (ITB), Tokyo Institute of Technology (TOKYO TECH) and United Nations Centre for Regional Development (UNCRD)

In 2012, the group formed a working group on performance indicators on the 3Rs and resource efficiency and closely examined the goals proposed in the Draft Hanoi 3R Declaration and sample list of indicators proposed by UNCRD.

The group believes that, although a set of data for evaluating 3R policy performance is important, 3R policy goals, targets and indicators should be flexibly set by the users (central government, local government, or sometimes private sector for environmental reporting systems) of such goals and indicators, owing to national differences in policy priorities.

Nevertheless, in the five priority areas proposed in the draft, namely “3Rs in municipal solid waste”, “3Rs in industrial sector (including SMEs)”, “3R Goals in Rural Areas”, “3R Goals for New and Emerging Wastes”, and “3R Goals for Cross-cutting Issues”, the group decided that factsheets of sample and representative indicators would be helpful. Such factsheets provide an overview, definition, policy goals to be monitored by the indicator, merits of implementation, similar or supporting indicators, existing good practices, and reference documents or existing guidelines related to the policy areas and indicators.

The factsheets annexed to this discussion paper were prepared to facilitate a better understanding of the utility of policy indicator setting to follow-up on 3R policy goals and policy implementation. Table 1 gives a list of indicators with factsheets provided by this group.

Table 1: Priority thematic areas in Ha Noi 3R Declaration and sample of 3R policy indicators with factsheets

Priority Thematic Areas	Goal	Sample indicator for factsheets	Type of indicator
3Rs in municipal solid waste	**Goal 1:** Significant reduction in the quantity of municipal solid waste generated	Total MSW generation and MSW generation per capita	Quantitative Pressure
	Goal 3: Significant increase in recycling rate	Recycling rate and target	Quantitative Response
3Rs in Industrial sector	**Goal 5:** Encourage private sector, including small and medium-sized enterprises (SMEs), to implement measures to increase resource efficiency and productivity	Measuring Waste Reduction, Reuse and Recycling through Industrial Symbiosis	Qualitative and Quantitative set of indicators Response
	Goal 9: Develop proper classification and inventory of hazardous waste as prerequisite towards sound management of hazardous waste	Hazardous Waste Management	Existence of regulation to control hazardous waste: Qualitative Response Amount and rate of generation of hazardous waste: Quantitative Pressure
3Rs in Rural Areas	**Goal 11:** Promote full-scale use of agricultural biomass waste and livestock waste	Promoting full-scale use of agricultural biomass residue and livestock waste	Quantitative
3Rs for New and Emerging Wastes	**Goal 13:** Ensure environmentally sound management of e-waste	Standards for Collection, Storage, Transport, Recovery, Treatment and Disposal to Ensure Environmentally Sound Management of E-waste	Qualitative Response
	Goal 15: Progressive implementation of extended producer responsibility	Recycling Legislations based on the Concept of Extended Producer Responsibility (EPR)	Qualitative Response
3Rs for Cross-cutting Issues	**Goal 17:** Improve resource efficiency and resource productivity by greening jobs nation-wide in all economic and development sectors	Indicators based on Material Flow Analysis/Accounting (MFA) and Resource Productivity	Quantitative Pressure/response
	Goal 18: Maximize co-benefits from waste management technologies for local air, water, oceans and soil pollution and global climate change	Co-benefits of the 3Rs (reduce, reuse and recycle) of municipal solid waste on climate change mitigation	Quantitative Pressure/response
	Goal 20: Strengthen multi-stakeholder partnerships in raising public awareness and advancing the 3Rs.. leading to behavioural change of the citizens	Measuring Public Awareness and Actions for the 3Rs	Qualitative/Quantitative Response
	Goal 23: Promote green procurement	Structure, content and implementation of green procurement	Qualitative Response

These factsheets annexed to this paper are initial versions and subject to further revision.

The working group will increase the number of factsheets in the future and provide this information to future Regional 3R Forums in Asia and the Pacific and make it available online.

03 What are performance and policy indicators for the 3Rs? Why do we need to use them?

PSR Model and waste/3R-related indicators

A typical framework for an environmental policy indicator is that based on the Pressure-State-Response (PSR) model (OECD 2003) (see figure 1). A pressure indicator represents environmental 'pressures' from human activities, a state indicator represents environmental conditions influenced by environmental pressures, and a response indicator represents a social response to minimising such environmental pressures or changes in environmental conditions. Waste management and 3R-related indicators such as 'Amount of total municipal waste generation', 'Recycling rate', or existence of certain policy mechanisms and the measurement of efficacy of such mainly represent anthropogenic activity.

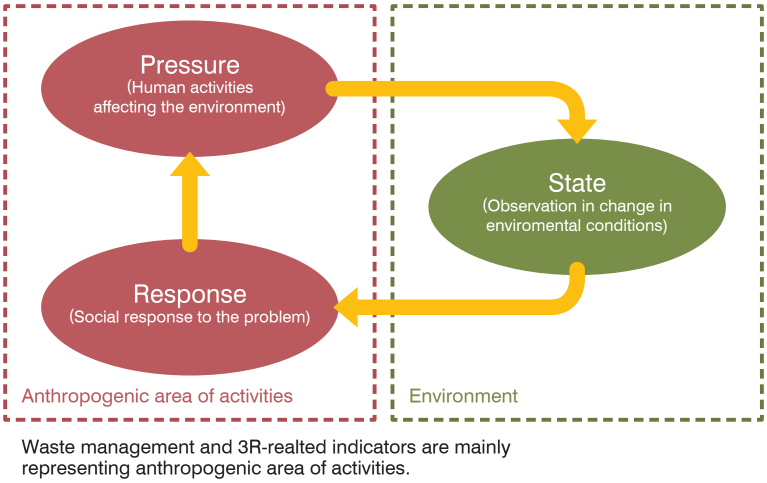


Figure 1: PSR model of environmental indicator

The concept of pressure (drive) and response indicators was chosen as the same is used by Japan's Ministry of Environment in the field of environmental statistics and by the OECD in its environmental indicators.

The 3R policy and performance indicators discussed in this discussion paper are comprised of information and data to monitor progress towards 3R-related policy goals, and as such are intended to reflect the current situation, to track progress and to evaluate the effectiveness of 3R policy and performance. In the above PSR model, since it concerns readiness or effectiveness of 3R policies, most of the indicators are related to 'Response' and some to 'Pressure'. Of the indicators prepared for an initial set of factsheets, for example, "Total MSW generation and MSW generation per capita" and "Amount and rate of generation of hazardous waste" can be considered as 'Pressure' indicators. However, they can also be interpreted as 'Response' indicators if the related data shows a reduction in amount over time as a result of 3R policy implementation.

Quantitative and qualitative indicators

Indicators can act as benchmarks for comparisons between different countries, and also to set milestones or roadmaps in waste management and other 3R-related issues.

Quantitative indicators, such as total MSW generation, recycling rate, and resource productivity, can form the basis for assessment by providing information on conditions and trends in waste management and other 3R-related issues using quantitative assessments. They can evaluate the performance of 3R policies in a comparative manner over time. By using such indicators, we can review existing efforts and targets for waste prevention, reuse, recycling, recovery, and landfill diversion. Assessments based on such indicators not only show the current state but also show how future policy directions could be charted, which assists in policy formulation.

At the same time, policy goals cannot always be quantifiable, especially when certain policies—such as EPR-based recycling policies or ESM standards for e-waste—do not exist or are still being formulated, or information on specific policies is not shared between countries. In such cases, qualitative indicators, which demonstrate well-prepared and functional policies are in place or under preparation in certain countries, can be useful in monitoring progress in 3R policy goals in the region. Once such specific policies (EPR-based recycling policies, ESM standards for e-waste, green procurement) are in place in a country, such country can prepare qualitative indicators to monitor the specific features and efficacy of the policies, based on the country's policy interests, which could be the collection rate of targeted end-of-life products under EPR-based recycling policies.

Criteria for selecting indicators

To set appropriate environmental indicators, several criteria can be used. The OECD uses the following: 1) policy relevance and utility, 2) analytical soundness, and 3) measurability, as explained in table 2 below:

Table 2: OECD criteria for environmental indicators

Policy relevance and utility for users	Indicators should • provide a representative picture of environmental conditions, pressures on the environment or societal responses • be simple, easy to interpret and able to show trends over time • be responsive to changes in the environment and related human activities • provide a basis for international comparisons • be either national in scope or applicable to regional environmental issues of national significance • be comparable with reference values, so that users can assess the significance of the related values
Analytical soundness	• be theoretically well founded technically and in scientific terminology • be based on international standards and international consensus regarding validity • be linkable to economic models, forecasting and information systems
Measurability	The data required to support the indicator should be: • readily available or made available at a reasonable cost/benefit ratio • adequately documented and of known quality • updated at regular intervals in accordance with reliable procedures

Source: OECD (2003)

However, in consideration of the challenges associated with policy implementation and data gathering, one of the key tasks for developing countries is not "indicator-setting" but deciding on priorities for waste management and 3R-related issues. As discussed above, this background paper includes some sample factsheets on selected 3R policy indicators. Once policy priorities are set, a vast amount of knowledge and expertise can be tapped to assist policy makers in selecting target materials or waste streams for implementing 3R policy, as well as establishing appropriate indicators to evaluate the targets chosen.

Merits of Indicators

By linkage with national strategy, policy priorities, and local governmental efforts in promoting the 3Rs, 3R policy targets and indicators can be useful tools for tracking and reviewing progress in 3R efforts, as they could provide policy feedback and measure performance. Proper information gathering and analysis of 3R performance are useful in institutional arrangement groundwork, infrastructure coordination (such as logistical arrangements for collection as well as siting of treatment facilities), and market creation for recycled goods or 3R-related products, technologies and services.

04 Outline of Sample 3R Policy Indicators
(See the annexed factsheets for more details)

To show how 3R policy indicators might be useful tools for monitoring and reviewing 3R policy implementation, as well as sharing information on features and progress of 3R policies internationally, this section provides an overview of the sample 3R policy indicators.

Example 1 - Total MSW Generation and MSW Generation Per Capita

MSW (municipal solid waste) generation and MSW generation per capita are indicators of environmental pressures humankind exerts on the environment (OECD, 2003), and by extension, environmental pressures caused by the use of natural resources. Currently, 340 million tons of MSW is generated in Southeast Asia every year, 26% of the world total, and this is expected to rise to about 888 million tons by 2025 (World Bank, 2012). MSW generation is a fundamental indicator since municipalities usually prepare annual budgets on MSW management based on annual MSW generation (collection). Thus, reliable data exists for MSW generation.

The use of total MSW generation and MSW generation per capita indicators would enhance governmental decision-making capacity in MSW management. Reliable figures for total MSW generation would also raise the precision of the national inventory on waste sector greenhouse gas emissions.

Example 2 - Recycling Rate and Target

The overall recycling rate and target attempts to monitor progress in recycling and resource saving activities. The Recycling Rate and Target is often presented as a proportional value (%) and reflects the proportion of materials recycled or recovered from waste or the rate of inclusion of recycled materials in certain products. High figures usually imply progress in recycling activities.

Recycling rate is one of the representative indicators of 3R policy performance, thus many governments in Asia have incorporated it into national 3R targets. However, caution must be taken if inter-country comparisons are made solely based on one definition or interpretation of recycling, since policy priorities vary.

Example 3 - Recycling Legislation based on the Concept of Extended Producer Responsibility (EPR)

The EPR indicator refers to the existence or strengthening of policies on recycling and waste management targeting specific end-of-life products or waste streams, and involves producers in recycling or waste management activities. This kind of qualitative indicator, which suggests the existence of proper policy and its implementation, is also useful information, especially when shared between countries. Many countries in the region, including China, India, Indonesia and Malaysia have introduced or are considering EPR-based legislation, especially that targeting electronic or packaging wastes. Thus, sharing information on good practices, challenges faced by governments and lessons on policy implementation would constitute a useful tool to promote effective policy implementation.

05 Existing national targets and indicators related to the 3Rs and waste management in Asia (including existing statistics)

As introduced in the previous sections, there are many merits of using policy indicators for strategic implementation of 3R policy, as well as for disseminating the features and progress of 3R policies internationally. Throughout Asia and the Pacific, national targets and indicators in relation to waste management and the 3Rs have gradually been developed in parallel with the broad progress in 3R policy itself.

Japan has developed a variety of waste-related statistics over the years, as shown in table 3 below. In particular, under its Fundamental Plan for Establishing a Sound Material Cycle Society, it introduced Material Flow Analysis (MFA)-based indicators and other types of targets in 2003; namely resource productivity (GDP/natural resource input), cyclical use-rate (cyclical use amount/(cyclical use amount + natural resource input)) and final treatment of waste. The targets made in 2003 were set for 2010, but since they appeared to be achieved by 2008, new targets were set in the Second Fundamental Plan for Establishing a Sound Material Cycle Society in the same year, for 2015 and again for the Third Fundamental Plan in 2013 for 2020. Various other numerical targets were set in the same Plan too, such as reduction in MSW, industrial wastes, and on citizen awareness and behaviors, as shown in table 4 below. These targets and indicators were all set under specific recycling legislation; for example, the re-commercialisation rate (volume of sold dismantled material/volume of dismantled material) for the home appliance recycling law in Japan.

Table 3: Japan's Waste-related Statistical Data under Environmental Statistics

Economy-wide Material Flow Accounting	• Resource productivity • Cyclical use rate • Final disposal amount • TMR of metal resources, etc.
Municipal Solid Waste	• Treatment flow of municipal solid waste (MSW)(national) • Total generation of MSW • MSW generation per capita • Status of MSW management in each prefecture • Type, number and size of waste management facilities (incinerators and recycling facilities) • Status of establishment and capacity of waste management facilities in each prefecture • Remaining capacity and year of final treatment sites of MSW • Status of final treatment sites in each prefecture • Change in operational costs of MSW management
Industrial Waste	• Flow of treatment of industrial waste (national) • Total generation of industrial waste • Generation of industrial waste in different industrial sectors • Generation of different types of industrial wastes • Change in amount of recycling, reduction, and final treatment of industrial wastes • Number of different types of industrial waste management facilities. Treatment capacity, remaining capacity and remaining years of industrial waste management facilities • Number and amount of illegal dumping cases • Type of illegal dumpers
Recyclables	• Ratio of packaging waste in household waste • Production and shipment of packaging • Recycling rate and collection rate of packaging • Number of used home appliances accepted at designated collection points, number of recycled used home appliances, rate of recycling of home appliances, total weight of materials and components of different targeted used home appliances, amount of recovery and destruction of CFCs • Amount of generation of different types of construction wastes; status of recycling for each type • Generation of food waste and status of treatment • Number of end-of-life vehicle take-backs • Collection and recycling of small batteries and PCs

Table 4: Effort indicators under the 2nd Fundamental Plan of a Sound Material Cycle Society

Effort Indicators (target year: FY2015)

1. Numerical targets

[1] Reduction in municipal solid waste

(a) Total waste generation per capita/day >> 10% reduction in 2005 from 2000-level

(b) Household waste generation per capita/day >> 20% reduction

(c) Waste generation from business sector >> 20% reduction

[2] Final disposal amount of industrial waste

>> Reduction by 60% compared to FY2000 level (e.g., 47% reduction in 2005)

[3] Citizens' awareness of and behavior concerning 3Rs

>> Awareness: approx. 90%, Behavior: approx. 50%

[4] Promotion of recycling businesses

>> Market-size will double from FY2000 level (e.g., 1.3 times in 2005)

2. Other indicators monitoring progress made by individual stakeholders

[1] Percentage of customers not taking plastic shopping bags

[2] High-ranked (awarding) municipalities in terms of 3R efforts, and other indicators

In China, to monitor progress in the Circular Economy both at the national and local level, the leading agency in charge—the National Development and Reform Commission (NDRC)—released national Circular Economy indicators in 2007. In order to facilitate real application of such indicators, NDRC also released detailed instructions on how to calculate such indicators by factoring-in local conditions (see table 5 below). The country also released indicators for industrial park level, which suggests that the Circular Economy policy in China is inclined toward efficient use of resources in industrial production.

Table 5: Circular Economy Evaluation Indicator System (at macro level)

Category	Indicators
Resource output rate	Output of main mineral resource
	Output of energy
Resource consumption rate	Energy consumption per unit of GDP
	Energy consumption per industrial value added
	Energy consumption per unit product in key industrial sectors
	Water withdrawal per unit of GDP
	Water withdrawal per unit industrial value added
	Water consumption per unit product in key industrial sectors
	Coefficient of irrigation water utilisation
Integrated resource utilisation rate	Recycling rate of industrial solid waste
	Industrial water reuse ratio
	Recycling rate of reclaimed municipal wastewater
	Safe treatment rate of domestic solid wastes
	Recycling rate of iron scrap
	Recycling rate of non-ferrous metal
	Recycling rate of waste paper
	Recycling rate of plastic
	Recycling rate of rubber
Waste (wastewater) discharge or final disposal	Total amount of industrial solid waste disposal
	Total amount of industrial wastewater discharge
	Total amount of SO_2 emissions
	Total amount of COD discharge

Source: Adopted from Yong, et al. 2012

In the Philippines, under its Ecological Solid Waste Management Act, the following targets are set: to achieve a waste diversion rate of 25% for all solid waste via re-use, recycling and composting and other resource recovery activity before 2004; a minimum requirement to establish material recovery facilities (MRFs) in each barangay (minimum unit of local government); prohibition of all open dumpsites and requirement to either to close them down or upgrade them to controlled or sanitary landfill sites.

In Malaysia, under its Tenth Malaysia Plan 2011–2015, an increase in household recovery of waste from 15% to 25% by 2015 and closure of open dump sites were set as targets.

In Viet Nam, various indicators are listed in the National Strategy for Integrated Management of Solid Waste up to 2025. Example targets are: "to collect and treat up to environmental standards 100% of daily life solid waste in urban centres, 90% of which will be recycled, reused, recovered energy or used for organic fertiliser production" and "to collect and treat up to environmental standards 100% of non-hazardous and hazardous industrial solid waste".

International reporting of waste-related indicators uses the OECD statistics system, which also covers waste-related indicators, as shown in table 6. However, many of these statistics lack consecutive data and only have representative data for some years.

Table 6: OECD statistics related to waste

- Material use of different countries based on Material Flow Analysis (MFA) (Domestic Extraction Used (DEU), Domestic Material Consumption (DMC), Physical Trade Balance, breakdown of material use, stock)
- Amount of waste generated by sector (different sectors and urban waste) (no consecutive data)
- Amounts of waste generated by selected waste stream (no difference in industrial waste and urban waste, data on packaging)
- Generation of municipal waste (consecutive data), generation of household waste, municipal waste per capita, household waste per capita
- Composition of municipal waste (consecutive data)
- Status of disposal of municipal waste (latest information)
- Production, movement (import and export) and disposal of hazardous waste
- Waste recycling rates (paper and cardboard)
- Waste recycling rate (glass)
- Waste treatment and disposal installations (number and capacity of controlled landfills, treatment plants, permanent storage sites, and number, capacity and energy recovery of incinerators)

In order to move Asia forward, ERIA, a working group of the ASEAN Economic Research Institute, compiled an evaluation of existing 3R-related indicators used in ASEAN countries. Table 7 below shows this information in relation to MSW, industrial waste, hazardous waste and recyclables in the selected East Asia and ASEAN countries (Kojima 2012).

Table 7: Preliminary evaluation of existing statistics related to 3Rs and waste management

	Domestic Waste generation and disposed	Industrial Waste generation, disposed	Hazardous waste, waste generation, disposed	Collection of recyclables, recovery
Japan	○	○	▲	○
South Korea	○	○	?	○
China	○	○	○	▲ (industry)
Singapore	○	×	?	○
Indonesia	▲	×	○	▲
Malaysia	○	×	○	▲
Philippines	○	×	○	▲
Thailand				
Viet Nam	▲	▲	▲	▲

Note: ○ Data is collected and disclosed
▲ data is limited to specific areas or items. Not disclosed
× Data is not collected periodically

Source: Kojima (2012)

06 Role of central and local governments in data management

Setting clear national objectives, i.e., contextualising local waste management programmes as national-level strategy—such as those in Japan's Fundamental Law (2000) and plan (2003) for a sound material cycle society, China's Circular Economy Law (2009), and Malaysia's Solid Waste and Public Cleansing Management Act (2007) and recycling target under The Five Year Plan "Malaysia 2011-2015"—is essential in prioritising 3R policy and implementation mechanisms.

To monitor the progress of such strategies, it is crucial to have proper indicators and data management capacity, both at the central and local governmental level. As seen in the previous section, Japan set policy indicators based on Material Flow Accounting and other methods to monitor the progress of sound material cycle society policy and to review the progress made in the fundamental plan for sound material cycle society every five years. Conversely, some countries have set indicators to monitor the progress in strategy at national and local levels. In such cases, the responsibility for actual implementation and data collection falls on the local government.

One significant step aiding appropriate waste handling and management and 3R promotion is the provision of accurate and reliable data for this activity, especially for local-level decision making. However, detailed instructions on how local governments should actually collect and submit data is often omitted under this system, thus implementation of this indicator system is often voluntary and leads to data of low reliability. It is therefore crucial to strengthen the data management capacity of local government. Such data management should also be clearly linked with and be the requirement of waste management and 3R action planning at the local governmental level.

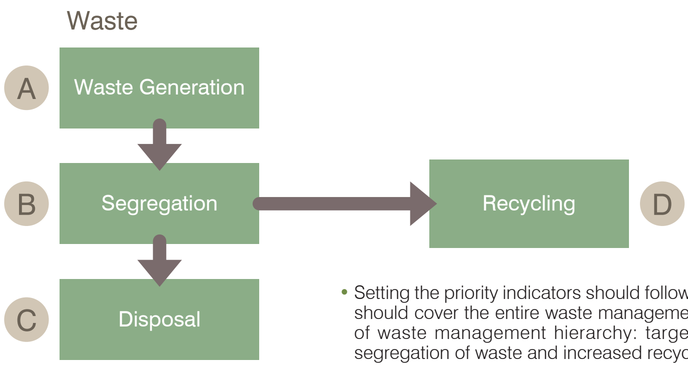
To improve governance of 3R policy in developing Asia, it is essential to set and implement strategy, objectives, and follow-up on such, which necessitates developing capacity to set appropriate objectives and indicators to track the progress of these policies. To bring this about, it is crucial to instill a *can-do* approach within local and central government, i.e., a willingness for capacity development and awareness-raising among stakeholders of the need for systematic data management, in order to effectively implement policy.

07 Interpreting indicators

Once indicator framing and measuring are finished, the next step is to interpret the results, i.e., transform the data into meaningful policy-relevant information, use this information as a basis for consistent comparisons and improve decision-making processes. Be mindful of the following, however, when interpreting indicators:

- Definition of policy target and objectives: How are targets and objectives related to indicators such as waste reduction, recycling, EPR and green procurement defined?
- What is actually covered by the indicators? For example, as regards coverage of the recycling rate, is it MSW collection and recycling only via formal entities, such as formal city/private waste management companies, or does it also include estimates of informal sector recycling?
- How are different types or streams of waste defined? For example, the definition of MSW may differ according to the country, so the definition of hazardous wastes, industrial wastes, etc., may also differ.
- For target achievement, the information on “base year” is crucial. Which base year is used?
- How are volume and weight estimates converted? (Units of measurement have to be accurate and consistent.)
- For policy-related indicators (such as existence of certain policies or incentives such as EPR-based recycling legislations and green procurement), are these policies operational and implemented in practice?

Further, interpretation of the overall performance of waste management and the 3Rs from a single indicator such as recycling could be misleading (see figure 1). If the amount of recycling is increased, waste disposal would decrease; however, this does not necessarily mean a decrease in waste generation at source or environmental impact from waste was reduced.



- Setting the priority indicators should follow waste management hierarchy; the indicators should cover the entire waste management chain with the priorities set as in the order of waste management hierarchy: targeting waste reduction at source, increased segregation of waste and increased recycling.

Figure 2: 3Rs and interpretation of the indicators

Caution must also be exercised to avoid misinterpretation of the indicator due to inaccurate data, inappropriate methodology of data collection, sampling and calculations, which would otherwise lead to false conclusions. Thus, 3R performance should be evaluated from a set of indicators. Also, capacity development for improving on indicators and interpreting the indicators themselves is necessary for proper planning and reviewing of 3R-related policies.

A further aspect to note is that qualitative indicators demonstrating the existence of certain policies reflect a fundamental shift in policy, social, or economic context surrounding the 3R activities and market of recyclables. For example, the existence of or interest in recycling legislation based on EPR in a country may indicate that the following several challenges have been recognised in such country: 1) Market-based recycling has become dysfunctional for the targeted products covered by EPR-based legislations, 2) Increasing physical and financial costs of solid waste management born by local government due to increasing volume of emerging wastes such as packaging and e-waste, 3) Rising consumer awareness has become a pressure for more recycling of waste products, and 4) Increased concern over improper treatment of recyclables containing hazardous substances has triggered policy intervention for establishing environmentally-sound recycling and management mechanisms.

Thus, policy indicators should be understood along with the policy priorities and goals of the country using them.

08 Creating effective indicators

08-1 Challenges

There are several challenges associated with waste management and the 3Rs, some of which are:

Data availability and accuracy

Data related to waste management, recycling and the 3Rs can be unavailable, scattered, unobservable, or time-consuming to compile for indicator setting. Further, although the informal sector plays a big role in Asia's recycling market, the data of which is very important, in a practical sense it is difficult to acquire official data from this only partially-organised sector, which distorts the actual waste recycling and recovery rate.

For example, data on volumes of recycling conducted by the informal sector, or goods and recyclables smuggled or illegally dumped or burned openly are typically unobtainable. Also, even if formal policy related to recycling and the 3Rs and requiring data management does exist, this does not preclude the possibility of falsifying data through exploiting 'grey' areas, especially if there are any incentives (such as subsidies or tax breaks) linked with volume targets.

Lack of standard methodology and Issues of definition

Even if the challenges of accuracy or unavailability of data are overcome, another major hurdle awaits due to the lack of standard methodology to calculate indicators. Different sampling and data collection methods may produce different results. Similarly, variation in the definition of indicators is also an issue of concern—for example, different countries use different rates of recycling. Also, similar yet different indicators exist, such as recycling rate, resource recovery rate, cyclical use rate and waste diversion rate, thus despite the similarity in the policy objectives and targets to be monitored by these slightly different indicators, it can be a challenge to consolidate and compare indicators used in different countries and form any coherent conclusions therefrom.

Data-related to existing policies and incentives

Some current policies and incentives may actually set the course of waste management and 3R activities. For example, information on the cost of landfill disposal (landfill gate fees, landfill taxes) is crucial to determine whether this is favoring landfilling operation or favouring other waste treatment options such as recycling and waste to energy. Therefore, it is important to have an accurate understanding of the existing policy instruments and economic incentives that have decisive effects over the hierarchy and possible options for waste treatment and recycling.

08-2 Solutions

Breaking the Vicious Cycle

Based on a comparative analysis of availability of data related MFA-based resource productivity indicators on non-OECD countries, Aoki et al. in 2012 pointed out that data availability and application of indicators to policy development, planning and review can be undermined by the vicious circle presented in figure 3.

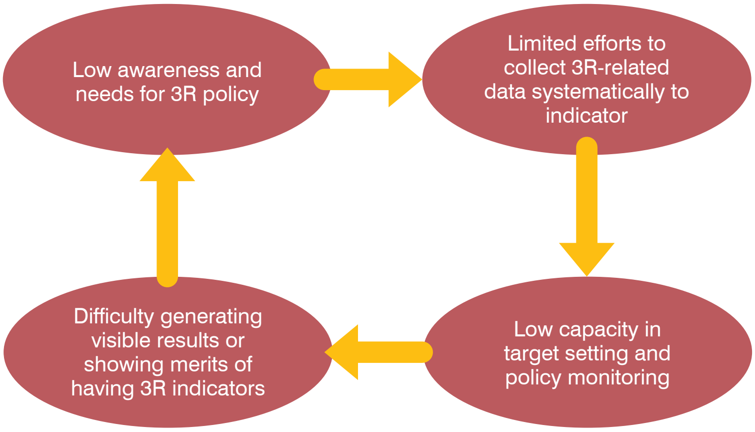


Figure 3: Vicious cycle of low awareness, limited efforts, low capacity and difficulty in showing merits
Source: Modified from figure 3 in Aoki et al., 2012

To overcome issues related to data availability and accuracy we need to break this cycle. To this end, it is crucial to set up a governance system and international collaboration focusing on 1) establishment of a national focal point to strengthen the institutional setup and improve coordination on data collection and 3R indicator development in each country, 2) development of model cases illustrating how target-setting and following-up of indicators can provide an improved informational basis for policy design and evaluation, and 3) training and capacity development in forming collaborations between policy makers, academia and research institutes to develop methodology and guidelines.

This discussion paper and factsheets are the first step in a trial undertaken by a working group of the Asia Resource Circulation Policy Research Group to break such vicious cycle. If national governments were to start evaluating their existing indicators or targets in waste management and the 3Rs, this would be of great assistance. Having an overview of how these targets are monitored or reviewed in practice and how role-sharing among stakeholders is structured to effectively implement policy would be a useful step.

Clear policy priorities and links to targets and indicators

3R policy indicators are tools to set clearer policy priorities and goals at the national and local level and to share such priorities with relevant stakeholders. The following are examples of questions and checklists related to setting priorities:

- Main method of waste treatment (Open dumping? Controlled landfill? Sanitary landfill? Incineration?)
- Coverage of waste collection services
- Is market-based recycling functioning or not?
- Is there a priority on GHG reduction thus in energy recovery?
- Are there any concerns about particular hazardous wastes?

- Is there any focus on particular recyclables?
- Do recycling industries create pollution?

Efforts taken to use appropriate targets and indicators in planning, monitoring and reviewing 3R policy implementation would help central and local governments of developing countries in Asia further clarify and raise policy priorities on the 3Rs.

09 Conclusion

Ideally, 3R policy indicators should cover the entire cycle of recyclable materials as well as recycling markets and technologies from generation, collection, transportation, storage, treatment and market for recyclables. Also, considering linkages with resource efficiency and the green economy, possible targets and indicators related to the 3Rs should not be limited to downstream issues, but rather issues related to resource productivity and efficiency or decoupling.

The use of the indicators can not only contribute to particular issue areas but also provide reliable data to support linkages on issue nexus, such as waste issues and climate issues. For example, reliable total MSW generation can contribute to improving the national inventory on greenhouse gas emissions from the waste sector.

An increasing number of countries are introducing 3R-lreated legislation and policies, thus many governments in Asia have started to use indicators and targets related to 3R promotion, such as the recycling rate. However, care needs to be taken in defining these targets and indicators. Comparisons of the same or similar indicators among countries requires caution due to the differences in definition based on differing policy priorities.

Promotion of the 3Rs also requires a market for green products and recycled products and materials. Sharing information on related policies and economic incentives would enhance and expand economic incentives for promoting 3R-related goods and services in the region.

Efforts to develop a harmonised information system related to the 3Rs would be a useful step in promoting resource efficient society in Asia, as would concerted efforts towards sustainable consumption and production.

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3R Policy Indicators
Factsheets Series

Factsheets for selected sample 3R policy indicators

- Total MSW generation and MSW generation per capita
- Recycling Rate and Target
- Measuring Waste Reduction, Reuse and Recycling through Industrial Symbiosis
- Hazardous Waste Management
- Promoting full-scale use of agricultural biomass residue and livestock waste
- Standards for Collection, Storage, Transport, Recovery, Treatment, and Disposal to Ensure Environmentally Sound Management of E-waste
- Recycling Legislations based on the Concept of Extended Producer Responsibility (EPR)
- Indicators based on Material Flow Analysis/Accounting (MFA) and Resource Productivity New!
- Co-benefits of the 3Rs (reduce, reuse and recycle) of municipal solid waste on climate change mitigation New!
- Measuring Public Awareness and Actions for 3Rs
- The structure, content and the implementation of green procurement

Total MSW generation and MSW generation per capita

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Tomohiro Tasaki National Institute for Environmental Studies, Japan

01 Outline of indicators

MSW (municipal solid waste) generation and MSW generation per capita refer to indicators of environmental pressures humankind exerts on the environment (OECD, 2003), and by extension, environmental pressures caused by the use of natural resources. Currently, 340 million tons of MSW is generated a year in South Asia, East Asia and the Pacific Region, 26% of the world total, and this is expected to rise to about 888 million tons by 2025 (World Bank, 2012). MSW generation is a fundamental indicator since municipalities usually prepare annual budgets on MSW management based on annual MSW generation (collection). Thus, MSW generation should be reliable data.

02 Type of indicator

Quantitative Indicator, Pressure Indicator

03 Policy goals to be monitored by this indicator

As a key indicator, total MSW generation can help identify the required capacity of waste management facilities and personnel, and aid in designing countermeasures.

MSW generation per capita represents the intensity of waste generation and can be used to assess progress in waste prevention activities (reducing and reusing) and shifts in consumption patterns towards resource efficiency, and MSW generation per capita can be used to make projections of total MSW generation in the future.

3R Policy Indicators Factsheets Series

Factsheets Series on 3R Policy Indicators
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04 Definition

How MSW generation is defined varies from country to country, and while such definitions do not need to be consistent across all countries , they should be of sufficient clarity to enable calculations of total MSW generation and MSW generation per capita.

Waste

Waste includes all materials discarded from households, offices, restaurants, hotels, schools, hospitals, factories, construction, agriculture and so on, i.e., items of no material value for people or businesses. In another sense, waste refers to the material that is discarded without being resold to other persons or companies, and is costly to collect, transport and dispose of. Under such definition, recyclables (salables) are not defined as waste since they can be traded in the informal sector in developing countries, with economic incentives (Kawai et al., 2012).

MSW

MSW is the solid waste collected and disposed of by or for municipalities; however, the nature of MSW varies from region to region (UNEP et al., 2005). Some countries define "MSW" as "ordinary solid waste" or "urban solid waste" managed by or for municipalities; the OECD (2010) states "municipal waste covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste", but this definition excludes waste from municipal sewage networks and treatment, as well as from construction and demolition activities. However, the definition by the World Bank (2012) includes industrial waste, and construction and demolition waste into MSW streams. Malaysia, Vietnam and Cambodia, on the other hand, have no definition of MSW, and the Philippine definition of municipal waste refers to wastes produced from activities within local government units, including domestic, commercial, institutional and industrial wastes and street litter (Republic Act No.9003). Japan defines MSW simply as waste other than industrial waste, all of which shall be managed by or for municipalities (Waste Management and Public Cleansing Law). However, such narrow definition excludes recyclables that are managed by others and waste self-disposed at source.

MSW generation

Total MSW generation and MSW generation per capita can vary according to the definition of MSW. Following the above-mentioned definition in a narrow sense, MSW generation refers to the waste described as (a) in **Fig.1** only. Then, MSW collection substitutes for MSW generation, excluding two waste streams as follows. One is recyclables generated and managed by anybody but municipalities, such as the informal sector, which is described as (b) in **Fig.1**. Most developing countries still depend on the informal sector for recycling. The other is waste to be self-disposed of at source described as (c) in **Fig.1**, which can be seen

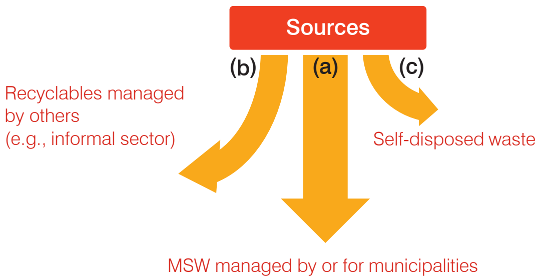

Fig.1 Waste streams and definition of MSW generation

in the region where population with the MSW collection service is relatively low. Burning, composting, burying on the ground and disposing into rivers are examples of self-disposal regardless properly or improperly. The Japanese Government tries to estimate amounts of (b) and (c) separately, and to the extent possible, despite the difficulty involved, because such could flow into the MSW stream of (a) in the future and improper handling of such is identified and regulated by government. Moreover, 3R efforts for (a) to (c) in **Fig.1** should be promoted, and monitoring all the flows provides visibility of the effectiveness of these 3R efforts.

05 Methodologies to estimate total MSW generation

Each country should adopt an appropriate way from the followings to estimate total MSW generation according to a country's capacity to collect data

Tier 1

Total MSW can be simply estimated by multiplying MSW generation per capita of selected areas by the country's total population. This involves collection of MSW per capita from as many areas and with as much variety as possible (at minimum, urban and rural).

Tier 2

MSW generation for unreporting areas can be estimated by multiplying reported MSW generation per capita and population and added to the total amount of reported MSW generation from municipalities.

Tier 3

MSW generation is reported from all municipalities to the central government. The Ministry of the Environment of Japan established a data collection system on MSW management, including MSW generation, and all municipalities (1,719 as of January 2013) are obligated to report the related data annually to the Ministry (Ministry of the Environment of Japan, 2012).

06 Methodologies to estimate MSW generation per capita

MSW generation per capita is estimated by dividing MSW generation of a certain area by that area's population. When MSW collection substitutes for MSW generation, the total population associated with such MSW collection should be used instead of the total population of the demographic area, as this avoids underestimating MSW per capita. The population associated with the MSW collection service must be less than the demographic data in developing countries, where MSW collection service is lacking, unless the demographic data is unreliable. Most central urban areas are covered by MSW collection services; while such coverage rates drop in suburban and rural areas.

MSW generation per capita from households can be measured by sampling and weighing household waste and counting the number of occupants in households. The figures of waste generation from an individual source are useful in revealing the intensity of material use by source and to monitor progress in 3R efforts. It is, however, difficult to identify MSW generation per capita from other individual sources.

3R efforts relating to the flows of (b) and (c) in **Fig.1** should be promoted as well, thus preferably the per capita indicator monitors not only (a) but also (b) and (c).

07 Supporting indicators

To characterise the waste streams shown in **Fig.1**, the following indicators would assist in waste management:

- Amount of recyclables and ratio thereof against MSW generation (collection)
- Amount of self-disposed waste and the percentage of self-disposal over collected MSW plus self-disposed waste
- Population associated with MSW collection service expressed as a percentage of the total population

08 Appropriate data management by stakeholders

- Central governments in charge of MSW management compile data from municipalities.
- Municipalities in charge of MSW management collect reliable data from localities and report such to central government.

09 Conclusion

The use of total MSW generation and MSW generation per capita indicators would enhance governmental decision-making capacity in MSW management. Reliable figures for total MSW generation would also raise the precision of the national inventory on waste sector greenhouse gas emissions.

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

Recycling Rate and Target

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01 Outline of indicator

The Recycling Rate and Target is often presented as a proportional value (%) and reflects the proportion of materials recycled or recovered from waste or the rate of inclusion of recycled materials in products. High figures usually imply progress in recycling activities. The indicator has several different aspects: 1) Ratio of recycled materials used in a certain product at the production stage (rate of utilisation of recycled materials); 2) Ratio of materials recycled or recovered from end of life or waste products; 3) Ratio of collected used materials for recycling purpose (collection rate); 4) Waste diversion rate; the rate or percentage of a potentially recyclable material that has been diverted out of the waste disposal stream and therefore not entering landfills.

02 Type of indicator

Quantitative Indicator, Response Indicator

03 Policy goals to be monitored by this indicator

The overall recycling rate and target attempts to monitor progress in recycling and resource saving activities. The policy goals related to this indicator are to achieve, via policies and measures, waste minimisation before final treatment (such as incineration and landfill) as well as reducing amounts of virgin materials used by increased use of recyclables (e.g., plastic, paper, metal). This is usually achieved via financial mechanisms and institutional frameworks involving relevant stakeholders.

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04 Definition

The most common method to calculate the recycling rate is as follows:
Recycling rate = Annual total waste recycled/ Annual total waste generation

In reality, based on the lifecycle of materials and products as shown in figure 1 below, the definition of the recycling rate and target may differ according to the goals of policies requiring calculations of such indicators.

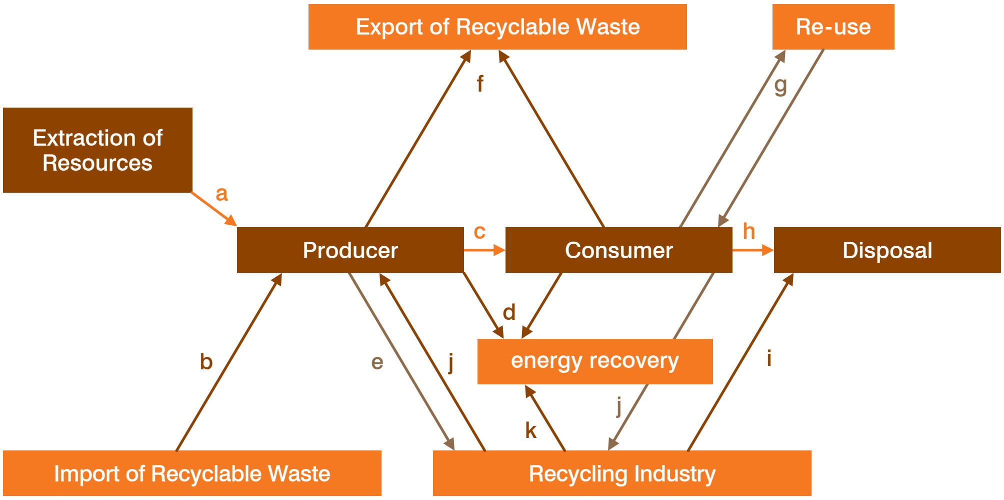

Figure 1. Material Flows and Recycling Target
Source: Michikazu Kojima (2012)

1) Cyclical Use Rate or Ratio of Recycled Materials used in a Certain Product

If the inclusion of recyclables into product manufacture is an important factor, i.e., as a replacement for virgin resources, the resource recycling rate (cyclical use rate in Japan's Fundamental Plan for Sound Material Cycle Society) should be used:
Cyclical Use Rate: (b+e)/(a+b+e)

Similarly, this can be calculated as a ratio of recycled materials used in a certain product:
Ratio of recycled materials used in a certain product (one product): (b+e)/(a+b+e)

2) Ratio of materials recovered from end of life/waste products

If emphasis is placed on efficiency of resource recovery of existing recycling systems or facilities, then this indicator can be used:
Original definition of recycling rate (= Total waste recycled/Total waste generated), approximated by: (e+k)/(j+h)

The resource recovery from the collected items can be calculated as:
Recovery Rate: (e+k)/(e+k+i)

3) Ratio of collected used materials for recycling purpose (collection rate)
If emphasis is to be placed on efficiency and coverage of collection of recyclables, the following can be used as an indicator:
Collection Rate: (j+f)/(d+h+j+f)

4) Waste diversion rate
If emphasis is on extension of life of landfills as well as improved waste management, the waste diversion rate can be used. This is the rate or percentage of a potentially recyclable material that has been diverted out of the waste disposal stream and therefore not landfilled:
Waste diversion rate: (j+f+d+g)/(h+j+f+d+g)

05 Policy instruments that can be used for improving recycling

The purpose of recycling is to improve the recovery of useful resources from used materials, which aims to minimise the materials proceeding to final treatment such as incineration and landfills and to minimise both environmental and economic costs associated with waste management. For this purpose, several policy instruments can be applied:

- Waste separation and sorted collection of recyclable resources
- Community-based collection of recyclables
- Awareness raising on the need for sorted collection
- Waste discharge fee
- Deposit-and-refund
- Extended Producer Responsibility (EPR)-based recycling policy
- Industrial Symbiosis, waste exchange programs, CPs
- Voluntary initiative or green purchasing for prioritised use of recycled goods
- Financial support for recycling businesses and industries

06 Merits of implementation

Recycling is a key component of waste management and resource efficiency strategy, both for municipalities and for industrial processes. Improving the recycling rate lowers the amounts of materials requiring final treatment, and by extension lowers the costs for final treatment, extending the useful life of landfill sites. Theoretically, promotion of recycling has multiple benefits, such as greenhouse gas (GHG) reduction, energy and material saving, lowered impacts on human health and job creation. A case study of a municipality in Thailand concluded that recycling can reap jobs at the rate of 7.5 labour days per tonne of generated recyclables (Menikpura et. al. 2012). Other merits are the separation of hazardous substances from landfill-destined waste, which avoids air, water and soil contamination and reduced use of virgin material extraction and production. From a life-cycle accounting perspective, production processing from virgin materials usually consumes more energy, leading to higher emissions of GHGs compared to recycling of used materials.

07 Similar indicators and supporting indicators

- Cyclical Use Rate
- Ratio of recycled materials used in a certain product
- Ratio of materials recovered from end of life/waste products
- Ratio of collected used materials for recycling purpose (collection rate)
- Waste diversion rate

See the definition for the details of these indicators.

- Amount of virgin resource saving: This refers to utilisation of recycled materials in place of virgin resources. Translating the use of recycled materials into this indicator indicates resource saving potentials from recycling activities and contribution to resource efficiency.

- Estimation of amount of recyclable materials handled by informal recycling market or estimation of size of informal recycling market: Estimation of the informal sector's contribution to recycling would raise the awareness in recycling activities conducted by waste-pickers, junkshops, recycling, and repair and refurbishing activities. This indicator reflects both the contribution of the informal sector in recycling activities and waste diversion as well as reduction in potential environmental and health risks from such activities.

08 Challenges and concerns

Regarding the definition

- How the recycling rate is defined differs according to the goals of the related policy.

- In the equations, factors affecting the numerator side are use of energy recovery, collection or utilisation of waste, and import and export; the factor affecting the denominator is use of total input of resources or waste generation.

- The definition also depends on what constitutes recyclables, i.e., whether materials are attributed with positive or negative economic value.

Regarding interpretation

- The term 'recycling' can cover material recycling and recovery activities, and can also embrace energy recovery.

- The indicator is affected by what constitutes the 'weight' of waste, i.e., whether dry or wet weight is used. The diversion rate varies with the weight of the waste streams; heavier waste streams tend to have lower diversion rates.

- Recycling activities in developing countries are often dependent upon informal recycling markets such as waste-picking, sales of recyclables from households or offices to junk buyers, small-junk shops and back-yard recycling. Thus, where informal recycling activities are prevalent, the actual amount of recycled materials or recycling rate would be larger than the official statistics indicate.

09 Appropriate data management by stakeholders

- Central government: Aggregation of existing information, conducting surveys on recycling industry
- Local government: Amount of waste transported, understanding of waste characterisation and conducting surveys on collectors
- Industrial Associations: Conducting surveys on member industries or non-member industries
- Information derived from manifest/consignment notes
- Academia and knowledge hubs

10 Direct and indirect impact

As a governmental policy, development of recycling follows two stages:
Initially, recycling is integrated into government policy for solid waste management, which is followed by awareness-raising campaigns, governmental regulation and legislation on specific recyclables before actual start of formal collection of recyclables. Recycling is considered to be an integral part of solid waste management operations of local government or local public utilities. This stage of recycling at the local governmental level aims to reduce the amount of solid wastes proceeding to intermediate treatment or final disposal, such as incineration and landfill, and to reduce or stabilise solid waste management costs for local governments. Also, such initiatives could extend the life of final disposal sites. Conventional 3R campaigns for municipal solid waste management, such as reduction of plastics used for packaging and containers are part of such initiatives. In other words, this stage aims at reducing the amount of final disposal, re-use of waste products and materials, and recycling (the 3Rs) as a part of integrated solid waste management.

The second stage is to facilitate a transition to a resource-efficient society by national governmental response to consumption and waste generation en-masse, by establishing national mechanisms for recycling. In this case, in addition to simple promotion of recycling, introduction of a cost-sharing mechanism and systematic infrastructure-building for resource circulation is required. An example of such effort can be seen in Japan's policy of 'Sound material cycle society'. The policy concept behind this is to bring about social change, in which the consumption of natural resources is minimised and the environmental load is reduced to the extent possible. A route towards this is to prevent products from becoming waste, promoting appropriate recycling of products, and securing appropriate disposals of waste that are not recycled. At this stage, recycling starting from waste management becomes a part of sustainable resource and materials management.

11 Best practices

A number of Asian countries have introduced national recycling targets:

Japan: Fundamental Plan for Establishing a Sound Material Cycle Society

- Cyclical Use Rate [cyclical use amount/(cyclical use amount + amount of natural resource input)]

Philippine: Ecological Solid Waste Management Act

- Diversion Rate: 25% of all solid waste, through re-use, recycling and composting, and other resource recovery activity by 2004

Malaysia: Tenth Malaysia Plan (2011-2015)

- Increased household recovery of waste from 15% to 25% by 2015

Singapore: A Lively and Livable Singapore: Strategies for Sustainable Growth 2009

- Recycling rate = Total Waste Recycled/Total Waste Generated (70% in 2030) 56% in 2008

Viet Nam: National Strategy for Integrated Management of Solid Waste Up to 2025

- To collect and treat, within environmental standards, 100% of daily life solid waste in urban centers, 90% of which will be recycled, reused as recovered energy or used as input for organic fertiliser production

12 Conclusion

Recycling rate is one of the representative indicators of 3R policy performance, thus many governments in Asia have incorporated it into national 3R targets. However, caution must be taken if inter-country comparisons are made solely based on one definition or interpretation of recycling, since policy priorities vary.

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Measuring Waste Reduction, Reuse and Recycling through Industrial Symbiosis

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01 Outline of indicator

Most industrial operations are linear processes in which raw materials are processed into products, with waste as a by-product. However, waste is also generated at the time of raw material extraction, during processing, and ultimately at the end-of-life stage of a product. To minimise, reutilise or recycle waste at each stage, industrial operations can be reconfigured though ***industrial symbiosis (IS)***, in which waste produced from one industry is reutilised by another as a raw material. Industrial symbiosis supports resource efficiency in two ways: Cleaner Production (application of techniques and technologies, and management strategies that reduce the waste generated from industrial operations) and Waste Exchange Programmes (exchange of one waste with another resource or raw material). Thus, the benefits of industrial symbiosis are twofold; economic, by lowering the cost of operations and waste disposal, and environmental, via pollution (waste) abatement. There are many concepts involved in IS; however, basic indicators of a successful IS are: 1) reduction in the waste generated from industrial operations, 2) Ratio of recycled materials used in raw material through waste exchanges, 3) Reduction in the amount of industrial waste landfilled, and 4) Reduction in the cost of waste treatment and disposal borne by industry.

02 Policy goals to be monitored by this indicator

Industrial symbiotic activities lead to upstream resource efficiency by reconfiguring the linear flow of materials and resources into a cyclical pattern by recovering and recycling waste into the production chain. The major policy goals to be measured by this indicator are to achieve waste minimisation, reduce virgin material use by using recyclable materials as raw materials, and divert

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waste from landfills into the production chain. Other policy goals are collaboration of industries into an eco-industrial cluster, green manufacturing and green purchasing, and even linkage with the Environment Management System (EMS) (e.g., ISO 14001).

03 Definition and Scope

Industrial symbiosis (IS)

Industrial symbiosis is basically "engaging several traditionally separate firms and industries in a collective approach to competitive advantage involving physical exchange of ***materials***, energy, water, and by-products" (Chertow, 2000)*[1]. Industrial symbiosis is a subset of industrial ecology with a particular focus on material and energy exchange. It offers upstream resource efficiency by lowering material in-flow in the production system by careful design of production processes and products (*Cleaner Production*), as well as reutilising waste as resources and raw materials in secondary industries (Waste/by-product Exchange).

Industrial symbiosis and cleaner production (CP) indicators

Cleaner production is a preventive measure to achieve upstream resource efficiency by reducing the use of energy, water and material resources, and minimise waste in the production process. It involves rethinking the entire life cycle of products, including resource extraction, selection of raw materials, product design, production and assembly of the final product, consumer use, and managing all end-of-life products.

Resource efficiency by using CP can be measured by quantifying any changes in cleaner production as measured by resource use, waste generation, etc. The basic CP indicators are*[2]:

- Gross turnover of the (industrial) waste management industry: This could reflect both the adoption of cleaner production practices, due to awareness of cleaner production and thus more involvement (industrial) of the waste management industry, or the opposite; greater adoption of cleaner production practices, resulting in less pollution, and lowered need for services of the (industrial) waste management industry.
- Expenditure on waste disposal: Since lowered waste disposal costs mean lowered waste generation, it can be indicative of CP practices. However, expenditure on waste disposal may decrease due to a range of other factors, such as lower industrial output, inappropriate or illegal disposal, or the use of more cost-effective waste disposal technologies.

CP indicator measurement is basically an ***input-output ratio***. On the input side, indicators of cleaner production could include:

- Measurement of energy used per unit of output produced
- Measurement of water used per unit of output produced
- Measurement of environmentally harmful inputs per unit of output produced

On the output side, indicators at the aggregate level of cleaner production could include measurement of:

- Discharges to atmosphere (tonnes per unit of output)
- Discharges to water (megalitres or kilograms of biochemical oxygen demand (BOD) or kilograms of chemical oxygen demand (COD) or kilograms of suspended solids (SS) per unit of output)
- Discharges to land (tonnes of solid waste per unit of output)
- Transfers of waste to storage (tonnes of waste per unit of output)

Measuring the CP requires complex indicators using the entire Life Cycle Assessment (LCA) and Total Cost Assessment (TCA) methods. CP indicators measure both the process performance and environmental performance.

Process performance indictors:
- Actual % reduction in material use per annum
- Target % reduction for year XXXX
- Actual reduction in material expenditure per annum
- Target reduction for year XXXX

Environmental performance indicators:
- Tonnes of raw material used per tonne of production
- Tonnes of waste produced per tonne of production
- Chemical composition of waste
- Amount of waste; discharge of waste to land/atmosphere
- Quantity of recycled material within the production process (in-site)
- Quantity of off-site waste recycling
- Cost of waste disposal pre- and post-CP
- Investments in performance improvements (techniques, strategies and technologies)
- Occupation health issues within production units

These CP indicators not only estimate the CP of a product or process, but also enable comparisons with other equivalents, improvement of existing processes or products and development of new products.

CP Index is the ratio of the productivity of a given system to its environmental impact. Productivity is measured in terms of economic efficiency using Total Cost Assessment (TCA), and the environmental impact is calculated using standard LCA methodology. But, making a ratio simply from the two CP indices (existing and alternative systems) will fail to adequately reflect the concept of time value of money, therefore the "productivity ratio" as a ratio of the productivity elements of the current process and alternative process, expressed as economic efficiency over time, should also be measured. Similarly, the "environmental ratio" as the ratio of reciprocals of the environmental impact elements between the current process and alternative process should also be measured. These two ratios are multiplied together to generate the **CP Ratio**. If the CP ratio is higher than 1 it means that the alternative is better than the current one, from the perspective of CP.

CP Index = productivity / environmental impact
CP Ratio = productivity ratio × environmental ratio*3

*1 Chertow, M. R. 2000, Industrial symbiosis: Literature and taxonomy. Annual Review of Energy and Environment 25:313–337.
*2 Aquatech Environment, Economics, and Information, 1997, A Benchmark of Current Cleaner Production Practices. Prepared for Cleaner Industries Section, Environment Protection Group Environment Australia.
*3 Kotelnikov, V. Measuring Cleaner Production (CP) - Harnessing Business Benefits. Ten[3] BUSINESS e-COACH – Innovation Unlimited. Available at: http://www.1000ventures.com/environment/cp_measuring.html

Industrial symbiosis and industrial waste exchange (IWE) indicators

Industrial symbiosis is based on the exchange and collaboration between or among firms, where one facility's waste (energy, water or materials) becomes another facility's feedstock. Such waste or by-product exchanges can be useful when an industrial plant reaches the limits of cleaner production but still generates some waste. Industrial waste exchange, involving reuse and recycling of industrial waste, is a widely recognised concept, and typically involves one-way exchanges (transactions) of waste at the end-of-life stage. IWE occurs in a) collaboration between industries that generate waste and industries that can use the waste as raw material; b) linking industrial waste generators with waste recycling companies; and c) linking municipalities (as facilitators) with waste generating industries and recyclers. The following could be used as indicators in industrial waste exchange:

1. Input/Output ratio and amount of waste exchanged in/from an industry
2. Volume of waste diverted from landfill and tonnes of GHG emissions avoided
3. Reduced cost of waste disposal (for waste-generating industries)
4. Cost saving in raw material input (due to lower raw material inputs of reused/recycled waste)

One of the basic requirements of waste exchange is an up-to-date ***database*** of waste generating industries and potential recyclers and reusers, which should include the following information:

- Company contact information
- Company waste streams and inputs
- Material description
- Quality
- Quantity: weight or volume
- Exchange logistics
- Pick-up or drop-off information
- Material sorting
- Warehouse space or outdoor bins
- Results of exchanges (measurable impacts)
- Commodity exchanged
- Companies involved
- Material weight
- Market value of material (which can fluctuate) or landfill tipping rate
- Commodity-associated CO_2 equivalence for material (varies with reuse or recycling)

IWE Performance Indicator Selection

- Number of businesses participating
- Type of participating businesses
- Number of business partnerships formed
- Number of material exchanges resulting from partnerships (e.g., continuous or one-off)
- Tonnage of waste diverted from material exchanges
- Total financial savings to businesses (e.g., waste suppliers, recipients) from material exchanges in landfill tipping fees, waste bin pick-ups, reduced cost of raw materials and market value of commodities
- Greenhouse gas savings from material exchanges
- Website traffic statistics are used to determine site activity*4

*4 Department of Environmental Affairs and Tourism South Africa, and DANIDA, 2005. National Waste Management Strategy Implementation South Africa-Review of Industrial Waste Exchange. Report Number: 12/9/6 Annexure G

04 Policy instruments useful for improving recycling through industrial symbiosis

There are many interrelated and connected policy instruments that can assist recycling through industrial symbiosis:

- National Industrial Policy: Policies favouring eco-industrial clusters, cleaner production, design for environment and waste exchange programmes
- Volume-based landfill tax for industrial waste landfills
- Product stewardship and Extended Producer Responsibility (EPR)
- Green purchasing of goods manufactured with recycled products/waste reuse
- Financial support for industrial waste recycling

05 Challenges and concerns

Indicators measuring cleaner production are complex and involve the entire life cycle of products. The industrial waste exchange indictor is simpler, as the amount or weight of exchanged can be quantified for both the industry selling or giving away the waste and the industry buying or taking-in such waste. However, identifying actual fractions of waste used in products is complex. Not all the waste exchanged can be used in a production system, thus some loss may occur in the post-treatment of waste before re-use as a raw material. A waste exchange database is an integral part of IWE, as it provides a central location for individuals and organisations to either check on, or add to, waste materials in the list, then make contact with the relevant parties concerned. Such database needs to be coherent, consistent and continually updated.

06 Best practices

Industrial Waste Information Exchange Programme (IWIEP) in Asia

Among Asian regions, Japan, the Philippines and Thailand have conducted IWIEPs. IWIEP links suppliers and users of industrial waste to enhance utilisation of waste. A third party collects information on the kinds of wastes generated by waste generators and which wastes can be utilised by users. This information is then provided to waste generators and users to facilitate matching between them.

Material Exchange Centre - Thailand

Thailand's Environment Institute initiated a web-based information exchange project in 2005. In this system, companies match their waste disposal and raw material needs through a computerised database, and subsequently exchange waste. For waste suppliers, these types of transactions avoid disposal costs, while for users raw materials can be purchased at lower prices than new materials, which reduces the energy needed during manufacturing processes.

Thailand Centre for Transfer of Clean Technology

The Technology Promotion Department of Thailand's Ministry of Science, Technology and Environment (MOSTE), founded in 1992, is responsible for developing and transferring technologies as well as enhancing and strengthening capabilities to acquire and transfer technologies from both foreign and domestic sources to Small and Medium Enterprises (SMEs), and rural people. Its main technology focus has been rural and agriculture based enterprises. This Department is to be transformed into the **Centre for Transfer of Clean Technology (CTCT)** and will become Thailand's national data and web networking centre for clean technologies and Cleaner Production (CP).

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

Hazardous Waste Management

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01 Outline of indicator

The basic qualitative indicator Hazardous Waste refers to the existence of regulations controlling hazardous waste. The presence of regulations themselves should also promote environmentally sound management of hazardous waste. Amounts and rates of generation of hazardous waste are the main quantitative indicators. To assess a country's hazardous waste treatment and disposal capacity, imports and exports of hazardous waste should be taken into account. Many Asian countries have ratified the Basel Convention and compile the required data for submission to the convention secretariat every year. Such data covers information on hazardous waste regulations, existing facilities, generation and import and export.

As regards disposal, it is preferable to dispose of non-recyclable hazardous waste at the location of its generation. However, in the absence of appropriate domestic treatment or disposal facilities, it should be exported to an environmentally sound facility through the 'prior notice and consent' procedure. Environmentally sound management is also a prerequisite for export of recyclable hazardous waste*[1]. In accordance with the economies of scale of recycling technologies and pollution prevention, and due to fragmentation of the production processes involved, resource efficiency may be improved by providing regional recycling centres.

*1 "Guidance Document on the Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention" (1994) stated that the Self-sufficiency Principle, the Proximity Principle and the Least Transboundary Movement Principle should be considered in relationship and balance. In addition, it states "it should also be recognised that considerations for disposal may be different from those for recovery, which, if soundly managed, can provide environmental and economic benefits and should be encouraged".

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02 Type of indicator

Existence of regulations to control hazardous waste: Qualitative Indicator, Response Indicator
Amount and rate of generation of hazardous waste: Quantitative Indicator, Pressure Indicator

03 Policy goals to be monitored by this indicator

If hazardous waste is dumped or recycled without environmentally sound technology, serious environmental problems and health hazards may result. Policy goals on hazardous waste are to minimise environmental and health risks due to hazardous substances contained in hazardous waste and to utilise hazardous waste as resources via environmentally sound technologies.

The first step to manage hazardous waste within a country is to formulate regulations governing hazardous waste generation, storage, transport, treatment and disposal facilities. If such regulations do not exist, a model national legislation provide by the Basel Convention can be used. Reporting requirements given in such regulations will form the basis of the data used in hazardous waste management.

Using the collected data on hazardous waste generation and disposal, the associated environmental risks can be minimised and correctly managed. Ideally, generation of hazardous waste should be minimised, but this can present quite a challenge in a rapidly growing economy. An alternate indicator of management efficiency used in place of absolute amount of hazardous waste generation is GDP per unit of the amount.

Usually, readily available data on hazardous waste generation refers to the amount of hazardous waste treated and disposed with government-approved technology. However, any reduction in the amount of reported hazardous waste generation could point to an increase in informal recycling or illegal dumping (see the section on Challenges and concerns).

04 Definition

In most Asian countries that have ratified the Basel Convention, national legislation follows the convention's definition, i.e., it is defined as hazardous waste if it is within the category of wastes listed in Annex I of the Convention and exhibits one of the hazardous characteristics contained in Annex III such as explosive, flammable, toxic or corrosive. Annex VIII also lists up typical hazardous wastes.

The Basel Convention allows parties to formulate individual definitions but requires such parties to report their definitions to the secretariat, which then disseminates such to the other parties.

05 Supporting indicators

Other related statistics are as follows:
(1) Hazardous waste generation by industry
(2) Amount of hazardous waste by treatment and disposal type, such as recycling, energy recovery and landfill

As explained in the following section, hazardous waste generation by industry, as well as by type, such as waste oil and lead acid batteries, is useful in interpreting trends in hazardous waste generation.

06 Challenges and concerns

- Reduction in hazardous waste generation can be targeted by national policy, but observed reductions in hazardous waste may indicate a rise in illegal dumping, thus caution should be observed in interpreting the indicator. Reasons for the type of waste being reduced should be first identified, and if such explanations lack credibility, indications of illegal dumping should be investigated.
- Any reduction in exported hazardous waste through ‘prior notice and consent’ also warrants caution as such could have resulted from either an increase in appropriate treatment by domestic facility or improper treatment via unauthorised recycler, or smuggling.
- Some countries lack legislation for hazardous waste, but control it by regulation on industrial waste, while leaving hazardous household waste to local governments. Under such legal systems, where the types and generation of hazardous waste lack appropriate classification, the risks allied with hazardous waste can be minimised by enforcing regulations on generator’s responsibility of industrial waste, pollution control to recycling and disposal facilities and local government waste management.

07 Appropriate data management by stakeholders

Generators of hazardous waste are usually required to issue manifests or consignment notes when transferring hazardous waste to carriers for delivery to authorized treatment or disposal facilities. It is also common practice for waste generators, treatment and disposal facilities to report to the government on amounts of hazardous waste generated, treated and disposed of, respectively, the reporting structure of which forms the basis of substantiation for the indicator.

Importers and exporters of hazardous waste are required to obtain prior consent from competent authorities before shipment, and the amounts involved constitute another source of data.

08 Best practices

Regulations on hazardous waste need to be disseminated to industry and other related stakeholders by the government, and enforcement thereof is a key route to fostering environmentally sound management.

Example 1 — Course for Certified Environmental Professional in Scheduled Waste Management, organised by Environment Institute of Malaysia

The Environment Institute of Malaysia, under the Department of Environment in the Ministry of Natural Resource and Environment, provides a course entitled Environmental Professional in Scheduled Waste Management (‘Scheduled waste’ means hazardous waste in Malaysia). This five-day course is for managers and supervisors involved in managing toxic and hazardous waste at industrial waste facilities, and covers “scheduled waste legislation and policy”, “scheduled waste facilities and licensing procedure”, “storage, packaging and labelling of scheduled waste”, “options for disposal and treatment technology”, “identification, classification and properties of scheduled waste”, as well as other topics.

In addition, if specific hazardous waste streams are not managed well, the government should organise stakeholder meetings and discuss action plans and future regulations for such streams.

Example 2 Risk Reduction in Lead Acid Battery Recycling in the Philippines

The International Lead Management Centre conducted a pilot programme with UNCTAD, UNDP, the Philippine Department of Trade and Industry and local industries to reduce the risks in lead recycling in the Philippines. The programme involved an environment assessment of a large recycling facility in September 1997. The Centre provided technical support in upgrading the facility to reduce environmental emissions, and the recycling company reformed its used lead acid battery collection system, which led to an informal recycler receiving a hazardous waste transport license as collecting agent for authorised recyclers.

Reference documents and existing guidelines

If your country lacks regulations governing hazardous waste, the first step is to issue hazardous waste legislation. Please refer to this Basel Convention information: *Model National Legislation on the Management of Hazardous Wastes and Other Wastes as well as on the Control of Transboundary Movements of Hazardous Wastes and Other Wastes and their Disposal*. http://www.basel.int/Portals/4/Basel%20Convention/docs/pub/modlegis.pdf

Guidance document for improving national reporting, including data collection:
Committee for administering the Mechanism for promoting implementation and compliance of the Basel Convention [2009] *Guidance Document on Improving National Reporting by Parties to the Basel Convention*.
http://www.basel.int/Portals/4/Basel%20Convention/docs/natreporting/GuidFinal-22102009-e.pdf

Technical Guidelines on hazardous waste such as “used oil”, “waste lead-acid batteries”, “biomedical and healthcare wastes”, “wastes consisting of, containing or contaminated with POPs”, “elemental mercury and waste containing or contaminated with mercury”, “co-processing of hazardous waste in cement kilns”, were developed by the Basel Convention. These guidelines are posted on the following website: http://www.basel.int/Implementation/TechnicalMatters/Developmentof-TechnicalGuidelines/AdoptedTechnicalGuidelines/tabid/2376/Default.aspx

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

Promoting full-scale use of agricultural biomass residue and livestock waste

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Nirmala Menikpura Institute for Global Environmental Strategies (IGES), Japan

01 Outline of indicator

Agricultural biomass residue and livestock waste are readily found in rural areas, with manure left exposed and biomass burnt in the open. These materials can be used to improve farm productivity—specifically, produce food and energy, generate incomes and reduce environmental impacts. Unfortunately, these residues and waste are not being fully utilised, for example, it was estimated that open burning of rice straw residue is practiced over an estimated 4.7 million hectares of rice fields in Thailand, with residues amounting to 21.7 million tonnes per year.[1] Only part of the rice straw is being used in some of the provinces as animal feed and for energy production.[2]

The indicator "promoting full-scale use of agricultural biomass residue and livestock waste" aims to maximise use of agricultural biomass residue and livestock waste through reuse and recycling measures. This would bring about a number of co-benefits, including GHG emission reduction, energy security, poverty reduction, sustainable livelihoods in rural areas, investment mobilisation, regional economic gains and public health improvements.

Fig.1 Burning of crop residues[3]

02 Type of indicator

Quantitative indicator

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03 Policy goals to be monitored by this indicator

This indicator can monitor the achievement of **Goal 11** proposed under the draft Ha Noi 3R Declaration on Sustainable 3R Goals for Asia and the Pacific for 2013-2023. The primary quantitative indicators selected for Goal 11 are:

- Amount of agricultural biomass residue and livestock waste used
- Number and capacity of new projects initiated that use agricultural biomass residue and livestock waste as material input

In light of the potential co-benefits that can be achieved, the following quantitative indicators would also be useful in measuring the overall socio-economic and environmental progress made by effective utilisation of agricultural biomass: (1) Annual biomass residue generation, (2) Annual biomass utilisation to recover energy and nutrients, (3) Annual GHG reduction via effective utilisation of agricultural biomass, (4) Total renewable-energy production using agricultural biomass, (5) Net fossil-fuel savings, (6) Number of employment opportunities created, (7) Annual income generation via agricultural biomass based projects at regional level, and (8) Annual country's currency savings (due to avoided imports of fossil fuel and materials).

04 Definition and scope

- Agricultural biomass residue refers to plant residues leftover after harvesting; generally crop residues and weeds.
- Livestock waste refers to excreta and manure of animal raised and also organs of dead animals.
- Agricultural biomass residue and livestock waste can be used for the purposes of soil enrichment (e.g., soil cover material, animal feed, biochar), as a medium for food production (e.g., mushrooms), energy generation (e.g., electricity, biogas, solid fuel, bioethanol), and so on.

Fig.2 Use of crop residues for soil cover[3]

Fig.3 Use of crop residues for electricity generation

05 Policy instruments useful for promoting full-scale use of agricultural biomass residue and livestock waste

- Economic instruments are important for promoting full-scale use of agricultural biomass and livestock waste, especially at small and medium-scale farms. Creating market demand for agricultural biomass residue and livestock waste by developing markets for products utilizing these materials, use of a feed-in-tariff and use of the carbon market would act as key drivers to encourage farmers, entrepreneurs and investors.
- Introduction of appropriate cost-effective technologies applicable at the local level.
- Promotion of local investment and private businesses for biomass utilisation and replication of the most suitable schemes (e.g., biomass down) throughout the country. Intervention from governments, private sectors, NGOs and academia would increase awareness and the capacity

of farmers and communities to use locally available agricultural biomass residue and livestock waste, especially in remote areas.[2]

- Public education on sustainable agriculture, organic farming and environmental impacts would greatly aid in promoting full-scale use of farm residues. Inserting such into school programmes could substitute in remote areas where farmers have low capacity for investment and suffer labor shortages.

06 Merits of implementation

- The practice of burning agricultural biomass residue to reduce the risk of uncontrolled fires and prevent insects and pathogen outbreaks is widespread. Promoting full-scale use of agricultural biomass residue can contribute significantly to successful implementation of policies geared towards ending open burning, and also reduce the risk of health and environmental impacts, and more importantly, life and property loss due to uncontrolled fires.
- Livestock waste is often left unattended, and this accumulated high-moisture waste generates a foul odour, methane and contaminates water and soil. Utilisation of this waste for soil amendment, energy generation and so on can significantly reduce negative impacts on the environment and public health.
- Use of agricultural biomass residue and livestock waste can significantly increase farm productivity and thus improve household livelihoods of farmers, generating new jobs for non-farmers, and thus increase resilience.
- Providing green energy to local communities.

07 Similar indicators and supporting indicators

- Non-burning practice/policy
- Reduction of annual amount of agricultural biomass residue burnt
- Quantity of compost production from agricultural biomass residue and livestock waste
- Organic farming policy and organic products in the market
- Quantity and number of facilities for renewable energy production from agricultural biomass residue and livestock waste

08 Methodology of data collection and calculation

- Primary indicators on the amount of agricultural biomass residue and livestock waste used can be measured by scale at the plant or site level. The number and capacity of new projects using agricultural biomass residue and livestock waste can be recorded based on registration data. Measurement of the amount of agricultural biomass residue and livestock waste used by entrepreneurs can be monitored via keeping records of residue and waste inputs to facilities. Monthly energy production and manure production can be recorded at the plant level, thus total annual production at the regional level can be calculated by totaling data from all plants.
- In practice, there are many small-scale agricultural biomass residue and livestock waste utilisation projects at the farm and community level that do not keep systematic records. For such cases, the amount of residue and waste used by farmers and communities can be approximated

based on sampling. If agricultural biomass residue is used for soil cover, the amount of residues can be estimated based on total cultivation area multiplied by average biomass residue production per unit area. Statistics maintained by the Ministry of Agriculture may provide average national values for agricultural biomass residue for crop production. However, there are many variables, such as the density of plants, invasion of weeds and types of plants. Sampling plots at each farm would improve the accuracy of data collection.

09 Challenges and concerns

- In general, estimation of on-farm use of agricultural biomass residue and livestock waste is challenging, especially where only a portion of the residue and waste is utilised and farmers do not keep records. In this case, farm residue and waste generation and utilisation can be estimated based on area and productivity of crops or number of livestock.
- Small-scale agricultural biomass residue and livestock waste utilisation projects and entrepreneurs may not keep proper records of residue and waste inputs and operations may be intermittent, which will affect the accuracy of data collection.
- The number and capacity of new projects using agricultural biomass residue and livestock waste as material inputs may not represent actual utilisation, but can enable estimates of potential use.

10 Appropriate data management by stakeholders

- Generally, the Ministry of Agriculture responsible for agricultural promotion should maintain data on agricultural production, with actual data collected by local offices of the Ministry. Local administrative offices such as city offices should keep records of entrepreneurs and factories in their jurisdictions. Such frameworks can be developed based on the national administrative system.
- Entrepreneurs and farmers utilising agricultural biomass residue and livestock waste should maintain records to the extent possible to enable estimations of residue and waste they use.

11 Direct and indirect impacts

- Use of agricultural biomass residue as an alternative energy source would negatively impact on food security. Residues such as ash and char from thermal processes should be used for soil improvement to minimise the negative impact to land productivity. Additionally, this residue should be used locally to enhance the potential of nutrient circulation in the district.
- Burning emits more greenhouse gas than non-burning of crop residues, but non-burning practice may increase net GHG emissions from the paddy rice cultivation system, depending on the water management system used.
- Product marketing is a key driving force to raise utilisation rates of agricultural biomass residue and livestock waste. Conversely, shortages in residue and waste inputs to facilities could occur if there are too many facilities.

12 Existing practices

- Thailand promotes residue's utilisation as an alternative to open burning.[4]
- National biogas programme for improving energy security in rural Asia: Bangladesh, Cambodia, Indonesia, Lao PDR, Nepal, Pakistan and Viet Nam.[5]
- Biomass town programme in Japan.[6]

13 Conclusion

The success of any kind of agricultural biomass residue and livestock waste utilisation project depends on the conversion routes, plant scale, market price of products, plant factors, and the cost of biomass, thus policy rules, stakeholder involvement and sound technology applications are needed for sustainable management of agricultural biomass residue and livestock waste.

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Standards for Collection, Storage, Transport, Recovery, Treatment and Disposal to Ensure Environmentally Sound Management of E-waste

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01 Outline of indicator

Global sales of electrical and electronic equipment (EEE) have been rising significantly over the last few years. The rapid uptake of information technology around the world, coupled with frequent design and technology updates in the EEE manufacturing sector is causing the early obsolescence of many of these EEEs, resulting in a rise in electrical and electronic waste (e-waste). The annual amount of global waste generated is estimated at 20–50 million tonnes, most of which derives from Asia. There are thus growing concerns that most of the e-waste generated in developed countries ends up in economically-challenged developing countries that lack the infrastructure for dealing with it properly. Specifically, the absence of environmentally sound management (ESM) of e-waste in such countries results in adverse socio-economic, public health and environmental impacts from the toxins in e-waste. E-waste contains a number of toxic metals as well as valuable and scarce resources, thus must be handled in specific ways in order to avoid possible public health and environmental concerns. High quality end-of-life (EoL) standards incorporating collection, storage, transport, recovery, treatment and disposal of e-waste could contribute significantly towards ESM of e-waste, thereby protecting the environment and the health and safety of populations, as well as saving valuable EEE resources.

02 Type of indicator

Qualitative Indicator, Response Indicator

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03 Policy goals to be monitored by this indicator

This indicator enables monitoring of the environmental performance of the entire EoL chain of e-waste and the policy gaps in technological, infrastructural, institutional, legislative, social and political aspects related to EoL management of e-waste. In particular, it could monitor operations related to the emerging informal e-waste recycling sector in a number of developing countries. This indicator is strongly related to the following Goal 13 of the Ha Noi 3R Declaration on Sustainable 3R Goals for Asia and the Pacific for 2013-2023:

"Ensure **environmentally sound management of e-waste** at all stages, including collection, storage, transportation, recovery, treatment and disposal, with appropriate considerations on **health and safety aspects** of those involved"

04 Basic principles

Utility of standards as policy tools

ISO 17000 defines standards as a formalised set of requirements applied to manufacturing processes, products, services and procedures, both technical and managerial. While technical standards specify the technical properties of a product, the management standards relate to organisation and maintenance of certain procedures in order to achieve a specific objective, such as reducing the environmental impact of a product. The standards for collection, storage, transport, recovery, treatment and disposal of e-waste can be classified as management standards as well as technical standards, as they may specify managerial as well as technical requirements. However, in the context of developing countries, it could be argued that managerial standards are more critical given the circumstances mentioned above. Standards are less binding than legislation, although they can compliment it. For example, standards can be used to operationalise the targets required by legislation. Although the standards can set clear requirements for EoL management of e-waste, they should not prescribe specific technologies or practices, in order to stimulate innovation. One key precondition for a successful e-waste standard is to achieve a balance between effectiveness and efficiency of EoL operations in seeking to achieve high environmental performance at an acceptable cost.

Definition of e-waste and management approach

What is e-waste? There is considerable debate over the precise definition as it not only consists of information and communication technology appliances (computers, mobile phones) but also white goods (air conditioners, cooling devices), hence the need for a clear definition. Furthermore, since e-waste is generated from various types of EEEs, different means for collection and treatment are required. Related standards thus need to clearly specify the type of e-waste covered. In addition to defining e-waste, the standards should identify the roles of each stakeholder involved in the EoL management of specific types of e-waste.

Consider recycling chains and stakeholders

ESM of e-waste requires the strict cooperation of all EoL operators and the optimisation of the entire EoL chain. For example, high quality recycling may fail if the upstream collection operations are performed improperly and e-waste is damaged during collection, storage and transport. Hence standards are required for all operators involved in the EoL chain, which includes collection, transport, storage, preparation for re-use and treatment and disposal of non-recyclable fractions. A systems approach is the key when setting the requirements for the standards. While each requirement should help improve the performance of the EoL operators in each stage of e-waste management—collection, storage, transport and treatment—it should also maximise the environmental and economic performance of other operators in the entire EoL chain.

Review

EoL standards for e-waste should be reviewed periodically to mirror the latest in scientific research and technological advances. EoL standards therefore need to stipulate practical review periods (four or five years).

05 Requirements

Requirements for EoL management standards can be broadly classified into general requirements and specific requirements, as shown below:

General Requirements
Legal compliance; Handling of e-waste; Environmental, health and safety management systems; Financial liabilities and insurance; Labour and social requirements

Specific Requirements
Collection, storage, handling and transport of e-waste; Treatment of e-waste

General Requirements

As a general requirement, all EoL operators should **comply with local, national and international legislation** applicable to their operations. They should have a thorough knowledge of applicable legislation and have the ability to track changes and to obtain information on new and upcoming legislation.

Proper handling is essential during collection, storage, transport and treatment of e-waste. All EoL operators should be required to handle e-waste in a way that prevents damage to the equipment that may preclude re-use or proper recycling. EoL operators should therefore be required to demonstrate that they have the necessary trained staff to properly handle e-waste, have the infrastructure in place to enable the careful handling of e-waste and have put in place damage-prevention measures.

A properly maintained and operated environmental, **health and safety management system** (EHSMS) should be required for all e-waste EoL operators. This should allow the operators to identify and realise improvement potentials and to continuously improve their performance. EoL standards should oblige EoL operators to have **relevant insurance covering damage** to third parties, including environmental damage, impacts on the health of workers, neighbours and their properties and to ensure clean site operations.

Specific Requirements

Collection standards should stipulate the need for collectors to ensure that collection facilities are close to consumers and conduct periodical household collections of e-waste. To enable re-use and effective treatment, standards should require operators to collect, store, handle and transport e-waste in a way that prevents damage to e-waste during operations (in order to avoid pollution due to breakage, leakage or corrosion), does not hinder the removal and specific treatment of hazardous materials and components in subsequent down-stream operations, and that supports the sound re-use and recycling of e-waste and proper disposal of materials that cannot be treated otherwise. **Standards for storage and collection** should also stipulate that transport vehicles and containers must be equipped to achieve the above targets and storage sites are equipped to prevent pollution due to damage, leakage and corrosion.

To minimise the environmental impacts of e-waste, **standards should stipulate the priority for 3R practices such as prevention, preparation for re-use and re-use and recycling**. Re-use of EEE offers significant environmental and social benefits. However, **EoL standards for re-use** should consider setting limits or targets for minimum energy efficiencies of equipment for re-use. Standards should also require operators to avoid incineration and disposal of recyclable fractions of e-waste. Since e-waste containing hazardous materials requires specific treatment, EoL standards should clearly **define such hazardous materials** and **specify that they be handled by state-of-the-art recycling facilities.**

Traceability of trading partners, analytical capacity of materials in recyclables, introduction of mass balance tools, sound management of residues and acceptance of recyclables based on technical and managerial capacity are strong indicators of good recyclers.

Transboundary shipments and illegal exports of e-waste present a significant challenge to any attempt to regulate and monitor e-waste. Therefore, EoL standards should set **specific stipulations that prevent illegal transboundary shipments of e-waste**. As a minimum it should stipulate compliance with the Basel Convention. EoL standards should stipulate further measures to be undertaken by the operators to prove the legality of import and export of e-waste.

In this sense, a **data system for input/output management** would be a useful approach for e-waste management. Good recyclers tend to introduce certain mass balance tools. For example, the WEEE forum has developed a tool called "WF_RepTool", which defines a structure for calculating the recycling and recovery rates achieved on the basis of the same data structure and an agreed classification of treatment technologies and reports the treatment results to the authorities in a uniform manner.

06 Examples of existing e-waste management standards

Responsible Recycling (R2)

EPA in the US encourages all electronics recyclers to become certified by demonstrating to an accredited, independent third-party auditor that they meet specific standards to safely recycle and manage electronics. The purpose of the above certification programme is to share common elements that ensure responsible recycling of used electronics. These programmes advance best management practices and offer a way to assess the environmental, worker health, and security practices in managing used electronics.

e-Stewards

e-Stewards Certification is rapidly emerging as the leading global programme designed to enable individuals and organisations disposing of old electronic equipment to easily identify recyclers that adhere to the highest standards of environmental responsibility and worker protection. e-Stewards Certification, initiated by Basel Action Network (BAN), is open to electronics recyclers, refurbishers and processors in all developed countries

WEELABEX

WEEELABEX (acronym of 'WEEE LABel of EXcellence') is a project run by the WEEE Forum in co-operation with stakeholders from the producers' community and processing industry. The project aspires to design both a set of European standards with respect to the collection, sorting, storage, transportation, preparation for re-use, treatment, processing and disposal of all kinds of e-waste, and a harmonised set of rules and procedures that will provide for conformity verification.

07 Examples of ongoing global initiatives related to environmentally sound management of e-waste

Basel Convention Mobile Phone Partnership Initiative (MPPI)
http://archive.basel.int/industry/mppi.html
Basel Convention Partnership for Action in Computing Equipment (PACE)
http://archive.basel.int/industry/compartnership/index.html
Solving the E-waste Problem Initiative (StEP)
http://www.step-initiative.org/

08 Related indicators

The following are some additional indicators that could be used to monitor ESM of e-waste in developing countries:

- Well-defined regulatory procedures adequate to control illegal exports of e-waste and to ensure their environmentally sound management
- Improved ability to gather data and inventory on e-waste generation, including transboundary movements
- Access to appropriate and cost effective technologies to manage e-waste within national boundaries
- Establishment of proper intuitional infrastructures for collection, storage, transportation, recovery, treatment and disposal of e-waste at national levels
- Number of state-of-the-art recycling facilities
- Collection rate of e-waste
- Amount of e-waste treated in ESM facilities
- Development of scientific resources such as experts and laboratories to conduct environmental and human health impacts of e-waste
- Improving the working conditions and minimisation of work related to toxic exposure at e-waste collection, processing, recovery and disposal facilities
- Awareness-raising programmes and activities on issues related to health and safety aspects of e-waste to prompt better management practices
- Increased public-private-community partnerships to encourage establishment of formal e-waste recycling and disposal enterprises
- Address obstacles related to implementing EPR and mandate producers, importers, retailers to absorb costs of collecting, recycling and disposal of e-waste
- Require countries exporting used EEE to developing countries to formally test equipment prior to export
- Prohibit import of e-waste if receiving country lacks adequate capacity to manage such wastes in an environmentally sound manner
- Promote reduction and reuse of EEE
- Training of customs and enforcement officers, as necessary, to control or verify export or import of e-waste and work on identifying e-waste in the Harmonised System of the World Customs Organisation

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WEEELABEX
http://www.weee-forum.org/weeelabexproject

WEEE Forum ReP tool
http://www.weee-forum.org/services/weee-forum-reporting-tool-wfreptool

R2 Standard
http://www.epa.gov/wastes/conserve/materials/ecycling/certification.htm & http://www.r2solutions.org/

e-stewards
http://e-stewards.org/

UNEP/IETC E-waste Manuals
http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/EWasteManual_Vol1.pdf
http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/EWasteManual_Vol2.pdf

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

Recycling Legislation based on the Concept of Extended Producer Responsibility [EPR]

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01 Outline of indicator

The EPR indicator refers to the existence or strengthening of policies on recycling and waste management targeting specific end-of-life products or waste streams, and involves producers in recycling or waste management activities. Such policies make producers and importers physically and financially responsible for used product take-back, collection and treatment, and over the last two decades have broadened in scope to cover products such as used packaging, electronics, batteries, and end-of-life vehicles. Asian economies are currently facing increases in amounts of difficult-to-treat wastes and associated environmental risks, and many, including China, India, Indonesia, or Malaysia, have already introduced or are considering EPR-based legislation, particularly that targeting electronic and packaging wastes. In addition to recycling legislation, EPR can be implemented to promote design for the environment (DfE), recycling and the used product take-back system either on a voluntary basis, by individual producers or producer associations, or as a voluntary agreement between government and individual producers or producer associations.

02 Type of indicator

Qualitative Indicator, Response Indicator

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This project is conducted by the Asia Resource Circulation Policy Research Group, a collaborative research group focused on policy research on 3R promotion in Asia; coordinated by IGES with input from researchers from IGES, IDE-JETRO, NIES, University of Malaya, Asia Institute of Technology, Bandung Institute of Technology, Tokyo Institute of Technology and UNCRD.

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Subject to further revisions

03 Policy goals to be monitored by this indicator

This indicator can be used to monitor to what extent EPR is reflected in national recycling policies in encouraging manufacturers, importers and retailers to share the financial and physical responsibilities of collecting, recycling, and disposal of recyclable wastes. The element of EPR that obliges produces to provide information on environmental features and composition of their products to consumers and recyclers is also important.

The table below is an example for reporting on the status of preparation, development and implementation of EPR-based recycling legislation or policies.

Status of implementation	Name of policy (Year)	Type of product items covered by the policy
Fully implemented		
Postponement period before full implementation		
Under preparation of specific legislations		
Existence of provisions supporting EPR principle		
Based on voluntary approach/ agreement		

04 Definition

The definition of extended producer responsibility (EPR), according to the Organisation for Economic Co-operation and Development (OECD), is "an environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of the product's life cycle", and in several countries, EPR-based recycling programmes are termed "product stewardship programmes", and are very similar in nature. The distinction is not explained in this document.

05 Policy instruments that can be used within, or in conjunction with EPR-based legislation

Administrative instruments	Collection and/or take-back of discarded products, substance and landfill restrictions, achievement of collection, re-use (refill) and recycling targets, fulfillment of environmentally sound treatment standards, fulfillment of minimum recycled material content standards, product standard, utilisation mandates.
Economic instruments	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits
Information-based instruments	Reporting to authorities, marking/labeling of products and components, consultation with local governments about the collection network, information provision to consumers about producer responsibility/source separation, information provision to recyclers about the structure and substances used in products

Source: Tojo, N. 2004. Extended Producer Responsibility as a Driver for Design Change – Utopia or Reality? IIIEE Dissertation 2004:2. IIIEE: Lund.

06 Merits of implementation

Combining various instruments, EPR-based legislation aims at achieving at least one of the following three distinct objectives:

1) Improved waste management and resource recovery: To establish effective collection of end-of-life (EoL) products from consumers, promote environmentally sound treatment and efficient recycling, and reduce the amount of wastes from landfills.
2) Changing allocations of cost for waste management and recycling: To reduce financial and physical burdens of waste management on the public sector, necessary costs for recycling are collected and utilised from various stakeholders related to waste generation in certain product categories.
3) Design for the environment: To provide economic incentives for producers to make design changes towards easier recycling.

07 Similar indicators and supporting indicators

- List of products and/or product group targeted by recycling legislations nationally.
- Collection rate and recycling rate of targeted used products under the specific recycling legislation (see Factsheet on Recycling Rate and Target: Hotta, Kojima and Visvanathan 2013)

08 Challenges and concerns

- Interpretation of EPR: The purpose of introducing EPR varies by country; for example, EPR can be interpreted as a voluntary environmental management initiative or voluntary recycling and take-back activity similar in concept to Corporate Social Responsibility.
- Difficulty of identifying producers: When non-brand, counterfeit, secondhand or repaired products are common in the market, it is often very difficult to identify who the producers are in the context of EPR.
- Infeasibility of take-back scheme: Some products preclude the use of the physical responsibility take-back scheme due to the transportation distance between country of origin and sale.
- Competition with the informal waste management sector: The informal recycling sector has low operating costs and can therefore offer higher cash payments for end-of-life products compared to formal government-approved recycling businesses.
- Infrastructure for waste collection and treatment: Many cities have no established collection system for recyclables and are purely market-based. This means recyclables are recycled under market mechanisms, which is not problematic except that the existing infrastructure for recycling is often small-scale and unsafe for workers and the environment. Thus, once EPR-based recycling mechanisms are up and running, substantial investments in physical infrastructure as well as human and institutional capacity for collection and treatment will be needed.
- Import and export of recyclables: Policy intervention in the collection of recyclables would release a huge amount of recyclables on to the market. In combination with strong demands for resources outside the country, this would lead to an economic driver for export of recyclables for those introduced under EPR-based legislation.

09 Appropriate data management by stakeholders

- Central government: Information management on recycling standards, recycling targets, overall status of recycling mechanisms under legislation.
- Producer: Information on producer/manufacturer, shipments, materials used in products, dismantling procedures, etc.
- Local government: Information on collection schemes, source separation, if local government has responsibility in collection.
- Designated/registered recyclers: Amount of used products received and recycled; environmental information related to recycling process, etc.
- Producer Responsibility Organisations: Ideally, under the EPR principle, each individual manufacturer/producer has to be responsible for the treatment of its products physically and financially. However, in practice, producer responsibility organisations (PRO) are often established to share these producer responsibilities under more formal recycling policy. Since PROs are often managing a common recycling fund, they would be the focus of data management.

10 Direct and indirect impacts

The presence of actual legislation or interest therein as regards EPR in a certain country may point to the following several challenges being faced by such country: 1) Market-based recycling is dysfunctional for the products targeted under EPR-based legislation; 2) Rising financial costs of management and physical handling of solid waste born by local governments due to rising volumes of emerging wastes such as packaging and e-waste; 3) Rising consumer awareness has become a 'push' factor in increased recycling of waste products; 4) Increasing concerns over improper treatment of recyclables containing hazardous substances has triggered policy intervention to establish environmentally-sound recycling and management mechanisms.

11 Best practices

A number of Asian countries have introduced legislation based on the EPR concept:

- **China:** Rules on the Administration of the Recovery and Disposal of Discarded Electronic and Electrical Products (promulgated in 2009, effective in 2011)
- **India:** E-waste Management and Handling Rules (promulgated in 2010, effective in 2012)
- **Japan:** Packaging Recycling Law (1995, revised in 2006), Home Appliance Recycling Law (1998), End of Life Vehicle Recycling Law (2002)
- **Republic of Korea:** Extended Producer Responsibility (EPR) System (covering electronic products, tires, lubricants, batteries, packaging materials, etc., 2003), Act on the Recycling of Electrical and Electronic Equipment and Vehicles (2008)

Further, Indonesia, Malaysia, Thailand, and Viet Nam are currently planning or drafting legislation or policies based on the EPR concept.

Resource Recycling Management Fund of Taiwan Province of China

Currently, ad valorem fees are collected from firms for 14 kinds of recyclable products and are pooled in the Fund. Recycling operators and treatment contractors receive subsidies via the Fund if they conform to certain environmental and quality standards. The Fund is also used to adjust for any volatility in the recycling market.

12 Conclusion

Many countries in the region, including China, India, Indonesia and Malaysia have introduced or are considering EPR-based legislation, especially that targeting electronic or packaging wastes. One of the ultimate goals of EPR is to promote design for the environment of target products. This indicator would assist in sharing information on EPR schemes between countries, promote resource efficiency throughout Asia and contribute to sustainable consumption and production.

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

Indicators based on Material Flow Analysis/Accounting (MFA) and Resource Productivity

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Chettiyappan Visvanathan Asian Institute of Technology

01 Outline of indicators

The global consumption of natural resources is soaring, especially in rapidly industrialising economies. This increasing demand is depleting the natural resource stocks and is also a major driver for other environmental problems, including climate change and the loss of biodiversity. Efficient resource use has become an issue for policy makers in their efforts to realise sustainable resource management.

Keeping an account of the resource inputs, extraction and consumption, as well as analysing the outputs (as waste) is a fundamental need when planning resource efficiency and conservation. Material Flow Analysis/Accounting (MFA) is an analytical method of quantifying flows and stocks of materials or substances in a well-defined system. MFA can be applied at several levels, such as product, regional and national economy level. The accounting may be directed at selected substances and materials, or at total material input, output and throughput (Figure 1). Nevertheless, all of these analyses use the accounting of material inputs and outputs of processes in a quantitative manner, and many of them apply a system or chain perspective.

Factsheets Series on 3R Policy Indicators
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Ver. 1, February 2014
Subject to further revision

Type of analysis	I		
	a	b	c
Objects of primary interest	Specific environmental problems related to certain impacts per unit flow of:		
	substances e.g. Cd, Cl, Pb, Zn, Hg, N, P, C, CO_2, CFC	**materials** e.g. wooden products, energy carriers, excavation, biomass, plastics	**products** e.g. diapers, batteries, cars
	within certain firms, sectors, regions		
	II		
	a	b	c
	Problems of environmental concern related to the throughput of:		
	firms e.g. single plants, medium and large companies	**sectors** e.g. production sectors, chemical industry, construction	**regions** e .g. total or main throughput, mass flow balance, total material requirement
	associated with substances, materials, products		

Figure 1: Types of material flow analyses
Source: Bringezu and Moriguchi, 2002

02 Macro-level MFA (Economy-wide MFA)

Material flow analysis/accounting (MFA) is the study of material flows on a national or regional scale. It is therefore sometimes also referred to as regional, national or economy-wide material flow analysis. MFA is one of the analytical tools that **make it possible to monitor countries' resource consumption trends and efficiency in resource use at the macro level. It uses already available production, consumption and trade data in combination with environmental statistics (OECD 2008).** In principle, MFA can show not only types and amounts of natural resources flowing into the economy, but also reveals what happens to materials as they move inside and out of the economy, and how this relates to resource productivity as well as environmental burden (OECD 2008). It also makes it possible to assess the environmental burden through economic activities of a nation, and determine how material-intensive an economy is.

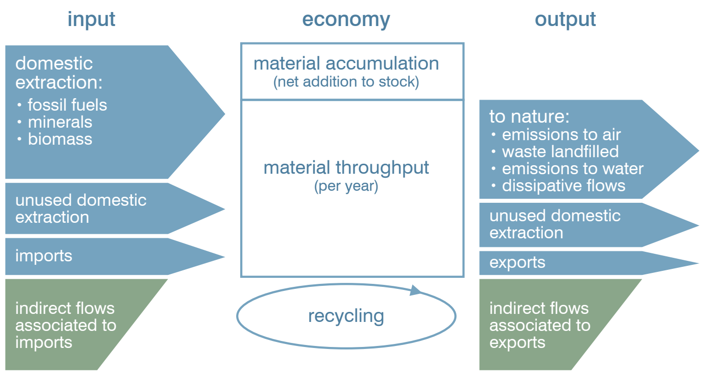

Figure 2: General scheme for economy-wide MFA
Source: Eurostat 2001

Among the existing guidelines, the OECD has developed a comprehensive set of materials called "Measuring Material Flows and Resource Productivity" for conducting Material Flow Analysis for policy makers. These materials cover 1) General OECD guide, 2) Accounting Framework, 3) Some examples of country activities, and 4) Specific module-based practical guidelines for assisting policy makers in implementing national material flow accounts. For those readers who want to know more about MFA, this factsheet recommends the OECD guide **"Measuring Material Flows and Resource Productivity"** as a major information source. It is available at:
http://www.oecd.org/env/indicators-modelling-outlooks/resourceefficiency.htm

03 Type of indicator

Quantitative indicator, Pressure indicator, Response indicator

04 Policy goals to be monitored by these indicators

Indicators that are based on the MFA help to identify the inefficient use of natural resources, energy and materials in process chains or the economy at a macro-level (OECD 2008). Thus, these indicators are some of the most significant tools for monitoring policy and international efforts for improving efficient use of resources as well as sustainable resource management. They can provide an integrated view of resource flows through the economy, and look at capture flows (hidden flows or the so-called "ecological rucksack", such as mining overburden, harvest losses, pollution and waste generated upstream in the production process etc.) that do not enter the economy but are relevant from an environmental point of view. In addition the indicators can reveal how material flows shift within countries and between countries beyond their national borders.

05 Indicators

Statistics related to material flows are usually combined in different indicators. Some examples of material flow indicators are presented below(the following definitions are based on the OECD 2008). These indicators are usually represented by weight; i.e. tonnes.

The following indicators are commonly used in material flow accounting to measure the resource efficiency of a country or region:

Input Indicators

Domestic extraction used (DEU): DEU measures the flows of materials that originate from the environment and physically enter the economic system for further processing or direct consumption.

Direct Material Input (DMI): DMI comprises all materials which have economic values and are directly used in production and consumption activities.
DMI = DEU + import.

Total Material Requirement (TMR): TMR includes the indirect (used and unused) material flows associated with the imports of an economy but that take place in other countries. Thus, TMR is the most comprehensive material input indicator as it is comprises all input flows. It can measure the total material base of an economy and the possible indirect impact of material use.

Consumption Indicators

Domestic Material Consumption (DMC): DMC represents the total quantity of materials used within an economy.
DMC = DMI – Exports

Total Material Consumption (TMC): TMC measures the total material use associated with domestic production and consumption activities.
TMC = TMR- exports and its indirect flows.

Balance Indicators

Net Addition to Stock (NAS): NAS describes the annual accumulation of materials within the economic system (neither released into the domestic environment nor exported, but contributing to a physical increase of the economic processing system itself) and thus could also be termed "physical growth of the economy". NAS shows how materials in buildings, infrastructures and durable goods, such as cars and industrial machinery are expanding in an economy.

Physical Trade Balance (PTB): PTB expresses whether resource imports from overseas exceed the resource exports of a country, or global region, and to what extent domestic material consumption is based on domestic resource extraction or on imports from abroad. PTB reflects the physical trade surplus or deficit of an economy.
PTB = Imports-Exports

Output Indicators

Domestic processed output (DPO): DPO is defined by the OECD as the total mass of materials which have been used in the national economy, before flowing into the environment. These flows occur at the processing, manufacturing, use, and final disposal stages of the economic production-consumption chain. This equals the flow "outputs to nature" and comprises all outflows of used materials from domestic or foreign origin. DPO includes emissions to air and water, wastes deposited in landfills and dissipative flows. However, recycled materials are not included in the DPO indicator.

Total material output (TMO): Sum of domestic processed output (DPO) and export as well as unused domestic extraction. Thus it is comprised of all three categories of output flows either release to the environment, export and unused extraction.

Hidden Flows are materials that are extracted or moved, but do not enter the economy. According to the OECD hidden flows can be described as the "displacement of environmental assets without absorption into the economic sphere". One example of a hidden flow is unused materials from mining operations.

Resource Efficiency Indicators

GDP/DMI: GDP per DMI can indicate the direct materials productivity. Japan uses this indicator to measure its resource productivity to monitor the progress of its Fundamental Plan for Sound Material Cycle Society. Germany uses raw material productivity: GDP per DMI-biomass for its National Sustainable Development Strategy.

GDP/DMC: GDP per DMC can indicate the materials productivity of a domestic economy. The EU employs this indicator as a part of its Sustainable Development Indicator.

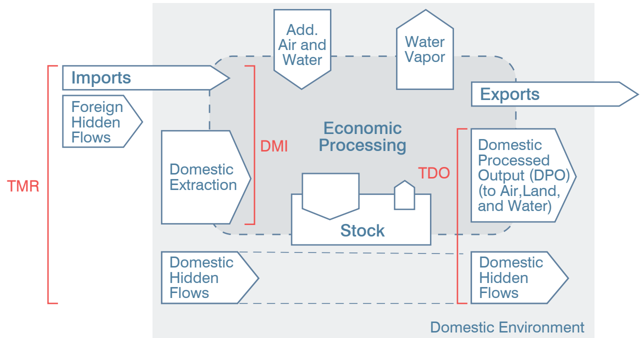

Figure 3: An economy-wide MFA scheme
Source: Matthews et al. (2000)

Indicator Classes	Indicators or aggregates		Accounting rules
	Acronym	Full name	
Input			
	DMI	Direct Material Input	DMI=Domestic materials+Imports
	TMR	Total Material Requirement	TMR=DMI+HF(unused extraction and IF)
Output			
	DPO	Domestic Processed Output	DPO=emissions+waste+dissipative flows
	DMO	Direct Material Output	DMO=DPO+Exports
Consumption			
	DMC	Domestic Material Consumption	DMC=DMI-Exports
	TMC	Total Material Consumption	TMC=TMR-Exports-hidden or indirect material flows of exports
Balance			
	NAS	Net Additions to Stock	NAS=DMI-DPO-Exports
	PTB	Physical Trade Balance	PTB=Imports-Exports
Efficiency			
	GDP/Input or Output indicator	Material productivity of GDP	GDP divided by indicators values (€ per mt)
	Unused/Used	Resource-efficiency of materials extraction	Ratio of unused (hidden or indirect) to used (DMI) materials

Note: HF: hidden flows; IF indirect flows

Table 1: Aggregates of MFA Indicators
Source: (Eurostat 2001)

06 Material flow accounting for domestic solid waste issues

MFA is a suitable method to model waste management systems as it supports decision-making in waste management from the viewpoint of material recycling. MFA in the waste sector can form a baseline scenario to assess future development. In addition it supports material flow management by identifying the priority areas to consider for distributing waste flows to various constructions taking into consideration technical, economic and ecological framework conditions.

The following published documents have made use of MFA in Waste Management Planning and Recycling:

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07 Methodologies to estimate material flows

It is advisable to carefully consider the purpose and existing capacity to conduct this analysis as it is a very data-intensive exercise. The OECD (2008) recommends that countries consider 1) the purposes and uses for which the accounts are established, 2) institutional arrangements and partnerships (establishing focal points and a scientific basis) for continuous efforts, 3) cost and benefit, and 4) already available statistical base. It is advisable to take a stepwise approach. For example the OECD 2008 shows the following steps:

Module 1 for tracing input flows into the economic system and disaggregation by materials and material categories.

Module 2 for expanding Module 1 by adding information on output flows to establish simple material flow balances.

The simple resource efficiency of an economy can be measured by developing Module 1 and 2.

Module 3 to disaggregate material use by different economic sectors.

Module 4 to address hidden flows associated with imports (and to exports).

Module 5 to address the side effects of the extraction of materials or environmental impacts from material consumption and extraction.

Module 6 to assess the changes in material stocks in a national economy.

These are still on-going efforts by researchers and experts, especially Modules 4-6 are still under development.

08 Merits of implementation

Unless material flows are monitored on a regular basis, it is difficult to design policies for improved resource efficiency and impossible to assess whether such policies are effective.

09 Material flow accounting and its application

The following section is based on the OECD Working Group on Environmental Information and Outlooks (WGEIO) special session on material flow accounting.

I. The experience of Japan

The MFA was studied mainly in response to the domestic issue of increasing solid waste. A flow chart describing Japan's macroscopic material flow balance was published in the annual 'Quality of the Environment' report. In Japan, the MFA has already been used as a part of reporting on the state of the environment, and for the development of environmental indicators. Since 2003, Japan has introduced MFA based indicators to monitor the progress in its national efforts for establishing a Sound Material-Cycle Society.

Every year, the government monitor and check the trend and data of these indicators. And every five year, the Fundamental Plan including the targets based on these indicators is going to be revised. These targets are resource productivity (GDP/DMI), cyclical use rate (cyclical use amount/(cyclical use amount + DMI)], and final treatment of waste. In 2003 Japan introduced MFA-based indicators and policy targets for 2010 to monitor the progress of 3R implementation at the macro-level. Since it was likely to achieve these targets for 2010, new targets were set for 2015 in the second Fundamental Plan in 2008. Again in 2013 new targets were set for the third Fundamental Plan. Japan is also monitoring its TMR.

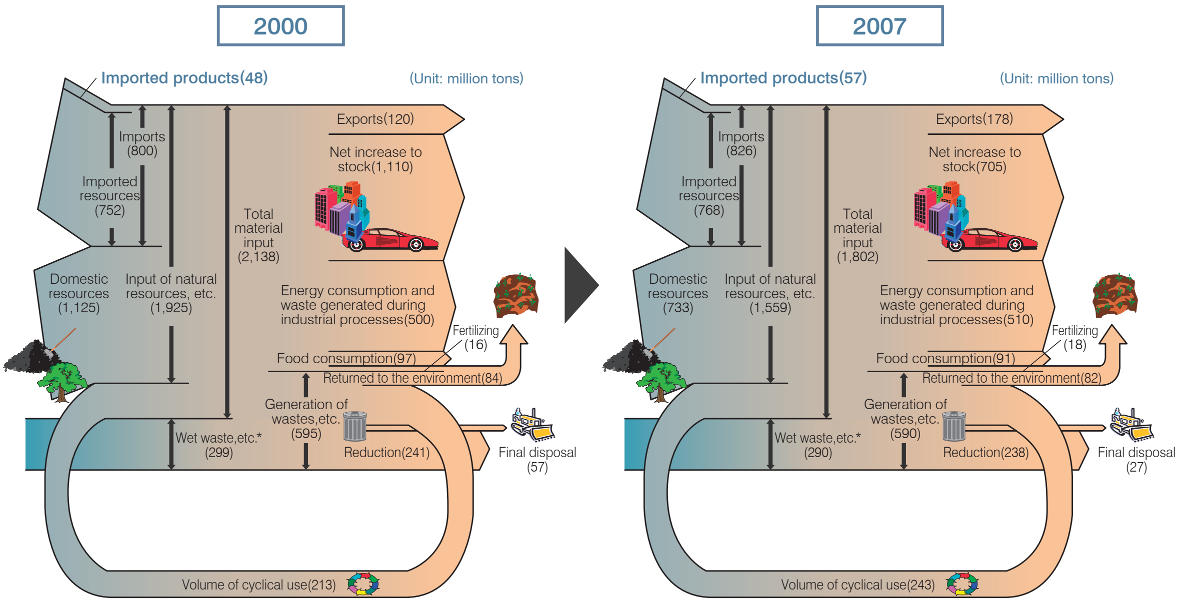
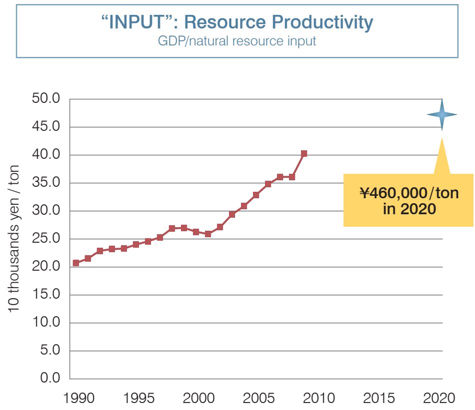
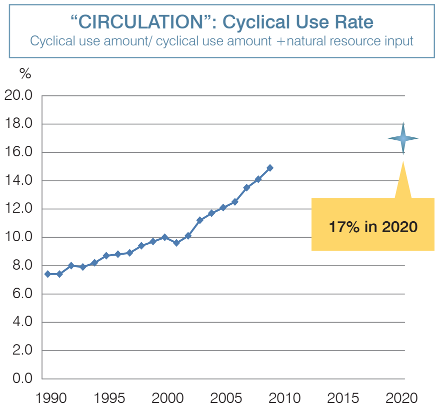


Figure 4: Material Flow of Japan (2000 and 2007)
Source: Ministry of the Environment of Japan (2011),





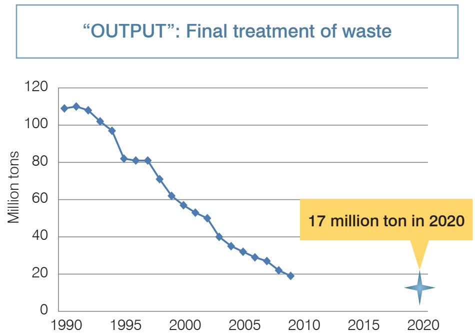


Figure 5: MFA-based indicators in the Fundamental Plan of Sound Material Cycle Society of Japan

Source: The 3rd Fundamental Plan for Establishing Sound Material Cycle Society (2013)

II. The experience of Canada (based on information of Statistics Canada)

The Material and Energy Flow Accounts (MEFA) record in substantial detail the annual flows of materials and energy—in the form of resources and wastes—between the Canadian economy and the environment. The accounts record the quantities of natural resources produced (that is, harvested or extracted) by industries, households and governments, and show how these resources are consumed by these same agents. Likewise for wastes, the accounts show the quantities produced by each agent and how these wastes are "consumed," either as recycled materials or as flows into waste disposal sites or to the environment. The MEFA share their classifications of industries, households and governments with Statistics Canada's Input-Output Accounts.

III. The experience of Sweden

Statistics Sweden developed material flow statistics for Sweden, with the objective of aggregating the description of the total material throughput for the society, as well as working towards eco-efficiency by improving resource productivity. The results contribute to provide a link between society's use of materials and natural resource accounting.

IV. The experience of the EU

Germany also monitors raw material productivity (GDP/DMI-biomass). The EU is also publishing a Resource Productivity Indicator for EU-27 countries (Eurostat 2012).

10 Application to developing countries in Asia and the Pacific

Aoki-Suzuki et al. (2012) suggests that the application of EW-MFA is still very limited in developing countries. It nevertheless has become a fast-growing field of research with increasing policy relevance (Bringezu and Moriguchi, 2001).

The Asia-Pacific Material Flows online databases of CSIRO and UNEP provide estimates of national total domestic extraction, DMC, and PTB For most countries in the Asia-Pacific region. These databases include indicators related to resource efficiency (GDP/DMC etc.) as well as four major and eleven detailed different categories of material-related data for extraction, DMC, and PTB between 1970-2008.
http://www.cse.csiro.au/forms/form-mf-start.aspx

In the developing countries surveyed by Aoki-Suzuki et al. (2012) a large number of organisations, including governmental bodies and academia, are collecting statistics relevant to MFA, but data collection is fragmented. There is a lack of coordination, and it is difficult to get an overview of existing data. Furthermore, there is still relatively low awareness among policy makers of the potential benefits of MFA.

Thus Aoki-Suzuki et.al. (2012) recommend increased international collaborative efforts that focus on the following: (a) establishment of national focal points for coordination of MFA data collection and compilation in each country; (b) development of case studies illustrating how MFA has provided policy makers with an improved basis for policy design and evaluation; (c) training and capacity development to harmonise data definitions and documentation formats, building on the work already done by the OECD and the EU; and (d) international collaborative research projects to further develop the capacity of academia and research institutes to analyse MFA data and effectively engage with policy makers.

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Ministry of the Environment

3R Policy Indicators Factsheets Series

Co-benefits of the 3Rs (reduce, reuse and recycle) of municipal solid waste on climate change mitigation

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Nirmala Menikpura Institute for Global Environmental Strategies (IGES), Japan
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01 Outline of indicator

Greenhouse gases (GHG) from the waste sector are estimated to account for almost 5% of total emissions (Hoornweg and Bhada-Tata, 2012), and this amount is predicted to increase due to increasing waste generation and upgrading of final disposal sites from open dumping to sanitary landfill without gas recovery system in developing Asian countries (Sang-Arun et al, 2011). Methane (CH_4) is the major GHG from the waste sector and it makes up approximately 18% of the anthropogenic CH_4 (Bogner et al, 2008; Agamuthu and Fauziah, 2013)

The amounts of GHG emissions from municipal solid waste can be minimised through the 3Rs (reduce, reuse and recycle). However, it is very difficult to quantify the contribution from "reduce" and "reuse". Therefore, the discussion on GHG emissions reduction from solid waste management generally focuses on how to avoid landfilling of organic waste, maximise the use of organic waste (e.g. as animal feed, soil amendment, biogas for alternative energy), capture landfill gas for energy use, and avoid burning of plastic waste, etc. (Sang-Arun et al, 2011; Menikpura et al., 2013). Good examples of local actions on mitigating climate change from solid waste management can be seen in most of the countries but mainly on a voluntary basis (see Figure 1 for examples). Furthermore, many of those cities do not have a clear understanding about their contribution to climate change mitigation.

Factsheets Series on 3R Policy Indicators
This project is conducted by the Asia Resource Circulation Policy Research Group, a collaborative research group focused on policy research on 3R promotion in Asia; coordinated by IGES with the participation of researchers from IGES, IDE-JETRO, NIES, University of Malaya, Asia Institute of Technology, Bandung Institute of Technology, Tokyo Institute of Technology and UNCRD.

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The indicator "co-benefits of the 3Rs (reduce, reuse, recycle) of municipal solid waste on climate change mitigation" aims to maximise the use of resources which can significantly contribute not only to reducing GHG emissions but also to receiving other co-benefits. These benefits include creating green jobs, improving social well-being, reducing health risks, enhancing economic development, saving landfill space and minimising environmental loads from landfill of fresh waste or incineration.

Figure 1: Some examples of 3Rs-climate friendly waste management practices

02 Type of indicator

Quantitative indicator.

03 Policy goals to be monitored by this indicator

This indicator can monitor the achievement of Goal 2 and Goal 18 proposed under the draft Ha Noi 3R Declaration on Sustainable 3R Goals for Asia for 2013-2023. The quantitative indicators selected for this integrated Goal are:

- Amount of annual GHG emissions from municipal solid waste management
- Amount of annual GHG emissions reduction from municipal solid waste as compared to the base year – based on direct emissions reduction
- Amount of annual GHG emissions reduction from municipal solid waste compared to base year – based on a lifecycle perspective

In light of the potential GHG emissions reduction through the utilisation of waste, the following quantitative indicators would also be useful to identify the magnitude of the GHG emission reduction based on the type of technology:

(1) Annual direct GHG emissions from each type of technology: open dumping, landfill, composting, anaerobic digestion, incineration, material recycling

(2) Annual GHG avoidance potential through resource recovery based on a lifecycle perspective for each technology

(3) Annual net GHG emissions (calculated by subtracting the GHG avoidance potential from direct GHG emissions) for each technology

04 Definition and scope

- Municipal solid waste refers to waste that has been discarded from households or business entities, and that falls under the responsibility of local governments. Detailed definitions of each country's municipal solid waste may be different.
- Organic waste refers to discarded waste that can be easily biodegraded. This often refers to food, plants, animal residues and products that are made of these materials, such as paper and biodegradable plastic.

- Material recycling refers to the recovery of materials from any kind of recyclables, excluding organic waste.
- Direct GHG emissions refers to the amount of GHG emissions that may be released during the biodegradation, combustion or processing of waste (utilisation of fossil fuel or fossil based electricity) under different treatment options, such as the transportation of waste, landfill, composting, anaerobic digestion and incineration (Figure 2).
- The lifecycle perspective refers to the accounting for both direct GHG emissions (e.g. those released during the biodegradation of organic waste, combustion or utilisation of fossil fuel for waste processing) and indirect, downstream GHG savings (e.g. avoided GHG emissions from landfill of organic waste, avoided chemical fertiliser usage due to the production of compost) throughout the life cycle (Figure 2).

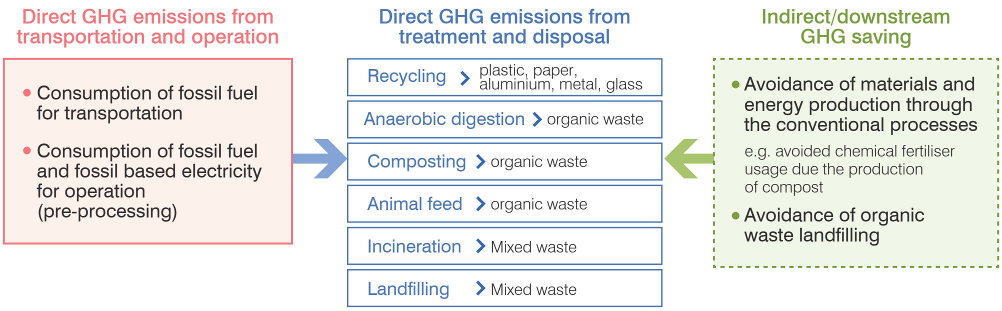

Figure 2: Outline of direct and indirect GHG emissions from different treatment options in the life cycle perspective

05 Policy instruments useful for promoting 3R implementation for climate change mitigation from municipal solid waste management

- Economic instruments are important for promoting 3R implementation for climate change mitigation from municipal solid waste management at the local level. Creating market demand for products or recovered resources from solid waste such as compost, biogas, electricity and recycled materials is important to encourage the implementation of the 3Rs. In addition, the use of a feed-in tariff and use of the carbon market would act as key drivers to encourage residents, communities, entrepreneurs and investors to implement the 3Rs.
- Introduction of appropriate cost-effective technologies, applicable at the local level, and their effective integration.
- Encouraging local investment and private businesses to make use of organic waste and carry out material recycling nationwide. Intervention from national governments, private sectors, NGOs and academia would increase awareness and the capacity of local governments and communities to implement the 3Rs and minimise the waste that is sent to landfills.
- Public education on improper waste management and its impact on climate change. Awareness-raising and capacity building on the benefits of sustainable waste management, including climate change mitigation as a reward for promoting the 3Rs. Introducing such education into school programmes and the media could also motivate social movement on the 3Rs for climate change mitigation.

06 Merits of implementation

- Increasing the utilisation of waste by diverting organic waste and recyclable materials from the final disposal site can significantly reduce GHG emissions and also generate several other benefits. These benefits include saving landfill space, reducing the budget for disposal site management, extending the lifetime of a landfill, reducing environmental contamination, reducing local health hazards caused by various emissions and disease carriers, creating green jobs and income based community well-being, circulating resources to fulfil social needs and contributing to world finite resource savings.
- The promotion of waste separation at source for material recycling and household or community based organic waste treatment can significantly reduce local authorities' waste collection and disposal workload so that they can provide more satisfactory service to the community.
- The use of organic waste for composting or anaerobic digestion can contribute to the national agenda on food and energy security as well as enhancing organic farming practice. Furthermore, organic waste utilisation and material recycling can contribute to the national agenda on poverty reduction, green economy development and resource circulation.

07 Similar indicators and supporting indicators

- Reduction of waste generation per capita
- Reduction of the annual amount of waste sent to open dumping and landfill
- Quantity of compost production that is available for soil amendment from municipal solid waste
- Quantity of recovered recyclable materials available to recyclers
- Amount of energy (bio gas or electricity) recovered from solid waste
- Number of employment opportunities created in organic waste utilisation and material recovery business
- Numbers of material recovery centres including composting, anaerobic digestion, waste separation facilities, recycling facilities etc.

08 Methodology of data collection and calculation

- The amount of annual GHG emissions and reductions from municipal solid waste management can be estimated by using the IPCC (IPCC, 2006) and Life Cycle Assessment (LCA) guidelines (Guinée, et al., 2001; Gentil et al, 2009). For this estimation, local authorities or designated stakeholders need systematic data collection. The basic data that is needed is the amount of waste by weight sent to each treatment facility; waste composition; amount of fossil energy used for waste collection, transport and processing; and amount of products recovered from each treatment or material recovery centre. Other data requirements, such as the emissions factors required to estimate the direct emissions, are listed in the IPCC Guidelines. Additionally, a list of the required data for lifecycle GHG estimation from individual treatment technologies is available in the IGES manual for the GHG calculation tool (Menikpura and Sang-Arun, 2013).

09 Challenges and concerns

- Many local authorities do not pay attention to proper data collection. Many of them do not have an on-site scale to measure the amount of waste that is received at the facility. Visual estimations, made by each authority, of the amount and composition of waste are subjective and without any scientific or experimental support. For an accurate estimation it is essential to have an accurate account of the amount of waste received at facilities. Training on measuring and estimating the amount and composition of waste is necessary to improve the accuracy of data collection. These GHG emissions estimation results can then be used when selecting proper waste management practices.
- In addition, local authorities are not aware of the importance of record keeping on the use of other resources, such as fossil fuel and electricity consumption for different treatment options and the types and amount of recovered resources. Such information is very important for accurately estimating GHG emissions and therefore local authorities should pay attention to recording such data systematically.
- It is best to keep collecting and recording data every day. However, this practice may not be possible in small cities due to a lack of budget and human resources. Therefore, the infrequency of data collection can be justified as being necessary to minimise the burden on local authorities but, consequently, the accuracy will be decreased.

10 Appropriate data management by stakeholders

- Generally, the local authorities should collect and maintain the data on a systematic basis. Data from each local authority should then be submitted to the regional and national authorities (which vary among countries) on an annual basis in order to develop a country's inventory database. Such frameworks can be developed based on a national administrative system.
- Estimation of GHG emissions can be carried out based on a monthly or annual basis depending on the capacity of local authorities. The national authority or designated stakeholders may take this role in countries where the local authorities do not have the necessary capacity to carry out these estimations. Local authorities could reduce their burden of time management and skill development for such assessments by using tools that have already been developed (e.g. IGES GHG calculator).

11 Direct and indirect impacts

- Improper practice at the material recycling facility or organic waste treatment facilities may become a public nuisance and cause environmental impacts, such as air, water and soil pollution. Standards or guidelines are required to ensure the proper handling of waste and the management of these facilities.

12 Existing practices on GHG accounting and mitigating targets

- All countries need to submit national communications of national GHG inventories to the United Nations Framework Convention on Climate Change (UNFCCC)
- Development of a joint credit mechanism between Japan and developing countries
- Clean development mechanism (CDM)
- Nationally appropriate mitigation actions of developing countries (NAMAs)

13 Conclusion

Implementing these quantitative indicators for climate co-benefits would be an important step in sustainable waste management since this initiative can directly contribute to improved waste management as well as targeting GHG reductions. However, the local authorities need to collect and maintain data systematically to estimate GHG emissions. Furthermore, this activity can directly contribute to the mandatory requirement of the UNFCCC regarding national communications and international negotiations on climate change.

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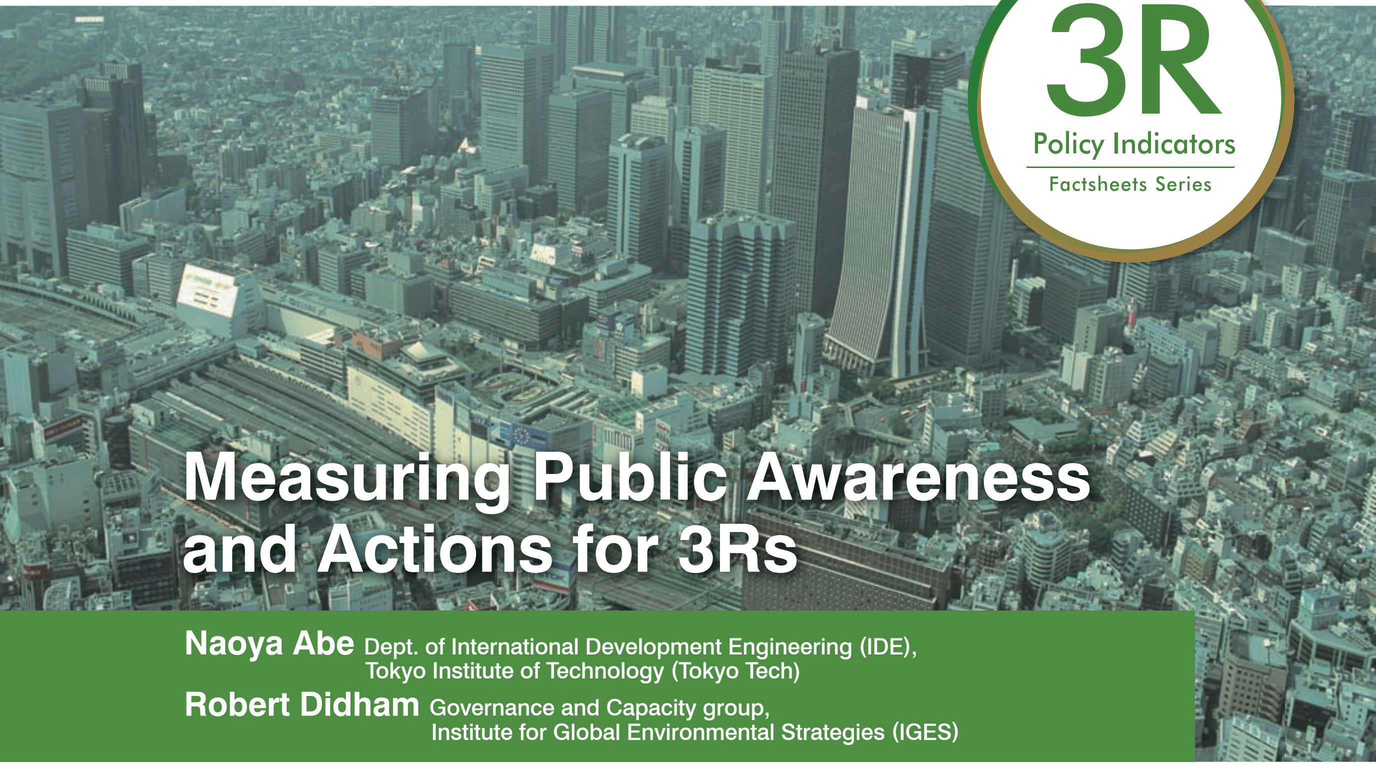

Measuring Public Awareness and Actions for 3Rs

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01 Background

Public awareness of appropriate solid waste management practices (3Rs; Reduce, Reuse, Recycle) is the starting point for and fundamental ingredient of a sound material-cycle and resource-efficient society. Public awareness forms the basis of public capacity, which enables the public to undertake actual actions of each element of the 3Rs. Such actions consequently become the inputs for the advancement or "performance" of 3Rs for a sound material-cycle society.

Central and local governments, environmental NGOs, entrepreneurs, mass-media, and others all influence public awareness through their policies, practices and operations, which as a whole leads to "capacity development", as portrayed in figure 1. How public awareness and the related actions can be increased forms the focus of this factsheet.

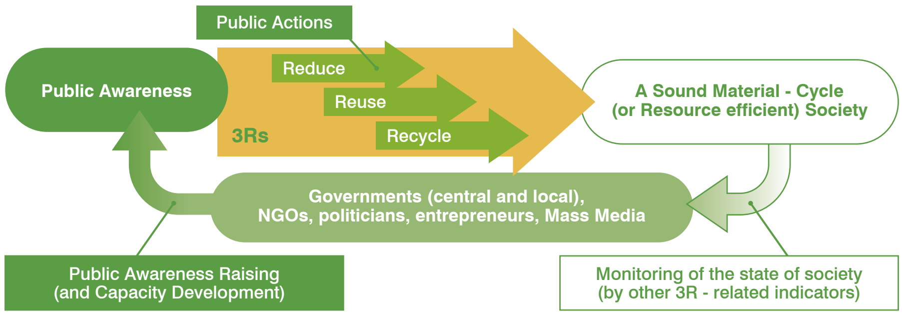

Figure 1. Schematic diagram showing interrelationship of public awareness and actions

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Subject to further revisions

02 Definition

This factsheet uses following definitions:*

Public - all individuals within society: ordinary citizens, state and municipal government officials, politicians, NGO staff, business executives and employees, including small and medium enterprise (SMEs) owners (see figure 2). In order to discuss "awareness", we cannot exclude any individuals who have opinions on the environment—all opinions count.

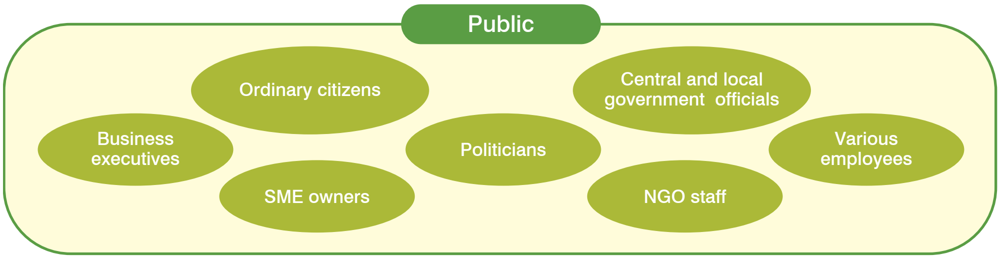

Figure 2. Scope of the term "the public"

In order to define "Public Awareness", it is useful to define other related terms. And while such terms may also very in meaning, the following are applied in this material. In particular, in light of proposed Goal 19, which broadly states public awareness as to "[R]aise public awareness on the 3Rs, sustainable production and consumption, and resource efficiency, leading to the behavioural change of the citizens", we go one step further in elaborating on this definition; see figure 3.

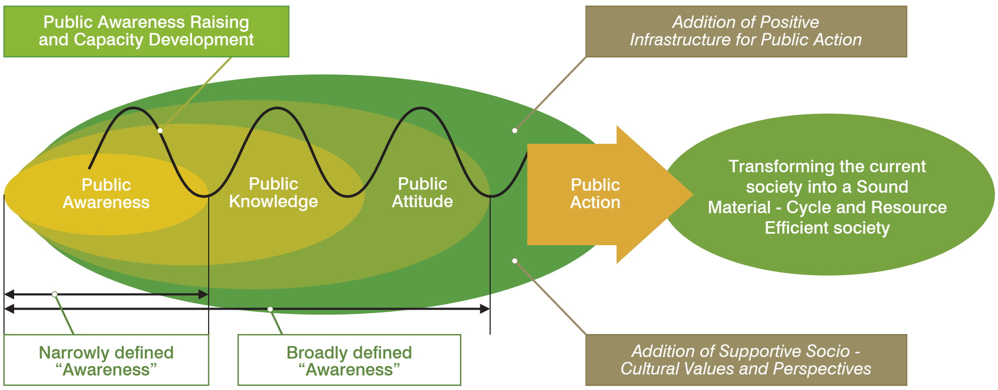

Figure 3. Hierarchy of "Awareness"

* The difference between 'public actions' and 'public participation' needs commenting on; while public actions are civic responses against certain external stimuli concerning the 3Rs, public participation usually refers to citizen engagement in governmental decision-making, policy formation, and planning processes. Public participation is a highly sensitive concept in politics, as there are many forms of participation, ranging from public comments to active planning methodologies, and from the less legitimate to the more legitimate (i.e., Arnstein's Ladder of Citizen Participation).

Public Awareness – acquired knowledge and concerns of individuals concerning 3Rs, sustainable production and consumption, and resource efficiency.

Public Knowledge – acquired experience and basic understanding of individuals concerning 3Rs, sustainable production and consumption, and resource efficiency.

Public Attitude – acquired values, expression of concern and interests, and motivation of individuals for actions concerning 3Rs, sustainable production and consumption, and resource efficiency.

Public Action – actions taken by individuals in regards to their behaviours, consumption choices, and lifestyle practices to accommodate or support 3Rs, sustainable production and consumption, and resource efficiency.

Public Awareness Raising – providing information and knowledge to individuals to increase their awareness of an important social issue (i.e., 3Rs) and how they can take positive actions to address this issue; usually conducted by governments, NGOs, civic organisations, or private firms.

In Figure 3, an ideal conception of Public Awareness Raising activities is presented that moves beyond a narrowly defined understanding of public awareness towards a complex and dynamic understanding that conceptualizes public awareness (knowing a subject) as part of a continuum which also includes public knowledge (understanding the subject), attitude (acquiring the values, concerns, and motivation about the subject) and action (taking actions that contribute to the subject). This can contribute to the transformation of the current society into a Sound Material-Cycle and Resource Efficient society by acknowledging the progressive movement towards enabling public action. However, it must be acknowledged there are also several external factors that influence progress along this continuum, and as such increased public awareness and attitudes are not always sufficient to result in the desired public action. A wider perspective is necessary to consider how external factors including the existence of a good infrastructure for positive practice and supportive socio-cultural trends and perspectives also strongly influence the achievement of public action, with the key purpose of integrating both the internal and external factors into a holistic impact strategy.

03 Targets of measurement

The target of measurement for Public Awareness and Actions are defined as shown in table 1. Sometimes the distinction between Public Awareness and Public Actions may be ambiguous; for example, implementation of environmental or 3R educational programmes at an elementary school can be regarded as "Public Actions" while the action can also be regarded as realising Public Awareness; Institutional intention as a school.

Public Awareness	Public Actions
Public **knowledge** concerning 3Rs, Resource Efficiency, or environment. If we broadly defined Public Awareness, then the term covers not only knowledge but also **experience, understanding, and motivation** on 3Rs, Resource Efficiency, or environment in general. >> See figure 3	**Practices or actions** by individuals, governments, private firms, civic organisations, and entrepreneurs, etc., towards Reduce, Reuse, Recycle (3Rs). Various forms of 3R activities are possible.

Table 1. Measurement Targets of Public Awareness and Actions
(Source: authors)

In the context of developing countries, awareness of central and local government officials and the owners of SMEs are particularly important.

04 Methods of measurement

For the methods of measurement of Public Awareness or Public Actions, a summary is given in table 2. Data collection requires access to individuals and actions on-site. For this purpose, a questionnaire can be distributed to potential respondents. Having considered several conditions in developing countries, **a face-to-face survey with a structured questionnaire** is the most realistic and effective, but also costly. To this end, the survey staff actually making contact with respondents should be well-trained as they need to maintain consistency as regards to how they explain and raise questions. The use of visual materials such as photos or videos, to explain the 3Rs would help respondents comprehend questions in the survey.

The format of survey questions can be one that simply poses dichotomous questions (i.e., answerable with yes or no) or measures how conversant a respondent is on a certain subject based on questions employing the Likert-type scale response (on a scale of 1 to 5). For example, if you want to know how often a respondent follows the waste separation rule, apply the Likert-type scale shown in figure 4:

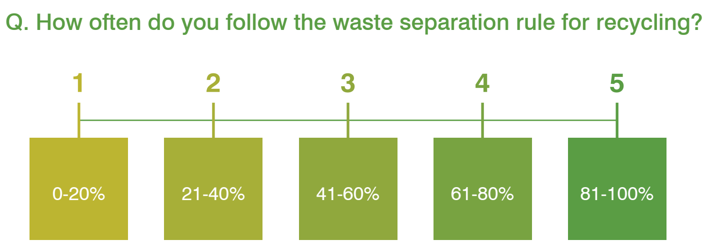

Figure 4. An example of a Likert-type question and response

As another example, the question could be: "Could you please list the main individual categories for household waste separation?" If the given locality using this question has five categories for waste separation, then answers can be scored based on what percentage of the categories respondents can identify.

Generally, for survey and questionnaire research investigating public awareness, knowledge and attitudes, it is considered best practice to always have at least one additional question, framed slightly differently, that cross-checks the answer of the original question. For example, the question "How often you follow waste separation" could be cross-checked by a Yes or No question such as: "Do you regularly practice recycling and waste separation?"

Public Awareness	Public Actions
Social Survey – questioning of public knowledge and attitudes on primary areas. Responses should be recognised as subjective judgements of the respondents. It is essential to pilot the survey in advance of full-scale application in order to check whether or not a questionnaire is appropriate and to tweak the format. Do not underestimate the time and effort involved in designing an appropriate questionnaire format. **A baseline survey** is important, which allows monitoring of the progress or change over time. It is also possible to conduct simple knowledge surveys before and after specific awareness-raising events in order to evaluate the direct benefits of a given initiative. **"Do you know" type questions** can be used to measure awareness. By raising several questions, we can identify the extent of knowledge (or percentage) concerning the 3Rs. You may want to attribute one point for a single question if an individual says "Yes, I know" and total the points for each person. **Scale of 5 Likert-type questions** can be used to measure knowledge and attitudes. Dichotomous questions (i.e., answerable with Yes or No) are also possible. In such case, "if yes, why"-type questions should follow to obtain supporting information to reveal what interventions are most needed for making future improvements to the system. Examples of surveys of Public Awareness by the European Environment Agency, International Union for Conservation of Nature (IUCN), Department of Conservation New Zealand, and Ministry of Environment Japan appear in the reference list. It is important to note that the questions in the examples are sometimes not only about narrowly defined "awareness" but also about attitudes and actions (i.e., broadly defined "awareness"). For details on survey design, for example, see King, Keohane, and Verba (1994) and Groves, Fowler, Couper, et al. (2009).	**Indicators** can be: **- Number of households composting their own garden waste** **- Amount of material sent to municipal composting** **- Number of categories of waste for separation** **- Total reduction amount of Household Waste** **- Total amount of recycled waste** **- Number of NGOs which are active in 3Rs** **- Number of schools where environmental education for 3Rs is conducted** **- Number of shops which support 3Rs activities in a locality** These figures can be obtained through either using existing statistics or actually observing such actions in-situ. Given the fact that environmental statistics are less often collected and maintained in many developing countries, site surveys may generally be required. The information and data collected should be as objective as possible but we may need to rely on subjective responses. *Additional Note*: Along with addressing questions regarding knowledge and attitudes on the 3Rs and resource efficiency, the social survey used to measure public awareness could also include questions on individual practices on the types of actions included in the above indicators, though this should not substitute for the above quantitative indicators; rather, it is an opportunity for cross-checking the relevance and accuracy of collected data.

Table 2. Methods of measurement
(Source: authors)

05 Caveats for measurement

A social survey provides a straightforward, clear way of measuring levels of public awareness; however, responses can be **sensitive to the way questions are framed (worded)**. **Questions should thus be posed in a neutral and non-leading manner.**

One of the goals of conducting public surveys is to enable chronological comparisons; we usually hope to see how a certain situation (i.e., in the context of this factsheet, the level of public awareness) progresses over time with application of certain appropriate public awareness raising initiatives, based on the establishment of an initial baseline and comparison against that baseline in subsequent surveys. However, use of the same individuals over time is often difficult as people can move into and out of a given survey area. Thus, it is important to be clear on what is being measured and how comparisons are made. A change in awareness in individuals may be measured over short-term periods in relation to specific interventions or awareness raising events, while over longer-term periods it is more feasible to measure the aggregate level of public awareness and also the extent of standard deviation in individual awareness levels.

It also needs to be understood that if a social survey is used, it is possible to ask direct questions about practices, but this can lead to exaggerated responses and only receiving answers that represent the ideal, i.e., what you want to hear. Thus, clear use of figures as mentioned above is more trustworthy than open-ended questions.

If a social survey and household performance (i.e., public action) indicators are used in conjunction, it is possible to 1) demonstrate performance, 2) identify gaps in achievement against pre-determined goals, and 3) identify appropriate interventions for addressing these gaps (at least to a relatively effective level). Potentially for appropriate interventions, a certain amount of interplay between awareness inputs (see indicators in section 6) and knowledge gain (as the social survey provides) to identify what is and is not working with a given awareness raising approach would be beneficial. If only a social survey is used, then in effect we can only glean information on awareness raising but not on practice and achievement. While household performance indicators demonstrate practice and achievement, but do not allow extrapolation of cause and effect.

Statistically speaking, random sampling is always a central concern and hurdle for researchers in terms of extrapolating meaning from statistics as it involves questions of legitimacy of representation in terms of characteristics of populations related to the question on what we want to know or measure. Practically speaking, conducting a strictly random sample without due attention to this point can be highly challenging. At the same time, it is important to note that a social survey need not solely be statistical and quantitative in nature and can be qualitative. This returns us to the central question as to what exactly it is that we want to know or measure.

06 Significance of Public Awareness Raising practices

Since the level or state of public awareness is critical in the context of the 3Rs, central or local government officials, NGOs staff, or private sector executives, will naturally need to consider how the level of the awareness of individuals can actually be raised. To this end, it would be helpful to lay out several possible measurement indicators, as exemplified below:

- **Number of existing programmes for 3Rs at local and national levels**
- **Number of NGOs or civic organisations which are active in 3R promotion**
- **Number of awareness raising events held**
- **Number participants in such events**
- **Number (or frequency) of awareness raising materials distributed**
- **Number of schools conducting environmental education**

Unfortunately, there are no objectively perfect or ‘correct’ measurement indicators. Used on their own these indicators do not “indicate” anything; they should be used together with a clear vision, plan, as well as leadership of how 3Rs can work and contribute to a community and beyond. In a simple conceptual formula, the significance of public awareness raising should be shown as in Equation 1. As it implies, any efforts without substantial commitment by the corresponding action initiator would only result in marginal effects. See [Box. 1] as an example of public awareness raising.

Signifiance of public awarenss raising
=
{Value of an appropriat e indicator to measure the magnitude of awareness raising activites}
×
{1 if there is a clear visi on or plan of what 3R policy aims to achieve; otherwise 0}
×
{1 if there is clear linkage of how awarenss raising is related to 3R plan; otherwise 0}
×
{1 if there is clear leadership to implement 3R policy; otherwise 0}

... (Equation 1)

Box. 1 An example of Public Awareness raising: a case of Nagoya city, Japan

The city of Nagoya, with a population of about 2.27 million (2012; fourth largest city in Japan), is located in the centre of Japan. In the 1990s it faced a serious challenge in the operation of a final landfill site. It was estimated that the city's sole landfill site would be full by the year 2000. As a solution, the city planned to construct a new landfill site on the coastal area owned by the city. The proposed construction site was a wetland—a rich feeding ground for migrating birds known as "Fujimae-wetland", which later became a designated site under the Ramsar Convention in 2003. Several environmental NGOs and many citizens recognised the importance and the value of the wetland and strongly opposed construction of the new landfill site, despite the presence of the serious waste situation.

Eventually, in 1999, the city abandoned its construction plans, which left a crisis management situation for the city mayor, who was faced with the need to dramatically reduce the amounts of municipal solid waste sent to the existing landfill site and extend the life thereof to the extent possible. For that purpose, the city adopted a new and drastic waste management policy, including very detailed separation of waste for recycling. Concurrently, the city conducted a number of public campaigns and sessions to explain the reasoning behind the radically new waste policy and what the city was trying to achieve. The brevity of the city's efforts, taken together with that of the various NGOs and highly motivated citizen to mobilise the city toward a new waste management policy is a good example of public awareness raising actions. For more information, see Okayama (2007) or Barrett (2008).

07 Conclusion and concerns

While the proposed ideas above are in general applicable to any country, special attention should be paid to the context of developing countries, as follows.

First, many developing countries are limited in terms of budgetary constraints, which means that conducting statistically relevant social surveys can be quite a challenge. As stated in table 2, in order to set a baseline and to continue comparative surveys, securing the necessary budget and **"awareness" of governmental officials** is important.

Second, the **"capacities" of either the public officials or non-governmental staff conducting surveys and subsequent statistical analysis of the collected data** are crucial in determining the state of public awareness and actions. In particular, those with strong public relations skills (i.e., local officials and field-oriented NGO staff) are needed. In such context, social surveys conducted jointly by local government and local or foreign universities or research institutes would link governments with academia and enable coordination with experts in carrying out surveys.

Third, **gradual steps or a "tiered approach"** would be useful in gauging public awareness, as achieving all desirable qualifications (e.g., number of questions and size of respondents) in one go could represent quite a challenge due to the many constraints and uncertainty factors which could hinder the measurement process. Thus, developing this process in incremental steps would assist in monitoring public awareness over the long term. If the collection of data and information are the end rather than the means, then this squanders whatever resources are available.

Fourth, **data and information collection processes for gauging public awareness should not be understood as a goal; they should only be used as tools underpinning goals or in decision-making processes**, i.e., to improve performance of the 3Rs. If the process becomes routine and the collected data and information are misused or underused then all inputs and efforts may be in vain and the corresponding loss in opportunity (i.e., that which could have been gained for other purposes if budget was allocated to efforts for collection) is substantial, especially in developing countries. In respect of information per se, it is crucial to bear in mind the maxim *no use, no value*. See Abe, Morizumi, and Sasaki (2012) on the utilisation of air quality information in Japan, which underscores this point.

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Ministry of the Environment

3R Policy Indicators
Factsheets Series

The structure, content and implementation of green procurement

Jiangwen GUO Institute for Global Environmental Strategies (IGES), Japan

01 Outline of indicator

Agenda 21, which was adopted at the 1992 United Nations Conference on Environment and Development (UNCED Earth Summit), placed Green Purchasing as a key tool to both reduce environmental load and raise levels of sustainable consumption and production. Further, Goal 23 of the HaNoi 3R Declaration (Sustainable 3R Goals for Asia and the Pacific for 2013-2023) is to *Promote green and socially responsible procurement at all levels,* thereby creating and expanding 3R industries and markets for environment-friendly goods and products.

Along with the growing severity in global environmental issues over recent years is the awareness among the international community for societal development based on a sound, sustainable economy. This can be realized through developing environmentally friendly goods and services via support from governmental administrative organizations, NPOs and businesses.

Green Purchasing, which places priority on environmentally preferable goods and services, is a key measure for developing environmentally friendly goods for the market through environmental management, and placing environmental consciousness into the mindset of consumers. It also embraces the issues of social policy, such as inclusiveness, equality and diversity targets, regeneration and integration. On the macroeconomic level, economic benefits can be realized in the form of efficiency gains from incorporating whole-life costing into decision making. The creation of sustainable markets is essential for long-term growth, and sustainable development itself fosters innovation. On the microeconomic level, green procurement can also aid in economic redistribution—with potential targets including job and wealth creation and aid for small businesses, including those owned by ethnic minorities.

Factsheets Series on 3R Policy Indicators
This project is conducted by the Asia Resource Circulation Policy Research Group, a collaborative research group focused on policy research on 3R promotion in Asia; coordinated by IGES with input from researchers from IGES, IDE-JETRO, NIES, University of Malaya, Asia Institute of Technology, Bandung Institute of Technology, Tokyo Institute of Technology and UNCRD.

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Subject to further revisions

02 Type of indicator

Qualitative Indicator, Response Indicator

03 Policy goals to be monitored by this indicator

This indicator enables monitoring of the life-cycle policy principle via "decrease, re-use, recycle and innocuous-treatment" in production and re-production, to improve eco-efficiency, maximize economic output from the minimum energy and resource inputs, and reduce pollution. Impacts span the entire product life cycle—manufacturing, transportation, use and recycling or disposal—instilling sustainable production and consumption practices and unifying the economy, environment and society. Also important in green procurement are the tools used and the means of implementing laws and policies.

Institutional arrangement and policy development

- Central government needs to initiate a framework to efficiently promote green procurement as a tool for fostering social inclusion, equality and environmental objectives throughout society.
- Policies could take the form of laws, regulations or guidelines.

Application

- Central government: In the field of spending and investment, sustainable procurement typically follows the needs within sustainable development. In this respect, and in light of dominant socio-economic and environmental concerns such as globalisation and climate change, governments are increasingly concerned that actions meet the needs of the present without compromising the needs of the future.
- At the market level, sustainable procurement is typically instrumental: authorities seek to address policy through procurement. Green procurement can help local governments save money, create local green jobs and improve their environmental sustainability; however, support—as well as the provision of toolkits—must be extended to local governments, especially when revenue concerns differ between central and local government, in the development of localized green procurement policy.
- Sustainable procurement is mutually applicable to private and public sectors, and proponents aim to extend application thereof across all facets of the economy.

Approach

- The basic mode of selection is Life-cycle analysis, as used in, e.g., eco-labeling of certificated products and services. Efficiency, waste, recyclability and material composition must be included in the analysis. Services need to account for the total environmental impact of the equipment utilized in performing such services, as well as any impact of the services themselves.

04 The list below provides an example form of reporting on the status of preparation, development and implementation of green purchasing

Example report template on status of green purchasing policy

- Policy name and issue date
- Policy category
- Leading authority of the policy
- Main/supporting authority(ies) of the policy, including central and local government
- Selection approach
- Selection criteria
- List of target product/services
- Update status of the product/services list for selection
- Economic scale of product and services for green procurement

05 Supporting indicators

- Green procurement evaluation system
- Green procurement training system

06 International practices

In the EU, Germany was the first country to embrace green public procurement (1980s), followed by Denmark (1994), France (1995), UK and Austria (1997) and Sweden (1998).
In Asia, Japan issued the Green Purchasing Law in May 2000 to promote domestic green procurement, which requires all central government bodies to practice green purchasing and make records of such public.

In China, central and provincial governments are required to prioritize environment-friendly products according to a green product inventory as of 2007. The list includes products approved by the China Certification Committee for Environmental Labeling and Energy Efficiency Certification Labeling bodies. Products must meet the specified environmental protection and energy saving standards.

In Korea, the Promotion of the Purchase of Environment-Friendly Products Act of 2005 requires public agencies at national and local levels to publish and enact green procurement policies and implementing plans and to report the results.

In Thailand, the "Government Management Plan" endorsed by the Cabinet in January 2008 required all agencies to buy green products within four years. All government agencies (department level) were obliged to purchase green products before 2011 (increasing in participation from one quarter of agencies in 2008 to all in 2011).

07 Laws and guidelines in selected countries and organisations

United Nations

- UN sustainable procurement guideline

European Union

- Public Procurement Legislation

Japan

- Green Purchasing Law (May, 2000)
- Basic Policy on Promoting Green Purchasing (Updated annually, last updated Feb., 2012)

Korea

- Act on the Promotion of the Purchase of Environment-Friendly Products (July, 2005)

China

- Government Procurement Law (Jan., 2003)
- Cleaner Production Promotion Law (2002 issued; 2012 revised)
- Circular Economy Promotion Law (Aug., 2008)
- Notice of State Council on Printing and Distributing the Comprehensive Work Scheme of Energy Conservation and Reducing the Discharge of Pollutants (May, 2006)
- GPP has been adopted into China's 12th five-year plan on national economic and social development

United States

- EPA's Final Guidance on Environmentally Preferable Purchasing

Circular Economy Promotion Law of People's Republic of China

(Date Issued: 29-08-2008; Effective Date: 01-01-2009)

This Law is formulated to promote development of the circular economy, improve resource utilisation efficiency, protect and improve the environment and realize sustainable development.

- "Circular Economy" refers to activities of decrement, recycling and resource recovery in production, circulation and consumption.
- "Decrement" refers to reduction in resource consumption and waste generation in production, circulation and consumption.
- "Recycling" refers to the direct use of wastes as products, or the use of wastes as products after repair, renovation or reproduction, or the incorporation of wastes, in whole or in part, into other products.
- "Resource recovery" refers to the direct use of wastes as raw materials or waste regeneration.

A comprehensive policy and law/regulation system exists for promoting development of the circular economy; China's 12th Five-Year-Plan on national economic and social development also incorporates the circular economy.

08 Conclusion

Promotion of the 3Rs requires a market for green and recycled products and materials be established. To bring this about, green purchasing and procurement policy could be mainstreamed to promote the 3Rs in an economically viable manner by highlighting its contribution to the green economy. Cross-border sharing of information on the framework, content and implementation of green procurement would enhance and expand economic incentives for promoting 3R-related goods and services in Asia.

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