OECD GLOBAL FORUM ON ENVIRONMENT

Focusing on

SUSTAINABLE MATERIALS MANAGEMENT

25-27 OCTOBER 2010, MECHELEN, BELGIUM

Policy Report 1

Policy Principles for Sustainable Materials Management

Working Document

OECD Environment Directorate, OECD, 2010

NOTE FROM THE SECRETARIAT

The purpose of this report is to identify broad policy principles ("framework conditions") – based on the need for efficiency, cost-effectiveness, and social acceptability – that can help OECD countries move forward in developing and implementing Sustainable Materials Management (SMM) policies and instruments specific to their own policy contexts.

It has been prepared for the OECD Global Forum on Sustainable Materials Management to be held in Belgium from 25 to 27 October 2010.

Together with the two other policy reports (*Setting and using targets for SMM* and *An overview of available instruments for SMM*), this report on *Policy Principles for SMM* will serve to fuel the discussion of Session 4 of the Global Forum related to Policies for implementing SMM.

It has been prepared by Dr. Lauren Heine, Lauren Heine Group, LLC, Bellingham, WA, and Mr. Marc Major, Clearwater Strategy, LLC, Los Angeles, CA.

This project was made possible though financial contributions from Japan, Switzerland and the United States.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction

Sustainable Materials Management (SMM) is a relatively new approach that represents a shift from waste management to materials management in support of sustainable development. Historically, governments have focused on managing wastes as a means of managing the impact of materials on the environment. While much success has been achieved with waste management policies, research has shown that waste management is often not the key process, nor is it the most efficient and effective process, for controlling material flows in the industrial and economic systems. While materials do have an important retention function, including for GHG emissions, it is important to consider the whole economy, of which waste management is a part, and to focus on material flows. SMM elevates the focus of governments, industry and consumers from individual material, product or process attributes, to the entire system of material flows and associated life-cycle impacts.

The purpose of this paper was to identify broad policy principles ("framework conditions") – based on the need for efficiency, cost-effectiveness, and social acceptability – that can help OECD countries move forward in developing and implementing SMM policies and instruments specific to their own policy contexts. The importance of this document lies in the fact that underlying principles are often overlooked in policy making – yet they form the basis for many laws, polices and programmes.

Development of the SMM Policy Principles was based on the SMM working definition, on a literature review and on OECD member country input. Part of this report also focuses on how these principles can be, and have been, applied in OECD countries along with notable opportunities and challenges. Insights from the member country applications helped to illustrate and clarify how the SMM principles may guide policy development.

Results

Four broad SMM Policy Principles are proposed as guidance for specific governmental policies to shift the behaviour of economic actors and human societies toward meeting their material needs without destabilising natural systems. The report provides a description and rationale for each of the SMM Policy Principles along with suggested strategies for implementation and examples of national applications by OECD member countries.

Broad Policy Principles for SMM

The working definition of Sustainable Materials Management is *"an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity".*

1. Preserve Natural Capital.

- Natural capital is the source of materials needed to support life. It is comprised of natural resource stocks (minerals and metallic ores, energy fossil fuels, soil, water and biological resources), land, atmosphere and ecosystems.
- Sustainable materials management can contribute to the preservation of natural capital. Natural capital can be preserved by increasing resource productivity, reducing material throughputs, and reusing/recycling materials to such a degree that depletion of natural capital is minimised and ecosystem services are maintained.

2. Design and manage materials, products and processes for safety and sustainability from a life-cycle perspective.

- The life-cycle includes extraction, processing, product design and manufacturing, transportation, product use, collection, reuse/recycling and disposal.
- The object of this principle is to maximise positive (and minimise negative) environmental, economic and social outcomes across the entire life-cycle as well as at every stage of the life-cycle.
- Increased cooperation between different actors in the life-cycle is critical, so that every actor is aware of the impacts of his actions and decisions on other phases of the life-cycle and acts accordingly.

3. Use the full diversity of policy instruments to stimulate and reinforce sustainable economic, environmental and social outcomes.

- Policy instruments that can stimulate sustainable materials management include regulations, economic incentives/disincentives, trade and innovation policies, information and voluntary partnerships.
- Policies which reinforce each other usually achieve more efficient, effective, equitable and lasting outcomes than those that do not.
- Information offering feedback on the full range of policy impacts is critical, especially so that policies can be adjusted appropriately.

4. Engage all parts of society to take active, ethically-based responsibility for achieving sustainable outcomes.

- Relevant stakeholders include individuals, the private sector, government organisations at the local, regional, national and international levels and non-governmental organisations.

- The collaboration of all stakeholders is a practical necessity to achieve SMM. Each party also has an ethical responsibility to make everyday decisions that lead to sustainable environmental, economic and social outcomes, both at home and around the globe.
- Information that is clear, useful, timely and freely available (transparent) is critical for stakeholders to be able to make decisions that lead to a green economy and a sustainable world.
- Ethically based responsibility requires each stakeholder to avoid actions that will shift negative environmental impacts to future generations and to promote actions that improve the social well-being of all people now and for those generations to come.

Principle 1 – Preserve Natural Capital

Natural resources and healthy ecosystems are essential to all life and provide the natural capital on which humans depend. Sustainable materials management can contribute to the preservation of natural capital and is needed to foster long-term sustainability. Policy Principle 1 envisions leveraging the best available science, engineering, business and management practices to counter the trend toward incremental destruction and depletion of natural capital and its preservation now and for future generations. By modeling human use of materials as a system of material flows, and environmental impacts it is possible to outline broad strategies that would lead to the preservation of natural capital. Based on these strategies, policies and policy instruments specific to each country's unique circumstances can be developed. Strategies for SMM Policy Principle 1 include:

1. Improve information about material flows and environmental impacts;
2. Increase resource productivity and resource efficiency[1];
3. Reduce material throughput, particularly of high impact materials;
4. Increase reuse/recycling of materials to preserve natural capital;
5. Advance technologies for obtaining materials from natural resources that eliminate waste and toxics and support long-term ecosystem health (Eco-innovation).

[1] Resource efficiency and resource productivity have been defined as follows by OECD in its publication "Measuring Material Flows and Resource Productivity, Volume I, The OECD Guide", OECD 2008:

Resource efficiency: There is no commonly agreed upon definition of resource efficiency. It is understood to refer to the economic efficiency and the environmental effectiveness with which an economy or a production process is using natural resources. It is also understood to contain both a *quantitative* dimension (e.g. the quantity of output produced with a given input of natural resources) and a *qualitative* dimension (e.g. the environmental impacts per unit of output produced with a given natural resource input).

Resource Productivity: Resource productivity refers to the effectiveness with which an economy or a production process is using natural resources. It can be defined with respect to:
(i) the economic-physical efficiency, i.e. the money value added of outputs per mass unit of resource inputs used. This is also the focus when the aim is to decouple value added and resource consumption.
(ii) the physical or technical efficiency, i.e. the amount of resources input required to produce a unit of output, both expressed in physical terms (e.g. iron ore inputs for crude steel production or raw material inputs for the production of a computer, a car, batteries). The focus is on maximising the output with a given set of inputs and a given technology or on minimising the inputs for a given output.
(iii) the economic efficiency, i.e. the money value of outputs relative to the money value of inputs. The focus is on minimising resource input costs.
The term also designates an indicator that reflects the output or value added generated per unit of resources used. This is typically a macro-economic concept that can be presented alongside labour or capital productivity. Resource productivity would ideally encompass all natural resources and ecosystem inputs that are used as factors of production in the economy. The term is however often used as a synonym for material productivity.

Principle 2 –Design and Manage Materials, Products and Processes for Safety and Sustainability from a Life-cycle Perspective

It is at the design stage that decisions are made that determine impacts throughout the life-cycle. SMM Policy Principle 2 calls for maximising positive (and minimising negative) impacts to the environment and human health and well-being through design. By managing for safety and sustainability at each life-cycle stage, efforts are made to ensure that risks are not shifted from one stage in the value chain, or from one geographical region, to another. Economic and social outcomes are optimised while natural capital is preserved and materials are sustainably managed.

SMM Policy Principle 2 also calls for increased cooperation between actors across the life-cycle so that all actors are aware of the impacts of their actions and decisions on other phases of the life-cycle and can act accordingly. Three overarching material, product and process design strategies support SMM and they can be encouraged via government policies. They are:

Detoxification – Detoxification supports SMM by eliminating the progressive build-up of chemicals and compounds produced by society that have harmful impacts on human health and environment, that cannot be properly or safely managed, or that are costly to manage from an economic or environmental standpoint. Detoxification is addressed through the application of *green/sustainable chemistry* and the process of *chemical substitution*.

Dematerialisation supports SMM by reducing the throughput of materials, particularly those with high negative life-cycle impacts. Dematerialisation means doing more with less and refers to more efficient use of raw materials (*resource efficiency*) without decreasing the quality of the service they provide. In addition to resource efficiency, dematerialisation strategies also include *material substitution* and *replacing products with services***.**

Design for value recovery supports SMM by ensuring that products and materials are designed for reuse and recycling and that an effective model for recovery is in place (*i.e.* reverse logistics). Design for value recovery may be driven by product-related policies that promote for example *extended producer responsibility (EPR)* or "c*radle-to-cradle" design*. Cradle-to-cradle design strives to restore continuous cycles of materials with long-term positive effects on profitability, the environment and human health.

Principle 3 – Use the full Diversity of Policy Instruments to stimulate and reinforce Sustainable Economic, Environmental and Social Outcomes.

To shift societies toward more sustainable materials management, governments can leverage a variety of policies and policy instruments including: regulations; economic incentives and disincentives; trade and innovation policies; information sharing; and, partnerships.

Each of these mechanisms has advantages and disadvantages and each can deliver benefits. However it is unlikely that any single mechanism is appropriate in all circumstances. Therefore, a multi-pronged approach, applying a diversity of policies and policy instruments, is more likely to influence all relevant players than a "one-size-fits-all" approach. Weaving these diverse policy mechanisms into combinations

that reinforce each other can help to generate more effective, efficient and lasting outcomes. Integrated policies and policy instruments can successfully drive actors in the same direction and can accelerate progress -- sometimes generating synergies. Policymakers can also reinforce the use of these instruments by upgrading measures of success toward SMM objectives -- at both the systemic and organisational levels.

Principle 4 -- Engage all Parts of Society to take active, Ethically-based Responsibility for achieving Sustainable Outcomes.

Material flows involve and affect many stakeholders throughout the supply chain and often across vast geographical areas. Because of the complexity of SMM, outcomes can be improved by inclusion and engagement of many players in collaborative efforts to create collective solutions. Stakeholder engagement can also facilitate socially acceptable and equitable solutions by engaging those affected and allowing them to participate in designing of systemic solutions. SMM outcomes can be improved by systematic cultivation of:

1. Multilateral stakeholder engagement, responsibility and collaboration;
2. Open information flows;
3. An ethical perspective.

Conclusions

SMM is a relatively new approach and there are limited examples of policies developed with the comprehensive SMM framework in mind. However, many OECD member countries have expanded existing policy frameworks in areas such as waste management, sustainable consumption and production and resource productivity to achieve SMM. Some policy instruments appear to be effective and relatively simple to implement in support of SMM such as environmentally preferable government procurement and the creation of research centres that drive resource efficiency and better yet, innovation.

Applying SMM can generate the following benefits by encouraging policymakers to take a systems view of materials that flow among the industrial, social and environmental systems, identifying impacts at the local, national and international levels:

- SMM supports a life-cycle view of impacts associated with material use which can help policymakers to better predict and manage downstream and long-term consequences of actions, to avoid shifting problems from one stage of the value chain to another, and to avoid shifting impacts from the present to future generations.

- SMM also encourages multi-stakeholder participation in the creation and execution of policies and practices relating to materials use. By encouraging processes that are broadly inclusive of stakeholders, governments can generate more ideas and ensure that policies are more locally relevant and subsequently more likely to gain greater support from those who are responsible for executing them.

- Inclusiveness also tends to increase the equity of outcomes by giving a voice to everyone who is potentially impacted - before outcomes are generated.

Member countries have also encountered challenges in their pursuit of SMM objectives that also provide learning opportunities. Some challenges include:

- Decoupling growth in wellbeing from growth in material consumption;
- Better understanding material flows and impacts, including direct and indirect flows and international impacts;
- Realigning regulations and incentives to ensure that behaviour which is economically rational is also sustainable;
- Improving consistency of the life-cycle focus;
- Advancing government-industry collaborations;
- Promoting productive stakeholder engagement;
- Achieving greater integration and synergies of policies and policy instruments.

The SMM Policy Principles described in this report are a resource for OECD Member countries seeking to develop policies and policy instruments that support them in meeting their material needs without destabilising natural systems.

RÉSUMÉ

Introduction

La gestion durable des matières (GDM) constitue une approche relativement nouvelle qui marque le passage d'une gestion axée sur les déchets à une gestion axée sur les matières. Auparavant, les gouvernements pratiquaient la gestion des déchets comme moyen de gérer l'impact des matières sur l'environnement. Les politiques de gestion des déchets ont certes enregistré des succès incontestables, mais des travaux de recherche ont montré que la gestion des déchets n'était souvent pas le processus le plus important, le plus efficient et le plus efficace pour maîtriser les flux de matières des systèmes industriels et économiques. Si les matières exercent assurément une fonction de rétention importante, notamment pour les émissions de GES, il importe toutefois de prendre en considération l'ensemble de l'économie, dont fait partie la gestion des déchets, et de faire porter l'effort sur les flux de matières. La GDM élargit l'objet de la réflexion des gouvernements, des industriels et des consommateurs : au lieu de viser les caractéristiques d'une matière, d'un produit ou d'un processus, ce mode de gestion s'intéresse à l'ensemble du système de flux de matières et aux impacts qui sont associés aux matières tout au long de leur cycle de vie.

Cette étude avait pour objet d'identifier les grands principes d'action (« conditions-cadres »), fondés sur le besoin d'efficacité, de rentabilité économique et d'acceptabilité sociale, qui sont susceptibles d'aider les pays de l'OCDE à progresser dans l'élaboration et la mise en œuvre de politiques de GDM et d'instruments adaptés à leur cadre d'action publique. L'importance de ce travail tient au fait que souvent, dans l'élaboration des politiques, il n'est pas tenu compte des principes directeurs, principes sur lesquels reposent pourtant nombre de réglementations, de politiques et de programmes.

Les principes d'action pour la GDM ont été mis au point à partir de la définition pratique de la GDM, d'une revue bibliographique, et de contributions des pays membres de l'OCDE. Une section du rapport traite de la façon dont ces principes peuvent être et ont été appliqués dans les pays de l'OCDE, ainsi que des opportunités et des défis les plus notables. Les enseignements tirés des exemples d'application par les pays membres permettent d'illustrer et d'expliciter comment les principes de la GDM peuvent guider l'élaboration des politiques.

Résultats

Quatre grands principes d'action pour la GDM sont proposés pour orienter les politiques publiques en vue d'infléchir le comportement des acteurs économiques et des collectivités humaines de façon à leur permettre de satisfaire leurs besoins matériels sans déstabiliser les systèmes naturels. Le rapport comporte une description et une justification de chacun de ces principes d'action, ainsi que des suggestions de stratégies de mise en œuvre et des exemples d'application par des pays membres de l'OCDE.

Grands principes d'action pour la GDM

La gestion durable des matières est définie dans le cadre de ce projet comme *« une approche destinée à promouvoir une utilisation durable des matières, qui comprend des mesures visant à réduire les incidences négatives sur l'environnement et à préserver le capital naturel tout au long du cycle de vie des matières, sans perdre de vue l'efficience économique et l'équité sociale ».*

1. Préserver le capital naturel.

- Le capital naturel est la source de matières indispensables à la vie. Il comprend les stocks de ressources naturelles (minéraux et minerais métalliques, combustibles fossiles, sols, eau et ressources biologiques), les terres, l'atmosphère et les écosystèmes.
- La gestion durable des matières peut contribuer à la préservation du capital naturel. Le capital naturel peut être préservé en augmentant la productivité des ressources, en réduisant la consommation de matières, et en réutilisant/recyclant les matières de façon à réduire au minimum l'épuisement du capital naturel et à maintenir les services écosystémiques.

2. Concevoir et gérer les matières, les produits et les procédés de façon à assurer la sécurité et la durabilité tout au long du cycle de vie.

- Le cycle de vie comprend l'extraction, le traitement, la conception et la fabrication des produits, le transport, l'utilisation des produits, la collecte, la réutilisation/le recyclage et l'élimination.
- L'objet de ce principe est d'obtenir le maximum de résultats environnementaux, économiques et sociaux positifs (et de réduire au minimum les résultats négatifs) tout au long du cycle de vie et à chacune de ses étapes.
- Il est essentiel de renforcer la coopération entre les différents acteurs tout au long du cycle de vie de façon que chacun prenne conscience des impacts de ses actions et décisions sur les autres stades du cycle de vie et agisse en conséquence.

3. Utiliser toute la panoplie des instruments d'action publique pour favoriser et consolider des résultats durables au plan économique, environnemental et social.

- Parmi les instruments d'action propres à favoriser une gestion durable des matières figurent les réglementations, les mesures économiques d'incitation et de dissuasion, les politiques commerciales et d'innovation, l'information et les partenariats volontaires.
- La complémentarité des politiques améliore l'efficience, l'efficacité, l'équité et la durabilité des résultats.
- Il est indispensable de disposer d'informations en retour sur tout l'éventail des impacts des politiques de façon à pouvoir ajuster celles-ci comme il convient.

4. Engager tous les secteurs de la société à assumer activement leurs responsabilités éthiques pour parvenir à des résultats durables.

- Parmi les acteurs concernés figurent les citoyens, le secteur privé, les organismes publics au niveau local, régional, national et international, et les organisations non gouvernementales.
- La collaboration de tous les acteurs concernés est une nécessité pratique pour parvenir à la GDM. Chacun a aussi la responsabilité éthique de prendre au quotidien des décisions de nature à donner des résultats durables au plan environnemental, économique et social, à l'échelle tant nationale que planétaire.

- Pour pouvoir prendre des décisions de nature à instaurer une économie verte et un monde durable, les acteurs concernés doivent avoir accès librement et en temps opportun à des informations claires et utiles (transparentes).
- Assumer ses responsabilités éthiques suppose que chaque acteur évite de mener des actions de nature à transférer les impacts environnementaux négatifs sur les générations futures et encourage les actions qui améliorent le bien-être social des générations d'aujourd'hui et de demain.

Principe 1 – Préserver le capital naturel

Des ressources naturelles et des écosystèmes en bon état de santé sont indispensables à la vie sur Terre et fournissent le capital naturel dont dépendent les êtres humains. La gestion durable des matières peut contribuer à préserver le capital naturel et elle est nécessaire pour assurer la durabilité à long terme. Le principe d'action 1 envisage d'exploiter les meilleures pratiques disponibles en matière de recherche scientifique, de technologie, de commerce et de gestion pour contrecarrer la tendance à la destruction progressive et à l'épuisement du capital naturel et pour assurer sa préservation aujourd'hui et pour les générations futures. En modélisant l'utilisation humaine de matières sous la forme d'un système de flux de matières ainsi que leurs impacts environnementaux, on peut définir des stratégies générales pour assurer la préservation du capital naturel. A partir de ces stratégies, on peut élaborer des politiques et des instruments d'actions adaptés à la situation particulière de chaque pays. Parmi les stratégies envisageables au titre du Principe d'action 1 pour la GDM figurent :

6. Améliorer l'information sur les flux de matières et les impacts environnementaux.
7. Accroître la productivité des ressources et l'efficacité d'utilisation des ressources.
8. Réduire la consommation de matières, en particulier de matières à fort impact.
9. Accroître la réutilisation/le recyclage des matières pour préserver le capital naturel.
10. Développer les technologies permettant d'obtenir à partir des ressources naturelles des matières qui préviennent la production de déchets et de produits toxiques et renforcent la santé à long terme des écosystèmes (éco-innovation).

Principe 2 – Concevoir et gérer les matières, les produits et les procédés de façon à assurer la sécurité et la durabilité tout au long du cycle de vie.

C'est au stade de la conception que sont prises les décisions qui déterminent les impacts tout au long du cycle de vie. Le Principe d'action 2 pour la GDM préconise d'intervenir sur la conception pour accroître au maximum les impacts positifs (et réduire au minimum les impacts négatifs) sur l'environnement ainsi que sur le bien-être et la santé de l'être humain. Une gestion soucieuse d'assurer la sécurité et la durabilité à tous les stades du cycle de vie vise à éviter que les risques ne soient transférés d'une étape de la chaîne de valeur ou d'une région géographique à une autre. Les résultats économiques et sociaux s'en trouvent optimisés, le capital naturel est préservé, et les matières sont gérées de façon durable.

Ce Principe 2 préconise aussi une coopération accrue entre les acteurs tout au long du cycle de vie de façon que chaque acteur prenne conscience des impacts de ses actions et décisions sur les autres stades du cycle de vie et puisse agir en conséquence. Trois stratégies générales de conception des matières, des

produits et des procédés sont en mesure d'appuyer la GDM et peuvent être encouragées par des politiques publiques :

Détoxication – La détoxication vient à l'appui de la GDM en éliminant l'accumulation progressive de produits chimiques et de composés produits par la société qui ont des impacts nocifs sur la santé humaine et l'environnement, qui ne peuvent pas être gérés de façon appropriée ou sûre, ou qui sont coûteux à gérer d'un point de vue économique ou environnemental. La détoxication est mise en œuvre en pratiquant la *chimie verte/durable* et la *substitution de produits chimiques*.

Dématérialisation – La dématérialisation vient à l'appui de la GDM en réduisant la consommation de matières, en particulier de celles ayant des impacts négatifs importants aux différentes étapes du cycle de vie. Elle suppose de faire plus avec moins et d'utiliser plus rationnellement les matières premières (*efficacité d'utilisation des ressources*) sans diminuer la qualité du service qu'elles fournissent. Outre l'efficacité d'utilisation des ressources, les stratégies de dématérialisation comprennent aussi la *substitution des produits chimiques* et le *remplacement de produits par des services.*

Conception axée sur la valorisation – La conception axée sur la valorisation ou éco-conception vient à l'appui de la GDM en faisant en sorte que les produits et les matières soient conçus en vue de leur réutilisation et de leur recyclage, et qu'un modèle efficace de valorisation soit en place (logistique inverse). Elle peut être induite par des politiques en faveur de la *responsabilité élargie des producteurs (REP)* et de la *conception « du berceau au berceau »*. La conception de produits fondée sur le principe « du berceau au berceau » vise à boucler les cycles de matières de façon à produire des effets positifs à long terme sur la rentabilité, l'environnement et la santé humaine.

Principe 3 – Utiliser toute la panoplie des instruments d'action publique pour favoriser et consolider des résultats durables au plan économique, environnemental et social.

Pour faire progresser les sociétés vers une gestion plus durable des matières, les pouvoirs publics peuvent utiliser toute une panoplie de politiques et d'instruments d'action, tels que réglementations, mesures économiques d'incitation et de dissuasion, politiques commerciales et d'innovation, échanges d'informations et partenariats.

Chacun de ces mécanismes présente des avantages et des inconvénients et tous peuvent avoir des impacts bénéfiques. Toutefois, il est peu probable qu'un seul mécanisme convienne dans tous les cas. Pour influer sur tous les acteurs concernés, au lieu de plaquer une solution toute faite, il est donc préférable d'adopter une approche à plusieurs volets reposant sur toute une panoplie de politiques et d'instruments d'action. Combiner ces différents mécanismes de l'action publique de façon à les rendre complémentaires peut aider à produire des résultats plus efficaces, plus efficients et plus durables. L'intégration des politiques et des instruments d'action permet de mobiliser les acteurs dans la même direction et d'accélérer les progrès, tout en créant parfois des synergies. L'emploi de ces instruments peut aussi être renforcé en perfectionnant les mesures responsables de la réussite des objectifs de GDM – au niveau tant systémique qu'organisationnel.

Principe 4 -- Engager tous les secteurs de la société à assumer activement leurs responsabilités éthiques pour parvenir à des résultats durables.

Les flux de matières impliquent et affectent un grand nombre d'acteurs tout au long de la chaîne d'approvisionnement et souvent dans de vastes zones géographiques. Du fait de la complexité de la GDM, les résultats peuvent être améliorés en intégrant et en faisant participer de nombreux acteurs aux efforts menés en collaboration pour mettre au point des solutions collectives. Cette participation peut aussi encourager l'élaboration de solutions socialement acceptables et équitables en permettant aux acteurs concernés de participer à la conception de solutions systémiques. Les résultats de la GDM peuvent être améliorés en favorisant systématiquement :

4. L'engagement, la responsabilité et la collaboration des acteurs au niveau multilatéral
5. Les flux ouverts d'information ;
6. Une perspective éthique.

Conclusions

La gestion durable des matières est une approche relativement nouvelle et il n'existe que peu d'exemples de politiques qui ont été élaborées en prenant en compte l'ensemble du dispositif de GDM. Toutefois, nombre de pays membres de l'OCDE ont étoffé le cadre de leur action dans des domaines tels que la gestion des déchets, la consommation et la production durables, et la productivité des ressources pour parvenir à une gestion durable des matières. Un certain nombre d'instruments de politique publique semblent être efficaces et relativement simples à mettre en œuvre à l'appui de la GDM, comme les achats publics de produits écologiquement préférables, et la création de centres de recherche qui améliorent l'efficacité d'utilisation des ressources et, mieux encore, stimulent l'innovation.

La mise en œuvre de la GDM peut procurer des avantages en encourageant les décideurs à adopter une vision systémique des matières qui alimentent les systèmes industriels, sociaux et environnementaux, pour en identifier les impacts au niveau local, national et international. La GDM préconise une conception des impacts associés à l'utilisation des matières, qui, en prenant en compte l'intégralité du cycle de vie, peut aider les décideurs à mieux prévoir et à gérer les conséquences en aval et à long terme de l'action publique, à éviter de déplacer les problèmes d'une étape de la chaîne de valeur à une autre, et à éviter de transférer les impacts des générations actuelles sur les générations futures. La GDM encourage aussi la participation de tous les acteurs à la création et à la mise en œuvre des politiques et des pratiques liées à l'utilisation des matières. En favorisant des processus qui intègrent largement les acteurs concernés, les pouvoirs publics peuvent générer davantage d'idées et faire en sorte que les politiques soient localement mieux adaptées et par conséquent suscitent davantage l'adhésion de ceux qui sont chargés de les mettre en œuvre. Veiller à l'intégration de tous les acteurs concernés assure aussi généralement une plus grande équité des résultats en permettant à tous ceux susceptibles de subir un impact d'exprimer leur opinion au préalable.

Dans la poursuite de leurs objectifs de GDM, les pays membres se sont aussi heurtés à des problèmes, qui peuvent être source d'enseignements. Ils ont été confrontés à des difficultés notamment pour :

- Découpler l'augmentation du bien-être de l'augmentation de la consommation de matières.
- Accéder à une meilleure connaissance des flux de matières et de leurs impacts, notamment des flux directs et indirects et des impacts internationaux.
- Recadrer les réglementations et les incitations de façon qu'un comportement économiquement rationnel soit aussi durable.
- Améliorer la cohérence au niveau de l'ensemble du cycle de vie.
- Développer les collaborations pouvoirs publics–industrie.
- Promouvoir une participation fructueuse des acteurs concernés.
- Assurer une intégration plus étroite et de meilleures synergies des politiques et des instruments d'action publique.

Les principes d'action pour la GDM qui sont présentés dans ce rapport constituent une source d'informations pour les pays membres de l'OCDE désireux d'élaborer des politiques publiques et des instruments d'action qui les aident à satisfaire leurs besoins matériels sans déstabiliser les systèmes naturels.

1. BACKGROUND AND OBJECTIVES

1. The OECD has introduced work on Sustainable Materials Management (SMM) to emphasise integrated material, product and waste policies and to address environmental impacts over the whole life-cycle of materials and waste. As a starting point a workshop was held in Seoul, Korea in November 2005 to explore the current understanding and the status of activities aimed at SMM in OECD Member Countries and to develop a working definition for SMM.

> Sustainable Materials Management is "an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity."[1]

2. The participants also agreed to the following ***explanatory notes*** to the working definition:

- *"Materials*" include all those extracted or derived from natural resources, which may be either inorganic or organic substances, at all points throughout their life-cycles.
- "*Life-cycle of materials*" includes all activities related to materials such as extraction, transportation, production, consumption, material/product reuse, recovery and disposal.
- An "*economically efficient"* outcome is achieved when net benefits to society as a whole are maximised.
- A variety of policy tools can support SMM, such as economic, regulatory and information instruments and partnerships.
- SMM may take place at different levels, including firm/sector and different government levels.
- SMM may cover different geographical areas and time horizons."

3. A second Workshop on SMM in Tel Aviv, Israel, 2008, focused mainly on the SMM contributions of leading economic actors in the private sector, as well as those of NGOs and international organisations. The Workshop discussion made it clear that there has been a lot of activity recently at the level of business in moving toward more sustainable management of material flows and production processes which have considerably changed the management of products and materials, in particular, by assuming the holistic life-cycle approach and incorporating all three pillars of sustainability into business practices.

4. The OECD 2009-10 Programme of Work called for new work on "policy aspects of SMM" including three thematic reports:

- An overview of the potential advantages and disadvantages of target-based approaches;
- Elaboration of a set of general policy principles that would facilitate SMM; and
- An overview of existing SMM instruments, and an assessment of which public policy instruments are likely to work best in which particular circumstances.

5. In addition, four case studies on priority materials were commissioned (*i.e.* on aluminium, critical metals, wood fibres and plastics). All this work will provide input to OECD's Global Forum on the Environment to be held in October 2010.

6. This paper is one of the three thematic reports. Its purpose is to identify broad policy principles ("framework conditions") – based on the need for material efficiency, cost-effectiveness and social acceptability – that can help OECD countries move forward in developing and implementing broad environmental objectives specific to their own SMM policy contexts. The importance of this document lies in the fact that underlying principles are often overlooked in policy making – yet they form the basis for many laws, polices and programmes.

2. INTRODUCTION AND METHODOLOGY

2.1 A Systems View of Material Flow Cycles

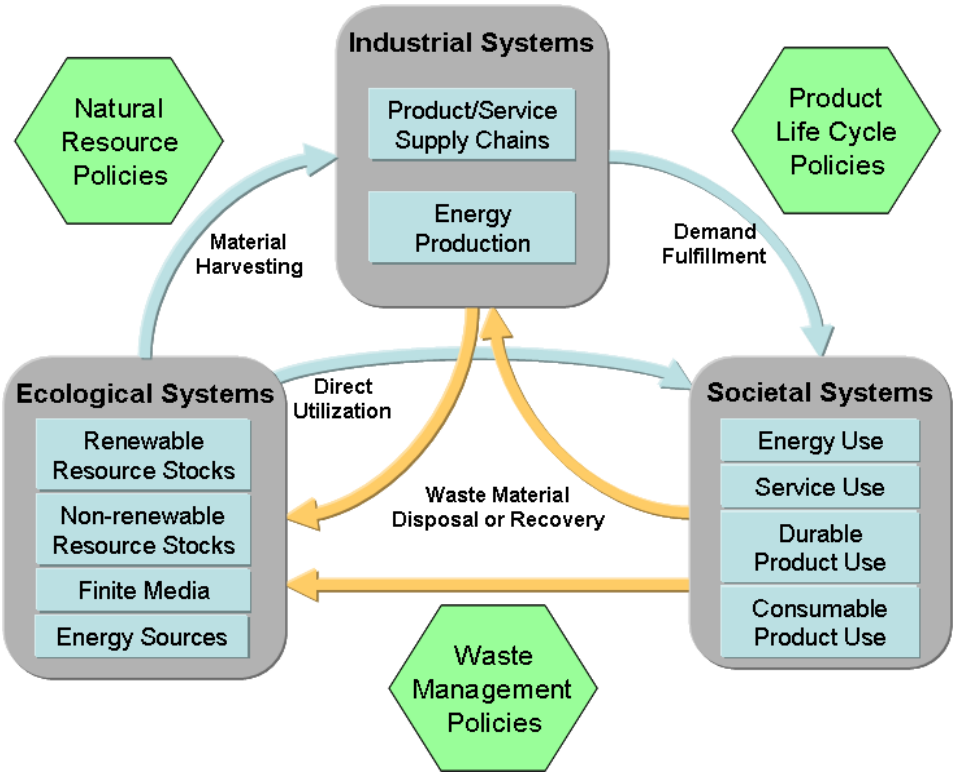
7. It is helpful to base SMM Policy Principles on a conceptual framework that includes the sources of materials and their pathways through ecological (natural), social and economic systems. Figure 1 presents a simplified systems view.[2]

8. **Ecological (Natural) Systems** represent the biosphere and the source of natural capital from which materials are derived. Natural systems include:

- Renewable resource stocks such as forests and, fish biomass which can be depleted if the rate of exploitation exhausts the existing stock.
- Non-renewable resource stocks such as metals, which assuming suitable collection infrastructure can be almost infinitely recyclable, and fossil fuels (oil, coal, gas) which are available for extraction, but once the finite stocks are exhausted cannot be replenished, and need to be substituted with other forms of capital.
- Environmental media, including air, water, and land, the quality of which may be degraded. For example, land may be reserved as parkland, used for agriculture or other forms of development, degraded due to soil erosion, or contaminated by misuse.
- Physical renewable sources of energy, including solar, geothermal, wind and tidal energy.[3]

9. **Industrial systems** utilise ecosystem services and derive materials from natural capital. Generated wastes that cannot be re-used are deposited back into the biosphere. Materials flow through supply chains that begin with extracted natural resources and end with the delivery of a finished product or service to society. Some materials end up essentially as stocks within long standing infrastructures like buildings, while others are rapidly consumed and disposed of. Energy production systems are similar to supply chain systems, but the end product is energy that is utilised within the industrial system or to fulfil societal demands, such as for residential or transportation uses.

Figure 1. Figure 1. Systems View of Material Flow Cycles[4]



10. **Societal systems** consume the products, services, and energy supplied by industrial systems, and generate waste that is either recycled back into industrial systems or deposited into the biosphere. Societal systems also consume ecosystem services and resource stocks directly (*e.g.* water). Products include both durable and non-durable goods. Durable goods (*e.g.* an automobile) are products that are used repeatedly over an extended period, possibly requiring ongoing consumption of supplies and energy. At the end of its useful life the entire product becomes waste, which is potentially recyclable. Non-durable consumer goods, also called consumables, (*e.g.* food) are used once and either wholly or partially consumed, with the remainder becoming potentially recyclable waste.

2.2 Project Methodology

11. This report was preceded by a review of the literature and other public media drawing on public, private, NGO and academic sources for SMM-related principles and strategies, tactics, guidelines and other resources related to SMM in OECD countries and beyond from which SMM principles could be derived. Over 350 individual principles related to SMM were analysed, and eventually narrowed down to four main SMM Principles.

12. Development of the SMM Policy Principles was based on consideration of the SMM working definition, on the literature review and on OECD member country input. The working definition of SMM spells out some basic criteria that should also be included in SMM approaches:

- Actions should be integrated – recognising other initiatives (waste management; sustainable consumption and production, resource productivity, green growth strategies, etc.);
- Actions should target environmental impacts (reduce) and natural capital (preserve);
- Actions should cover the whole life-cycle of materials; and
- Actions should take into account all three pillars of sustainability (including economic efficiency and social equity)

13. Part of this report also focuses on how these principles can be, and have been, applied in member countries. A questionnaire was presented to OECD countries and a few examples of national applications of SMM Policy Principles are briefly described to provide insight into the principles applied, the basis and objectives for its development, notable achievements and challenges. Insights from these member country applications may help to illustrate and clarify how the SMM Policy Principles may guide national policy development.

3. SMM POLICY PRINCIPLES

14. The four broad SMM policy principles are proposed to support the development of governmental SMM policies. The proposed main SMM Policy Principles are:

1. Preserve Natural Capital.

2. Design and Manage Materials, Products and Processes for Safety and Sustainability from a Life-Cycle Perspective.

3. Use the full Diversity of Policy Instruments to Stimulate and Reinforce Sustainable Economic, Environmental and Social Outcomes.

4. Engage all Parts of Society to Take active, Ethically-based Responsibility for Achieving Sustainable Outcomes.

15. In the following sections, each of the individual SMM Policy Principles is discussed to clarify the meaning of the principle, why it was selected and how it might be applied. The need for improved information on material flows and associated life-cycle impacts and on the effectiveness and efficiency of SMM policies and instruments was identified as critical to SMM. Information needs are inherent and specific to each of the individual principles.

3.1 SMM Policy Principle 1: Preserve Natural Capital

- *Natural capital is the source of materials needed to support life. It is comprised of natural resource stocks (minerals and metallic ores, energy fossil fuels, soil, water and biological resources), land, atmosphere and ecosystems..*

- *Sustainable materials management can contribute to the preservation of natural capital. Natural capital can be preserved by increasing resource productivity, reducing material throughputs, and reusing/recycling materials to such a degree that depletion of natural capital is minimised and ecosystem services are maintained.*

16. Principle 1, the preservation of natural capital, which is the source of materials needed to support life and to foster long-term sustainability, forms the overall basis for SMM. Natural resources and healthy ecosystems are essential to all human life and are a prerequisite for business as stated by WBCSD[2]. SMM policies can contribute to preserve natural capital, now and for future generations, using the best available science, engineering, business and management practices.

17. Natural capital includes energy, fossil fuels, soil, water, land, atmosphere, biological resources and ecosystems. Nature supports life by supplying provisioning, regulating and cultural benefits:

- Provisioning benefits include resources such as energy, fossil fuels, soil, water, land, atmosphere, biological resources and ecosystems that can be used to provide food, materials and energy;

- Regulating benefits include ecosystem services that sustain these resources by providing clean air, clean water, regular water flow, fertile soil, productive forests and fisheries, biodiversity, stable climate, processing of wastes and cycling of nutrients;

- Cultural benefits can be aesthetic, spiritual, educational and recreational.[5]

18. Together, these resources and services are considered natural capital – analogous to economic capital in the sense that they represent wealth. Preserving natural capital is a primary objective of SMM and should be considered in all SMM related policies. There are many approaches that may be applied concurrently and synergistically to provide an adequate supply of both renewable and non-renewable resources while protecting ecosystem health and ecosystem services in the service of society. Humans will continue to depend on the earth's natural resources for the foreseeable future. The challenge is to achieve a sustainable use of natural capital that does not create unsustainable associated impacts.

19. In its 2001 Environmental Strategy, the OECD has defined four criteria for environmental sustainability that align with SMM Policy Principle 1 to preserve natural capital for sustainable material flows:

- Regeneration: Renewable resources shall be used efficiently and their use shall not be permitted to exceed their long-term rates of natural regeneration;

- Substitutability: Non-renewable resources shall be used efficiently and their use limited to levels which can be offset by substitution by renewable resources or other forms of capital;

- Assimilation: Releases of hazardous or polluting substances to the environment shall not exceed its assimilative capacity;

- Avoiding Irreversibility: Irreversible adverse effects of human activities on ecosystems and on biogeochemical and hydrological cycles shall be avoided. The natural processes capable of maintaining or restoring the integrity of ecosystems should be safeguarded.[6]

[2] In 2001, WBCSD promulgated 10 messages by which to operate. Message 9 is the following: "Ecosystems in Balance – A Prerequisite for Business: Business cannot function if ecosystems and the services they deliver, such as water, biodiversity, food, fibre and climate, are degraded".

20. A number of strategies are described below that may help in the development of policies and policy instruments that support SMM Policy Principle 1.

3.1.1 Improve Information about Material Flows and the related Impacts

21. Governments may want to have the best available information about material flows and associated impacts in order to set broad priorities for preserving natural capital. The further development of SMM indicators and benchmarks will help to monitor progress.[7] There is a growing toolbox of resources available for measuring material flows and impacts to support SMM. Material flow analysis (MFA) has emerged as one useful tool[8]. Accompanied by additional tools such as Life-Cycle Assessment (LCA), information can be gained that provides perspectives on not only the quantity of material flows but also on the impacts associated with the flows, relative to other flows and to the carrying capacity of the earth as a whole. There is no one tool that provides all the answers. Governments may draw from the entire toolbox to obtain measurements that best support their priorities for SMM.[9]

22. Material flows and the associated impacts can occur locally, nationally and globally. Material consumption can also be direct or hidden (i.e., hidden material flows address materials that are extracted or moved, but do not enter the economy). Because of this complexity, any assessment of impacts from materials would need clearly defined parameters. Policymakers using the resulting data would want to ensure that impacts are assessed in a comprehensive way and that they are not unintentionally shifted to other regions.

3.1.2 Increase resource productivity and resource efficiency

23. Resource productivity and resource efficiency are measures that can be used to help assess the degree of decoupling of economic growth and industrial activity from the use of resources, i.e. getting more value for the resources used and using fewer resources for the same output (*i.e.* "doing more with less").[10] According to the OECD Council Recommendation on Resource Productivity [C(2008)40], resource productivity is understood to contain both a *quantitativ*e dimension (e.g. the quantity of output produced with a given input of natural resources) and a *qualitative* dimension (e.g. the environmental impacts per unit of output produced with a given natural resource input).[11] It recommends strengthening the capacity for analysing material flows and the associated environmental impacts to advance resource productivity and efficiency and collaborating globally to improve measurement systems. It also recommends taking action to improve resource productivity and efficiency at the macro, sectoral, and micro levels. Relative shifts in resource productivity or efficiency, *i.e.* occurring only within national boundaries, may not reflect impacts generated elsewhere in the chain.

24. Resource productivity and efficiency can be improved by optimising the rate at which materials are extracted from natural resources to achieve sustainable levels of material throughputs, as well as by reducing the throughput of materials with high negative environmental life-cycle impact. One way to achieve sustainable material throughput is to use less primary raw materials, water or energy in production processes. Another way is to manage renewable resources, *e.g.* forest products, in ways that do not exceed their rates of regeneration and that protect the health of their ecosystems. While natural resource policies do not fall within the scope of SMM, SMM does include policies such as government procurement that could lead to increased demand for sustainably harvested renewable resources. For instance, around 30%

of the commercially exploited forests (or roughly 320 million hectares) in the world are certified for sustainable management, which represents about 10% of global forest area. Governments may invest expertise and/or funding to support the development of legitimate standards and ecolabels for materials and products derived from sustainably harvested natural resources.

25. Improving resource productivity through production processes so as to use less inputs or more sustainable inputs (e.g. renewable, containing less toxic substances) can be achieved *inter alia* through technology improvement, eco-innovation, eco-design, material substitution and dematerialisation (see below section 3.2.2). Government could provide support for R&D, and incentives for investments in these areas. They may also encourage the development of regulatory and financial instruments focusing on a more sustainable use of resources.

3.1.3 Increase reuse/recycling to preserve natural capital

26. Re-injecting already used materials into the production system is an efficient way to minimise the demand for primary raw materials and resources and thus preserve natural capital. Governments can play an important role in advancing reuse and recycling and in identifying and guiding development of material recovery options. Governments may target the development of closed-loop systems for recovery and recycling of key materials, if open systems do not work satisfactorily, or result in additional negative environmental impacts; *e.g.* mandatory recycling of lead-acid batteries. Industry has automatic incentives to develop recycling systems for highly valued materials, but policies that would promote improved recovery and recycling infrastructure and practices could help recover additional streams of materials with marginal market value. In addition to commonly used instruments, such as advanced disposal fees, deposit refunds, landfill or incineration taxes or bans, and the use of extended producer responsibility (EPR), other more inventive and innovative tools or systems should be developed that could help society to consider waste as a resource, and thus could encourage material reuse and recycling.

3.1.4 Innovative Technologies for SMM (Eco-innovation)[12]

27. Eco-innovation may apply to any stage of a product or service life-cycle including the extraction of materials from natural resources. Eco-innovation technologies can help to preserve natural capital by increasing resource efficiency and productivity while reducing negative impacts. Governments can accelerate eco-innovation by investing in research and development in the academic and/or industrial sectors. Eco-innovations may range from improved efficiencies to entirely new technologies and feedstocks. For example, research in part supported by government funding, has resulted in a commercial process for mining phosphorus from wastewater in the form of struvite.[13] While this product cannot replace all uses of phosphorus, it can replace those that benefit from slow release phosphorus. The technology could potentially replace a significant amount of mined phosphate, with its associated negative impacts due to hazardous contaminants, while creating a revenue stream for wastewater treatment plants and tapping into a vast and renewable supply.

28. A major challenge to implementing Principle 1 reported by OECD member countries is the feasibility of decoupling industrial activity and economic growth and development from the depletion and degradation of natural capital. Incremental improvements are not enough.[14] For SMM, governments are faced with tracking the amount and impacts, both direct and indirect, of material flows; with prioritising

flows and impacts based on national characteristics; and with integrating policies and policy instruments to accelerate improvements. Because SMM is very complex, it may require new tools and strategies for integration and collaboration. One strategy may involve new applications of information technology (IT) to manage information about materials, material flows and impacts and to inform and engage stakeholders locally, nationally and internationally. IT is being applied to develop "Smarter Cities" that include "smarter" transportation, governance, water supplies, food supplies, and waste management, and gain more insight into supply chains and distribution logistics. "Smart" technology may be one tool to support radical efficiency increases and policy integration.[15]

3.2 SMM Policy Principle 2: Design and Manage Materials, Products and Processes for Safety and Sustainability from a Life-Cycle Perspective.

- *The life-cycle of materials includes extraction, processing, product design and manufacturing, transportation, product use, collection, reuse/recycling and disposal.*

- *The object of this principle is to maximise positive (and minimise negative) environmental, economic and social outcomes at every stage of the life-cycle.*

- *Increased cooperation between different actors in the life-cycle is critical, so that every actor is aware of the impacts of his actions and decisions on other phases of the life-cycle and acts accordingly.*

29. SMM Policy Principle 2 helps to define sustainable materials by calling for the design and management of materials, products and processes that are safe and sustainable over the full life-cycle. Life-cycle considerations include extraction, processing, product design and manufacturing, transportation, product use, collection, reuse/recycling and disposal.

30. According to architect William McDonough, "Design is the first signal of human intention". It is at the design stage that decisions are made that determine impacts throughout the life-cycle. SMM involves maximising positive (and minimising negative) impacts to the environment and human health and well-being through design. A focus on safety and sustainability at each life-cycle stage ensures that risks are not shifted from one stage in the value chain to another. Economic and social outcomes are optimised while natural capital is preserved.

31. While governments do not typically design materials, products or processes they can influence the design of safe and sustainable products. Procurement and investment policies, regulations and initiatives that inform decision-making are all tools to achieve this end. There are three overarching material, product and process design strategies which support SMM and which can be encouraged via government policies. They include: detoxification; de-materialisation, particularly of materials with high negative life-cycle environmental impacts;[16] and design for value recovery.

32. There is a certain circular logic in defining sustainable materials. They are materials that can be managed sustainably. Likewise, sustainable materials management is facilitated by the use of materials with certain sustainability characteristics such as:

- Low toxicity under all exposure scenarios throughout the life-cycle including manufacture using clean production, green chemistry and renewable energy;

- Derived from renewable or repeatedly recyclable materials;

- Designed for value recovery (energy, materials) including the design and implementation of an effective strategy for recovery and utilisation in "cradle-to-cradle" cycles[17, 18]

3.2.1 Detoxification

33. The principle of detoxification supports sustainable materials management by eliminating the progressive build-up of chemicals and compounds produced by society that have harmful impacts on human health and environment, that cannot be properly or safely managed and/or are costly to manage from an economic or environmental standpoint. In order to detoxify products, it is necessary to know the hazards and risks associated with the raw material options and to choose the safest alternatives. Detoxification is addressed through the application of **green/sustainable chemistry and the process of chemical substitution.**

34. **Green Chemistry** (based on the twelve principles of green chemistry)[19] and **Sustainable Chemistry**[3] are two terms that are commonly used to designate practices that aim at the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. These can be achieved by, among other things: i) using less hazardous and more sustainable feedstocks and reagents; ii) improving the energy and material efficiency of chemical processes; iii) using renewable feedstocks or wastes in preference to fossil fuels or mined resources; and, iv) designing chemical products for better reuse or recycling. An example of greener and more sustainable chemistry is the totally chlorine free (TCF) bleaching technologies used in the pulp and paper industry. TCF technologies involve no chlorine compounds and remove all but naturally present Adsorbable Organic Halides (AOX), dioxins and furans[20].

35. Sustainable chemistry can also be achieved through **chemical substitution**, i.e. the replacement of hazardous substances in products or processes by other less or non-hazardous substances. As examples of chemical substitution, the replacement of CFCs as propellants by Hydrofluoroalkanes HFA-134a and HFA-227 which have no ozone-damaging potential or the replacement of organic solvents in paints by aqueous solvents. Chemical substitution thus can reduce environmental and health risks along the life-cycle of products while ensuring the same functionality.

36. Government, academia and industry should support initiatives that prevent or minimise risk and pollution at all stages of a product life-cycle. To achieve this goal, governments could support sustainable chemistry education as well as investment in research and development that leads to: eco-design of chemicals; materials and components that are durable and can be reused and recycled[21]; eco-innovation; and alternative technologies and chemical synthesis techniques that can address many issues simultaneously. Companies can also use the opportunity of innovation in sustainable chemistry to gain a competitive advantage over their competitors. Because the development of sustainable chemicals may

[3] Sustainable Chemistry aims at the design, manufacture and use of chemical products that are efficient, effective, safe and more environmentally benign across their life-cycle (see: http://www.oecd.org/env_sustainablechemistry_platform/)

require high investments from industry with possible returns in the long-term, governments can develop policy frameworks which encourage such investment.

37. Governments need not necessarily prescribe alternatives to chemicals of concern. They may help companies by developing tools and strategies to guide the identification of safer alternatives. For example, the USEPA's Design for the Environment (DfE) Programme has developed comparative hazard assessment methods and criteria for defining safer chemicals through their Partnership programmes.[22]

38. Finding comprehensive chemical hazard data can be challenging. The EU REACH Regulation and Canada's Chemicals Management Plan help with assessing and prioritising substances according to environmental and health risks, and serve as powerful drivers for broader public access to chemical product information and hazard data to support safer alternatives.[23] Under REACH, substances of very high concern (SVHCs) will require substitution where there are viable alternatives and/or they will be granted time-limited authorisation for essential applications where no suitable alternatives exist. In the US, the California Green Chemistry Initiative (GCI) will create a green chemical product registry to inform consumers about the chemicals, and their associated hazards, in products sold in California. A variety of regulatory actions may be applied to products containing chemicals of concern. If the public disclosure feature of the California GCI is as effective as other public disclosure initiatives have been in the US (*e.g.* Toxics Release Inventory Programme), then a reduction in the use of hazardous chemicals in consumer products and an increase in the use of products with safer chemical profiles are likely.[24]

39. The initiatives noted above may also benefit other OECD countries through data sharing. OECD has already built a strong foundation to support movement to safer alternatives through the development of guidelines for the testing of chemicals,[25] and by providing information on the environmental releases and transfers of hazardous chemicals and pollutants through Pollutant Release and Transfer Registers.[26] Another programme managed by OECD that could support SMM through detoxification is the programme in Sustainable Chemistry, as described above.

3.2.2 Dematerialisation

40. Dematerialisation supports SMM by reducing the demand for and throughput of materials, particularly those with high negative life-cycle impacts, to preserve natural capital. Dematerialisation means doing more with less and refers to more efficient use of raw materials (and the use of less energy in the process) without decreasing the quality of the service they provide. Dematerialisation strategies include **replacing products with services** and **material substitution**. Replacing the individual purchase of farming or industrial tools, gardening or do-it-yourself tools or even of cars by a rental service may be an economically efficient and environmentally effective way to manage materials in some circumstances and thereby may decrease waste generation. Such services already exist, especially concerning high value materials, but on a limited scale.

41. Governments could take the necessary measures to support the development of such services, which may also result in job creation. Another example of dematerialisation can be found in packaging materials and involves "lightweighting" and eliminating wasted space. While dematerialisation may provide benefits, it is important to note that small efficiency gains can be quickly outpaced by overall growth. Innovation occurs in degrees, from incremental improvements to new designs that result in transformative

performance using minimal materials with significant impacts on material use and subsequent throughput.[27]

The Soda Club System – An Example of Providing Service with Fewer Materials [28]

Many people enjoy drinking carbonated water. The purchase and transportation of bottled carbonated water is energy and material intensive – even if the bottles are recycled or reused once they are empty. A product produced by the global Soda Club Group provides the same service – the provision of carbonated drinking water – but via a different business model. The Soda Club system involves the purchase of housing for a CO2 canister, a bottle to hold the carbonated water and the lease of a CO2 canister that can generate up to 110 liters of carbonated water per canister. Tap water can be used to fill the bottle. To carbonate the water, the bottle is attached to the CO2 canister and then injected with CO2. If one were to drink 24 liters of carbonated water each month, the total number of empty bottles generated each year would be 288. Fuel and energy costs from transporting bottles to and from stores could also be determined. The Soda Club system generates essentially no bottle waste as the bottles are reused (until they eventually fail), the water can be obtained from the tap, and the CO2 canister can be returned to the point of leasing or via mail for refilling. This product provides an example of how innovation in product design and associated business models can provide the same service along with dematerialisation.

42. Substitution of materials that are resource intensive and/or that have high negative life-cycle impacts with materials that have attributes of safety and sustainability across the life-cycle (*e.g.* low toxicity, sustainably harvested and renewable, reusable or recyclable) can be an effective dematerialisation strategy. Governments may establish policies that drive both resource efficiency and substitution. For example, the EU Packaging Directive uses a system of reporting and fees to prevent packaging waste by limiting the size of packaging relative to the product, limiting heavy metals in packaging materials and encouraging reuse and recycling by setting targets for Member States. Other OECD member countries (i.e., Japan, Korea, Canada, Australia, Turkey and the Netherlands) have set packaging fees to help reduce packaging and to fund recycling. In the Netherlands, these fees have been tied to CO_2 emissions.

3.2.3 Design for Value Recovery

43. Design for value recovery supports SMM by ensuring that products and materials are designed for reuse and recycling (of energy and materials) and that an effective model for recovery is in place (*e.g.* reverse logistics). Design for value recovery may be driven by product-related policies that promote for example extended producer responsibility or "cradle-to-cradle" design.[29] **Cradle-to-cradle design** is a voluntary, leadership approach to product design. The purpose of cradle-to-cradle design is to restore continuous cycles of materials with long-term positive effects on profitability, the environment and human health. [30] Metaphorically, cradle-to-cradle products are viewed as "nutrients" cycling in "metabolisms".

1. Products of Consumption and Biological Nutrients in the Biological Cycle

Products of consumption are typically derived from renewable feedstocks and are designed to completely breakdown in the environment in a benign or even beneficial manner. Products of consumption illustrate the principle that "waste equals food". Their degradation can support life in ecosystems. Designing products to function as biological nutrients requires a detailed assessment of the material chemistry and its toxicity to potentially exposed organisms throughout its life-cycle. In general, they function as nutrients in natural systems and may be designed to degrade rapidly and completely in the aquatic environment or to become soil amendments. Products that have been designed as products of consumption include cleaning products, personal care products and fabrics.

2. Products of Service and Technical Nutrients in the Technical Cycle

Products of service refer to products comprised of durable materials that can be recycled into high value uses. Using the metaphor of metabolism, durable materials are considered technical nutrients that can be recycled within technical metabolisms. A product designed to meet cradle-to-cradle design principles will be designed with a system for recovery and recycling as part of its business model. A product of service stands in contrast to a product of consumption in that it provides a service to the user but is not itself consumed. When the service is no longer provided, the product materials can be reused or recycled. Innovative leasing models have been developed to ensure that products of service are returned and its materials are recovered. Examples include cars, furniture, books and carpet.

3.2.4 Increased Co-operation between different Actors in the Life-cycle

44. Increased cooperation and information exchange between different actors in the life-cycle is critical so that all actors are aware of the impacts of their actions, and to increase their involvement in creative solutions for systemic change. Governments may convene stakeholders to facilitate cooperation and the flow of information between actors across the life-cycle. SMM is aided by aligning information flows with the flows of materials in products and processes. Examples of information tools that could support SMM range from databases of chemical ingredients and products that include comparative hazard information and greener chemical alternatives to scorecards for products or packaging, product life-cycle inventory assessments and product "footprint" assessments. Design and management, like policymaking, are creative and dynamic processes with ever-changing conditions. It is expected that adaptation and continual improvement in information quality and quantity related to materials will continue to support the design and management of materials, products and processes for SMM. Governments can help drive the development of information resources and tools and metrics that identify the sustainability attributes of chemicals, materials, products and processes.

3.3 SMM Policy Principle 3. Use the Full Diversity of Policy Instruments to Stimulate and Reinforce Sustainable Economic, Environmental and Social Outcomes.

- *Policy instruments that can stimulate sustainable materials management include regulations, economic incentives/disincentives, trade and innovation policies, information and voluntary partnerships.*

- *Policies which reinforce each other usually achieve more efficient, effective, equitable and lasting outcomes than those that do not.*

- *Information offering feedback on the full range of policy impacts is critical, especially so that policies can be adjusted appropriately*

45. To shift societies toward more sustainable materials management, governments can leverage various mechanisms including **regulations**, **economic incentives or disincentives**, **trade and innovation policies**, i**nformation** and **voluntary partnerships**. Each of these types of mechanisms has advantages and disadvantages.

3.3.1 Regulations

46. Regulations such as legislations or prohibitions on taking certain actions or risks or requirements to pursue certain actions can target outcomes measured in absolute terms (*e.g.* a specific percentage reduction of waste to landfill), but often leave little flexibility for economic actors. Examples of SMM-related regulations include bans on landfilling certain wastes and the Extended Producer Responsibility (EPR) regulations pioneered in Sweden and practiced in many OECD countries. EPR can be effective in promoting recycling. Policy instruments based on EPR can also be designed to drive eco-design at the beginning of the product lifecycle. However, if the instruments are focused only on improved recycling without driving initial eco-design, EPR may not generate the desired economic and environmental efficiencies.[31]

3.3.2 Economic Incentives and Disincentives

47. Economic incentives and disincentives can harness the power of the market to generate outcomes which are often creative and economically efficient. Outcomes from economic incentives alone, however, may not be sufficient to generate environmentally or socially meaningful results, because actors generally stop making improvements once the economic incentive to do so ends, whether or not sufficient social or environmental progress has been made. Examples of economic mechanisms employed by OECD governments include also disincentives such as increased fees on waste disposal; and incentives such as government procurement policies and a potential reduction in the value added tax (VAT) and tax for environmentally friendly products (all promoted by the government of the Czech Republic, among others). Additional examples include measures such as environmental investment subsidies and tax credits (*e.g.* by the government of the Netherlands, among others).

3.3.3 Trade and Innovation Policies

48. Other potent mechanisms to advance SMM include trade and innovation policie**s**, which promote technological advancement, economic efficiency and multilateral sharing of the fruits of innovation. For

example, governments could create economic incentives for more sustainable product design and end-of-life material collection, remanufacturing and recovery. Strategies could include research and development incentives, building of collection infrastructure and promoting public education. While some materials – particularly certain metal scraps – have sufficient market value to merit collection already, strategies could advance the recycling of materials with more marginal value or promote a shift away from materials with negative life-cycle environmental impacts. Governments could also support institutes designed to build and share repositories of information related to sustainable material innovation, as in Japan, Finland, the US and other OECD countries. The EU supports developing and promoting innovative financing programmes for green technologies,[32] and creating ongoing research collaborations to help provide producers with consistent, reliable information about the environmental impacts of common components, materials and new technologies. Through trade policies that facilitate technology transfer, environmental, economical and social benefits can be distributed[33] [34].

3.3.4 Information Sharing

49. Information sharing promotes alignment around definitions and metrics, as well as dissemination of best practices. In addition to the technology advancing programmes described above and stakeholder engagement and communication strategies described under Principle 4, many OECD countries also support common metric development and ecolabel programmes to facilitate consistent measurement, public education and promotion of products with superior material sustainability characteristics. In the US, the Electronics Products Environmental Assessment Tool (EPEAT)[35] has been supported in part by government funding to drive recycling and to decrease negative life-cycle environmental impacts associated with electronic equipment. Additional consumer-facing strategies might include understanding and influencing consumer behaviour which produces unsustainable outcomes, for example by exploring ways to reduce their consumption of materials that are resource intensive or that have negative life-cycle environmental impacts and exploring marketing practices which encourage sustainable consumption habits.

50. Integrated economic/environmental analysis provides another source of information that can assist governments in designing efficient and effective policies to stimulate SMM. It can also provide a common basis for dialogue among stakeholders and facilitate information sharing to improve the communication, uptake and acceptance of SMM policies and principles. Such analysis encompasses a range of economic techniques based around cost-benefit analysis and cost-effectiveness analysis and is used to assess the potential impacts on social welfare from policy initiatives. Issues such as environmental valuation techniques, the distribution of costs and benefits over time and groups within society, and appropriate discount rates all play an important role in the use of cost-benefit analysis[36].

3.3.5 Partnerships

51. Partnerships can also deepen and accelerate the efforts of leaders who want to improve their performance while stretching the boundaries of current best practice. Belgium and the US, among other OECD countries, have many voluntary partnership programmes. The Belgian Public Waste Authority Transition Network is a partnership that has developed a long-term vision to innovate on a system level (not incrementally) and to create a "transition path" to more sustainable material practices. The Network's focus areas include closing material cycles, designing safe materials to circulate in closed cycles,

increasing services (shifting from selling products to offering services) and creating more sustainable plastics.

3.3.6 Use a Diversity of Policy Instruments

52. Because each mechanism can deliver benefits, but no mechanism is ideal under all circumstances, a multi-pronged approach applying a diversity of mechanisms is more likely than a single "one-size-fits-all" approach to influence all relevant players. Weaving these diverse policy mechanisms into combinations which would reinforce each other can help to generate more effective, efficient and lasting outcomes. Integrated policies and policy instruments can successfully drive actors in the same direction and can accelerate progress, and generate synergies. In all cases, open multidirectional information flows can facilitate sustainable outcomes by providing feedback on the full range of policy impacts. This helps to build the participation of critical economic actors and other stakeholders, to lower potential resistance to innovation, to increase idea generation and to allow appropriate policy adjustment over time.

3.3.7 Obstacles to Sustainable Materials Management

53. Presently, SMM is limited by certain systemic conditions. First, economic actors regularly apply limited information to make short-term decisions that optimise certain economic performance measures, but sub-optimise the overall systemic outcome – for example, by generating unsustainable rates of resource depletion, or by causing social and ecological damage.

54. To rectify this situation, policymakers could work to adjust the framework that forms the stage for economic action to account for and encourage more sustainable materials choices. To begin, policymakers could consider upgrading measures of success at the systemic level that would encourage assessment of policies not only in terms of the short-term quantity of economic wealth generated, but in terms of overall tangible and intangible value created in the entire ecological-social-economic system over time. For example, Belgium and other EU countries recommend that policymakers move assertively to decouple economic advancement from growth in material and energy throughput.

55. Economic indicators such as Gross Domestic Product (GDP), though useful for the purpose of measuring undifferentiated economic activity, fail to distinguish positive economic activity (which generates human and environmental health and happiness) from negative economic activity (which generates human and environmental damage and misery). To improve metrics, policymakers could factor natural capital contributions into economic calculations, and price these to deter degradation or liquidation of natural capital. For example, a healthy and productive forest depends on services provided by nature; incorporating the value of these contributions along with the contributions of labour, fuel, planting, etc. would make cost-benefit calculations more accurate. Similarly, impacts that would diminish the productivity or resilience of natural capital could be included along with other costs.

56. Finally, in many circumstances those impacts and values which are directly quantifiable are not the only ones which are important. Devising additional metrics to measure the impact of the non-obvious and non-quantifiable would provide a useful tool for policymaking. Such measures could include rigorous value and opinion surveys, observational studies of human choices and happiness, alternative assessments of value (such as the value of forests, mountains and coral reefs for tourism and ecosystem services as opposed to just resource extraction), and the like.

3.4 SMM Policy Principle 4. Engage All Parts Of Society To Take Active, Ethically-Based Responsibility For Achieving Sustainable Outcomes.

- *Relevant stakeholders include individuals, the private sector, government organisations at the local, regional, national and international levels and non-governmental organisations.*

- *The collaboration of all stakeholders is a practical necessity to achieve SMM. Each party also has an ethical responsibility to make everyday decisions that lead to sustainable environmental, economic and social outcomes, both at home and around the globe.*

- *Information that is clear, useful, timely and freely available (transparent) is critical for stakeholders to be able to make decisions that lead to a green economy and a sustainable world.*

- *Ethically based responsibility requires each stakeholder to avoid actions that will shift negative environmental impacts to future generations and to promote actions that improve the social well-being of all people now and for those generations to come*.

57. Material flows involve and affect many stakeholders throughout the supply chain and often across vast geographical areas. Because of the complexity and dispersion (in both space and time) of decisions and impacts associated with material flows, outcomes can be improved by the inclusion and engagement of many players in collaborative efforts to create collective solutions. No single actor or industry has the capability, or the responsibility to ensure more sustainable outcomes unilaterally; however, various groups working together can achieve significant gains. SMM outcomes can be improved by systematic cultivation of:

- Multilateral stakeholder engagement, responsibility and collaboration;

- Open information flows;

- An ethical perspective.

3.4.1 Multilateral Stakeholder Engagement, Responsibility and Collaboration

58. Regular communication and collaboration among economic actors, government agencies, and the general public can improve the formulation and execution of SMM policies and decisions. Blending and balancing the best thinking from individuals, the private sector, non-governmental organisations and intergovernmental organisations at all levels can improve the quality of decision-making and enhance efforts at adoption, execution and adaptation.

59. Actors with a stake in sustainable materials management include individuals and organisations in the private sector, government at all levels, and non-governmental organisations. All parties have an ethical responsibility to make everyday decisions that lead to sustainable environmental, economic and social outcomes, both at home and around the globe. Stakeholders should be selected based on the specifics of the SMM challenge (*i.e.* material, product, process, region), but could include representatives from every stage of the life-cycle and value chain. It is also important to include individuals, typically from NGOs who can act as a voice for overall environmental well-being and potentially impacted ecosystems. While stakeholder engagement cannot displace the need for ethical and legal boundaries, it can optimise socially

acceptable and equitable solutions by engaging those who are affected and allowing them to participate in the design of systemic solutions.

60. Governments may not be able to directly convene all stakeholder initiatives for SMM but governments may be able to encourage other stakeholders to form coalitions to address material-related challenges for SMM. Governments could provide guidance on how to engage and facilitate stakeholder coalitions consistent with ethical values such as transparency and inclusiveness. By encouraging multi-stakeholder coalitions to achieve SMM, governments are acting to encourage all parts of society to take active, ethically-based responsibility for achieving sustainable outcomes. Examples of initiatives that address SMM through multi-stakeholder coalitions that are supported in part by governments through participation or funding include the Business NGO Forum for Green Chemicals and Sustainable Materials and the Sustainable Packaging Coalition, both run by non-governmental organisations (NGOs).[37, 38]

61. Specifically, stakeholder engagement can contribute to:

- More creative, insightful and thorough SMM decision-making;
- More active participation, collaboration and innovation in SMM research, innovation and change efforts;
- Greater trust and broader support for decisions, resulting in better integration of changes into existing systems, and more durable change overall;
- Better insight into hidden material flows;
- Better insight into local conditions, allowing actions with increased local relevance;
- Early detection of problems and opportunities in markets and communities of operation;
- Clearer understanding of the needs of complex multistakeholder systems;
- Greater alignment with the spirit of democratic participation and empowerment;
- An increased likelihood of socially acceptable outcomes.

62. To increase stakeholder engagement and sharing of responsibility, governments could act to decentralise decision-making and to address SMM decisions where the impacts occur. Governments could also consider shifting from command-and-control models of regulation toward more policy governance through setting of goals and expectations and delegation of progress to economic actors using flexible methods to reach common targets. Expanded roles of governments could include conveners of multi-stakeholder networks to support policy development and execution, and roles as connectors and partners to promote better information and connectivity. For example, governments could promote linkages and partnerships where none existed before – possibly among economic actors representing different industries who could potentially meet each others' sustainable materials needs (*e.g.* through industrial symbiosis arrangements or through the international Freecycle network[39]) or among stakeholders who rarely interact but could benefit each other.

63. Examples of mechanisms OECD countries have instituted to support and encourage partnerships in support of SMM and other sustainability objectives include:

- The Dutch Material Chain Approach, designed to bring together different actors in material supply chains in order to improve SMM performance and to establish "*clear and consistent definitions and…measurable criteria*" and quantitative metrics.

- The US EPA's Design for Environment's Partnership programmes. [40]
- Finland's Material Efficiency Centre, designed to provide advice and services for businesses, consumers and the public sector on improving material efficiency.[41]

3.4.2 Open Information Flows

64. Limited availability of material-related information throughout the supply chain is a significant barrier to SMM. Many producers, particularly those in complex industries with dozens or even hundreds of suppliers, barely know the identities of the suppliers in their value chains, let alone the social and environmental records and capacities of those suppliers or the origins and content of products.

65. Sustainable long-term decisions can be more efficiently and effectively achieved when all relevant parties understand and correctly attribute economic, social and environmental impacts, costs and benefits across the value chain. A critical factor in support of this objective is the free flow of clear, useful and timely information designed to accompany and align with material flows. Only with this information in hand can policymakers, managers and other stakeholders in each stage of the life-cycle offer high-quality evaluations of SMM options and make long-term decisions which optimise sustainable use of materials. To improve information flows in support of SMM, policymakers could:

- Promote common standards, metrics and frameworks which give producers, consumers, managers and regulators a framework to determine what information is important;

- Create rules that support SMM but protect confidentiality where needed; information-sharing is most effective when all participating parties believe that such sharing will generate long-term advantage and will not put them at a competitive disadvantage;

- Create systematic feedback loops which ensure honest and regular multidirectional flow of information, questions and ideas to reveal impacts and opportunities which may be obscured by distance (in time or space) from the decision-making centre;

- Include policy review and self-correction mechanisms to adapt to evolving conditions.

66. Ideally, every actor in the value chain would have both the capacity to identify previously unknown social and environmental impacts of significance to the sustainability of the entire system and incentives to bring these impacts (and potential solutions) to the attention of others who could help meet the challenge. Policymakers could encourage such local empowerment, while taking care to create a playing field that does not penalise actions that provide accurate and transparent information. Examples of mechanisms to promote open information flow include:

- The Carbon Disclosure Project.[42]

- Whistleblower protection laws, which provide legal support and protection against retribution for individuals who report problems or crimes to authorities.[43]

3.4.3 Ethical Perspective

67. Ethically based responsibility includes, for example, that negative environmental impacts are not shifted to future generations and that we guarantee a high level of wellbeing for every person on this planet. Policymakers could further enhance sustainable material management by building systems which recognise and promote fulfillment of all actors' ethical responsibility to make everyday decisions which lead to sustainable environmental, economic and social outcomes, both at home and around the globe.

68. Given that materials are a basic necessity for survival and wellbeing, policymakers could improve the equity and stability of the global economic system by providing a common ethical basis for economic activity. One example of efforts to move in this direction is the OECD Guidelines for Multinational Enterprises.[44] A small sample of ethically-based questions related to SMM includes:

- Should policies aim to guarantee access to materials so that basic needs are fulfilled for every person on the planet?
- Should policies aim to mitigate the effect of rising prices for material use on the gap between the rich and the poor – both within and among countries?
- Should certain types of resource harvest be limited, and if so, under what conditions?
- Should economic actors restore disrupted natural features and ecosystems during or at the completion of their operations?
- How should countries combine "Open" Trade with adequate environmental protection – promoting both national environmental standards and international co-operation to promote environmental norms that adequately protect global environmental quality?

69. One way to advance common ethical practices providing consistent answers to questions like these would be to work toward universal adoption by governments and economic actors of established frameworks for ethical conduct such as the UN Global Compact Principles, the OECD Guidelines for Multinational Enterprises, the Equator Principles for socially and environmentally responsible lending, the SA 8000 labour standards code, and others. Table 1 summarises many of the ethical principles instilled in such frameworks, which tend to emphasise the importance of human and labour rights, environmental quality, community development, good organisational governance, and integrity of the rule of law. Policymakers could engage in discussion for the purpose of agreeing on an ethical perspective for making policies and decisions regarding SMM, and could then encode these ethical principles explicitly into national and international policies. Common challenges with ethical standards that could affect government policymakers include:

- Vagueness;
- Difficulty of enforcement if they are voluntary. Public exposure has created some change in a handful of cases, but violations that become high profile or that become the target of environmental and human rights campaigns are relatively few;

- Limited implementation. These standards have existed for years yet have been explicitly implemented by only a small fraction of economic actors worldwide.

70. A number of established ethical principles with particular relevance to SMM include:

- Polluter Pays Principle;
- Precautionary Principle;
- Right-to-Know Principle;
- Principle of Liability and Compensation for Victims of Environmental Damage.

71. These ethical principles have been embedded into numerous policies discussed in this report.

Table 1. Selected International Ethics-Related Standards: Survey of Embedded Principles[45]

Survey of Embedded Principles		UN Global Compact	OECD Guidelines for MNEs	Equator Principles	SA 8000[4]	GRI[5]	Other
Human Rights	Support and respect for protection of internationally proclaimed human rights	■	■	■			
Human Rights	Defense against complicity in human rights abuses	■					
Labour	Support of freedom of association and the effective recognition of the right to collective bargaining	■			■	■	
Labour	Elimination of forced or compulsory labour	■			■	■	
Labour	Abolition of child labour	■			■	■	
Labour	Elimination of employment and occupation discrimination	■				■	
Labour	Protection of workplace health and safety			■	■	■	
Labour	Prevention of mental, physical & verbal coercion & abuse				■		
Labour	Enforcement of rules against excessive working hours				■		
Labour	Payment of wages which meet legal and industry standards and are sufficient to meet basic needs of workers' families				■	■	
Labour	Encouragement of human capital formation, by creating employment opportunities, training opportunities, etc.		■			■	
Labour	Promotion of employee awareness and compliance regarding ethical policies and practices		■			■	
Labour	Protection from retribution employees who report malfeasance to management or authorities						
Environment	Adherence to Precautionary Principle	■					■
Environment	Adherence to Polluter Pays Principle						■
Environment	Adherence to Right to Know Principle						■
Environment	Adherence to Principle of Liability and Compensation for						■

[4] SA 8000 is a global social accountability standard for decent working conditions, developed and overseen by Social Accountability International (SAI).

[5] GRI is the **Global Reporting Initiative** (GRI). It produces guidelines and standards for sustainability reporting by all organizations, similarly to financial reporting.

	Victims of Environmental Damage						
Environment	Protection and conservation of biodiversity, including endangered species and sensitive ecosystems			■		■	
Environment	Sustainable management of natural resources			■		■	
Integrity of the Rule of Law	Work against corruption in all its forms, including extortion and bribery	■				■	
Integrity of the Rule of Law	Compliance with and avoidance of exemptions to local environmental, health, safety, labour and finance rules		■	■		■	
Integrity of the Rule of Law	Avoidance of improper involvement in local political activities		■			■	
Business Practices	Adherence to good corporate governance and management principles and practices, including management systems		■		■	■	
Business Practices	Encouragement of business partners, suppliers and subcontractors to apply ethical principles of conduct		■				
Community	Encouragement of local capacity building through close co-operation with the local community		■				
Community	Application of self-regulatory practices and management systems that foster confidence and mutual trust between enterprises and the societies in which they operate		■				
Community	Protection of cultural property, heritage & indigenous rights			■		■	
Community	Contribution to economic, social and environmental progress to promote sustainable development		■	■		■	

4. NATIONAL APPLICATION OF POLICY PRINCIPLES

72. For each SMM Policy Principle, OECD Member Countries were invited to respond to the following questions:

1. Has your country developed or applied this/these principle(s) at any level of the government? (Please provide a maximum of five examples and any supporting documents or links to the examples.)

2. What is or was the basis for the development of the application of this/these principle(s)?

3. What are the indentified or expected challenges and what objectives have been set or achieved with this SMM Policy Principle?

4. Are there any other relevant national, regional or local examples that would illustrate the principles described above? If yes, please also explain what principle(s) this/these example(s) would illustrate. Please provide any supporting documents or links to the examples.

73. The document ENV/EPOC/WGWPR/RD(2009)2 contains the compiled submissions received from OECD Member Countries in response to the questionnaire on national application of SMM Policy Principles.

4.1 National Application of SMM Policy Principle 1 – Preserve Natural Capital

4.1.1 National Application

74. Several OECD Member Countries have taken steps to apply Principle 1 by gathering information about material flows and the related life-cycle impacts and by setting broad national priorities.

75. **Australia** has set out to enhance individual and community well-being by following a path of economic development that safeguards the welfare of future generations, provides for equity within and between generations, protects biological diversity and maintains essential ecological processes and life-support systems. As with other OECD member countries, Australia noted the major challenge of breaking the strong link between waste generation and economic development.

76. Australia provided an example of applying SMM Policy Principle 1 by enhancing resource productivity, resource efficiency and recycling through successful "Industrial ecology" in the Kwinana Industrial Area (KIA) in Western Australia. Industrial ecology refers to the synergistic integration of materials use within and between industries – whereby one industry's waste may become another's feedstock or resource. The Kwinana Industries Council (KIC) was formed in 1991 to organise air and water monitoring for the industries in the KIA.[46] Since then, the KIC has expanded its responsibilities to manage industrial hazards programmes, air and watershed monitoring protection, and has coordinated

industry efforts to reduce industry emission impact on the sensitive marine environment of the adjacent Cockburn Sound. The KIC consists of 12 major industries as full members and 30 other industries (predominantly medium sized operations and service providers) as associate members.

77. **Finland** has set out to decrease and manage in a sustainable way material and energy flows to develop long-term goals on how to use natural resources sustainably and to improve eco-efficiency. In doing so, they also are seeking to strengthen the coordination of natural resource policies. From the social and economic perspectives, they are striving to increase overall wellbeing and to create new business possibilities based on natural resources.

78. In April 2009, Finland completed a 3-year study on the environmental impacts of the Finnish national economy. Using the ENVIMAT model developed by the Finnish Environment Institute, the Thule Institute at the University of Oulu and MTT Agrifood Research Finland, the study was able to provide a comprehensive picture of the environmental impacts of the Finnish national economy and an approach for considering direct and indirect material flows. The study will be used to develop policies and targets for different sectors.[47]

79. Also in April 2009, a Natural Resource Strategy for Finland was developed and presented to the Prime Minister. The strategy, which was compiled by a group of experts and managed by Sitra (the Finnish Innovation Fund), supports an approach to natural resources that promotes competitiveness, wellbeing and environmental responsibility. Responsibility for implementing the strategy is shared between different ministries.[48] The national strategy resulted in the following vision and strategic goals:

1. Finland has a thriving bioeconomy generating high added value.

2. Finland utilises and recycles material flows effectively.

3. Regional resources generate both national added value and local wellbeing.

4. Finland takes initiatives and leads the way on natural resource issues internationally.

80. **Sweden** has set up 16 Environmental Quality Objectives along with three action strategies and a set of environmental indicators.[49] The environmental quality objectives are designed to promote human health; safeguard biodiversity and the natural environment; preserve the cultural environment and cultural heritage; maintain long-term ecosystem productivity; and ensure wise management of natural resources. The overall goal is that, "within one generation, the major environmental problems currently facing will be solved."

81. The Environmental Quality Objectives describe what quality and state of the environment are sustainable in the long term. There are also social and economic dimensions involved. The majority of the Objectives contain provisions for conserving and restoring natural capital. For example under Environmental Quality Objectives 9 and 16: "*Good-Quality Groundwater"* and *"A Good Built Environment"* there are interim targets for waste and extraction of natural gravel.

4.1.2 Observations, achievements and challenges

82. Although waste prevention measures have been put in place in many OECD countries along with measures to reduce material throughput to increase resource productivity and to step up reuse and recycling, these measures did not explicitly address the preservation of natural capital from a sustainable materials management perspective.

83. A number of the OECD countries noted the serious challenge of decoupling economic growth and development from the overall increase in consumption of natural capital. Finland noted that decoupling has been achieved for several pollutants, but overall consumption of natural resources and energy is increasing -- particularly in the transportation sector. And certain toxics still cause problems. In Finland, as reported in other regions, eco-efficiency is improving, but it is not improving as rapidly as expected. Another challenge noted by Finland is the increasing importance of international natural resource policy and how to evaluate and prioritise impacts and objectives for natural capital based on national characteristics (*e.g.* climate, industry, etc.).

84. In Australia, the KIC achieves industrial waste reductions of approximately 421,600 tonnes per year. There are thirty-two by-product synergies and fifteen utility infrastructure synergies in the KIA. Feasibility work is underway on a further fifteen synergy opportunities. Information was not found on the role of government in setting up the KIC.

85. In Sweden, the Environmental Objectives have been successful in guiding the direction of the work of municipal and central authorities. However, the government is challenged to engage and motivate other actors in meeting the objectives, *e.g.* industry. The Environmental Objectives are ambitious and there are major challenges in reaching many of them within the set time limit. Sweden's priorities are to implement the policy measures already decided and to coordinate measures between them, to get maximum impact of each measure and to drive synergies.

4.2 National Application of SMM Policy Principle 2 -- Design And Manage Materials, Products And Processes for Safety and Sustainability from a Life-Cycle Perspective

4.2.1 National Application

86. In **Belgium,** SMM Policy Principle 2 is being incorporated into *policy planning* and *regulatory instruments*. The basis for these developments is the need for more upstream measures that decrease the amount of residual waste to be incinerated or sent to landfills.

87. The principle of *extended producer responsibility (EPR)* has been introduced for several waste streams such as WEEE, batteries and accumulators, waste oils, end-of-life vehicles, cooking oils, packaging materials and paper. These EPR schemes try to establish a link between different actors in the life-cycle of a product, starting from product design and ending with the collection and the recycling of the resulting waste. This link is established by giving financial and/or operational responsibilities to different actors in the life-cycle, with the original producer as main actor. While they have been successful in increasing collection and recycling rates, they have been less successful in stimulating more eco-design.

88. As an EU country, Belgium has a tradition of developing waste management plans for different waste streams. Some of these plans go beyond just the waste phase. Gradually waste *policy planning* is trying to integrate more measures that address different phases of the life-cycle. The biggest challenge for policy planning with a strong life-cycle perspective is the limited influence of the planning authority. Material cycles occur on a transnational or even global scale, while an environmental authority has only jurisdiction over what is happening within its own territory. And even then they may be limited by trade rules to avoid distorted competition with neighbouring countries, etc.

89. Belgian waste policy is based on the *waste hierarchy* (prevention, reuse, recycling, energy recovery and finally landfilling). Policies that have proven to be the most successful are those that work on all levels of the waste hierarchy at the same time. For instance, landfill taxes or bans have a greater effect when they are combined with the introduction of pay-as-you-throw schemes, with selective collection schemes and with waste prevention measures. Basing policy on the waste hierarchy automatically helps to focus on the issue from a life-cycle perspective. The biggest challenge with this approach is the development of sufficient knowledge/data about the impacts that occur throughout the life-cycle and defining proper system boundaries and starting hypotheses for an LCA, etc., so as to be able to judge when the waste hierarchy needs to be overruled for obtaining the best environmental result.

90. Belgium is now trying to introduce a *chain management approach* in their policy development. The idea is to identify material cycles that have a great potential for lowering their environmental impact and then to bring together all of the different actors in that cycle to see what possibilities there are for more cooperation between the different actors in the chain and for a more coherent set of policy measures that work on different phases of the life-cycle. The main challenge is to find sufficient actors within a value chain that are prepared to sit together and co-operate. There is also the problem that it may be difficult to engage actors in the life-cycle from outside governmental jurisdiction.

91. Belgium has developed a software tool for use by designers that is easy to use for calculating the *"ecological rucksack"* of the products they design.[50] This tool helps to inform designers about the hidden impacts of the materials they use in new products. The main challenge is how to stimulate designers to make use of this tool. Their driver is most often price and quality requirements imposed by their customers -- environmental issues may not be a high priority.

92. In the **United States**, national applications of SMM Policy Principle 2 include a number of *initiatives* that identify leadership in design for safety and sustainability of materials, products and processes from the life-cycle perspective and promote their advancement through public recognition or procurement. Examples include the US Environmental Protection Agency's (USEPA) programmes in Green Chemistry[51], Green Engineering[52], Design for the Environment[53] and Environmentally Preferable Purchasing.[54] Some of these programmes result in the development of tools and information resources that support design. Others result in public recognition -- whether through high profile awards or through the labelling of individual leadership products to bring market advantage. Products labelled or identified through these government initiatives are supported to varying degrees by government procurement. *USEPA's Green Chemistry Program* promotes green chemistry through the prestigious Presidential Green Chemistry Challenge Awards. This is the only Presidential level chemistry award in the US. USEPA also supports green chemistry through educational activities and research and development. Green chemistry is currently gaining significant momentum in the US outside of the USEPA, such as through the Green

Chemistry Institute of the American Chemical Society, through state initiatives such as those in Michigan and California.

> "Green chemistry is a pre-emptive strategy that reduces the use of toxic substances before they contaminate the environment and our bodies. It is a marked departure from the past where society managed industrial and municipal wastes by disposal or incineration. Green chemistry seeks to dramatically reduce the toxicity of chemicals in the first place, rather than merely manage their toxic waste after use and disposal." [55]

93. *USEPA's Green Engineering Program* works to incorporate green design concepts into chemical processes and products by providing tools and resources for engineers in academia and industry. A Green Engineering textbook, *Green Engineering: Environmentally Conscious Design of Chemical Processes* has been developed for instructing "green" thinking in engineering processes and applications. Software has been developed to provide chemical engineers with a suite of tools for assessing chemical hazards in process design. Continuing education courses and case studies to illustrate green engineering alternatives in chemical process design have been developed for industrial engineers.

94. *USEPA's Design for the Environment Program (DfE)* uses multi-stakeholder partnerships to engage with NGOs and industry to advance green chemistry in product design. The DfE Safer Product Labelling Programme promotes green chemistry and provides benefits to stakeholders throughout the supply chain by allowing manufacturers to submit product formulations for chemical profiling and assessment. Where formulators are successful in developing a product that uses low hazard chemicals, they are allowed to use the DfE-logo on that product. Where formulators are not successful, DfE will provide technical assistance to guide formulators to safer alternatives. The programme supports formulators in finding -- and raw material suppliers in selling -- safer ingredients. DfE has developed DfE Criteria for Safer Chemicals that help to identify low hazard chemicals within a particular functional use (*e.g.* solvent, fragrance, etc.). Information on the chemicals that meet DfE criteria and have been reviewed by a third party, is made publicly available via a database.[56] The programme also benefits institutional purchasers and consumers by use of the DfE logo which makes it easier to identify products comprised of chemicals that are safer for human health and the environment. The programme is popular with stakeholders from both industry and NGOs and there demand for its expansion. In the near term, Partnerships may address adhesives and children's products, such as markers.

95. DfE programmes are effective in part because they are based on multi-stakeholder input.[57] DfE has developed tools and approaches for comparative hazard assessment that inform decision making and that have been used as a basis for initiatives in the private sector.[58] When safer chemical alternatives have not yet been identified, DfE encourages best practices to minimise pollution, especially in the auto refinishing and spray polyurethane foam industries. DfE also performs life-cycle assessment (LCA) studies. The DfE Lead-Free Solder Partnership conducted an LCA for tin-lead and leading lead-free solder alternatives for use in electronic products, allowing electronics manufacturers to choose materials that pose fewer impacts over the life-cycle of their products. DfE has recently begun the Lithium-ion Batteries and

Nanotechnology Partnership, to conduct a LCA of current and future battery technologies that may be used in hybrid and electric vehicles.

96. *The Energy Star*[59]*: Portfolio Manager* is an interactive tool that allows one to track and assess energy and water consumption across a portfolio of buildings in a secure online environment. The tool can help set investment priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance.

4.2.2 Observations, achievements and challenges

97. Belgium is strategically moving its waste management policy planning toward SMM. The challenges they noted in the brief descriptions of the applications may be helpful to other OECD countries seeking to explore similar initiatives. Perhaps by integrating elements of the voluntary initiatives in the US with elements of the regulatory and other policy initiatives in Belgium, policies may be optimised for SMM. For example, perhaps a DfE-type Partnership programme could recognise designers who use the "ecological rucksack" tool to design products with sustainability benefits.

98. In the US, success has been demonstrated with promoting the design of materials, products and processes for safety and sustainability from the life-cycle perspective through market-based measures such as Energy Star, DfE Partnerships, EPEAT, Green Chemistry, Federal Electronics Challenge and government procurement. It may be important to look closely at initiatives such as these that have been effective and popular across stakeholder groups by defining leadership activities and achievable objectives.

4.3 National Application of SMM Policy Principle 3 -- Use the Full Diversity of Policy Instruments to Stimulate and Reinforce Sustainable Economic, Environmental and Social Outcomes

4.3.1 National Application

99. Several OECD countries described the application of SMM Policy Principle 3 as the basis for government initiatives.

100. **Belgium** has developed a multifaceted strategy to promote SMM, including a Transition Network established by the Belgian Public Waste Authority to create a vision, pilot projects and transition paths to move Belgium toward a future with sustainable materials management. The explicit goal is not to create incremental improvements, but rather to shift the whole system toward closed material cycles, substitution of services for products, improvement of the sustainability profile of basic materials like plastics, and improved consumer awareness.

101. The Belgian policy approach includes the waste hierarchy to drive policies that address different stages of the life-cycle. To reinforce policy objectives, Belgium has leveraged various kinds of policy instruments concurrently, including:

- Regulations – *e.g.* Extended Producer Responsibility, landfill and incineration bans for specific waste streams, requirements for management of particular waste streams;

- Economic Incentives – *e.g.* Landfill and incineration taxes, extra fees for non-recyclable household waste, subsidies for local governments to adopt waste prevention and to invest in infrastructure for material collection;

- Information Sharing - Communication campaigns for stimulating waste prevention and separation at source;

- Trade and Innovation Policy - Setting up networks of reuse centres;

- Voluntary Partnerships - Stimulating inter-municipal cooperation in the field of waste management.

102. **Czech Republic** applies a strategy for SMM which includes many information-related and economic incentive components. For example, the Centre for Waste Management maintains a database of the Best Available Technologies regarding waste recovery and disposal. The Czech Environmental Information Agency (CENIA) maintains information and statistics on many aspects of sustainability and the environment, for access by the general public. Other government agencies specialize in the evaluation and transfer of more sustainable materials technologies – for example, the Research Institute of Building Materials (VUSTAH) and the Technology Centre AS ČR.

103. The Czech Programme for Labelling Environmentally Friendly Products provides an ecolabelling scheme covering 61 categories of products or services. It is a relatively new programme but in 2008, there were 92 producers involved in this programme.

104. The Czech Ministry of the Environment has launched several research projects intended to provide producers with consistent, reliable information about the environmental impacts of common components and materials and with information on the environmental performance of new technologies. The intent is to aid producers in minimising the environmental impact of products. Efficiency, effectiveness and integration have been aided by initiatives to model waste management expenses under different scenarios.

105. The Czech Republic has implemented a number of economic instruments to support elements of SMM. As an example of an economic disincentive, the New Waste Act in the Czech Parliament proposes to increase fees on waste disposal. As examples of economic incentives, the Czech government is promoting green public procurement for public purchases and the Ministry of the Environment has worked to promote a potential reduction or abolition of the Value Added Tax (VAT) for products with environmentally-friendly features (*e.g.* superior energy efficiency, high recycled material content, etc.)

106. **Sweden's** Material Management Framework includes several policy instruments. The Environmental Quality Objectives incorporate both ecological (biodiversity, ecosystem productivity, natural resource management) and human (health, cultural heritage) considerations. The Environmental Code includes a provision requiring consideration of both economic costs and benefits when permitting and regulating facilities and activities which could negatively impact human health or the environment. To drive greater effectiveness, Sweden has adopted a policy approach that leverages a mix of instruments, including:

- Regulations – *e.g.* Producer responsibility for various materials (paper, tires, cars, batteries, electronics, and lighting); ban on landfill of organic and combustible waste;

- Economic Incentives – Deposit system for drinking containers; and

- Information Sharing - collaboration with other Scandinavian countries to support the Nordic Swan ecolabel, covering over 5000 products in some 70 product groups.

4.3.2 Observations, achievements and challenges

107. A number of the OECD countries have demonstrated that using a full diversity of policy instruments can lead to success in stimulating and reinforcing waste management policies. Extending waste management policies to include SMM is still in the early stages. Several Member Countries noted that Extended Producer Responsibility (EPR) Programmes have been successful in increasing collection and recycling rates in some countries, but they have been less successful in stimulating more eco-design. EPR can be effective in promoting SMM if the policy structure drives redesign at the beginning of the product lifecycle; but if focused only on improved recycling without redesign, it can generate outcomes that may be less efficient, both economically and environmentally.

108. Some policy instruments appear to be effective and relatively simple to implement in support of SMM. These include environmentally preferable procurement for governments and the creation of research centres that drive resource efficiency. The modification proposals for the Value Added Tax (VAT) favouring sustainable innovations in the Czech Republic hold the potential to significantly increase economic actors' planning for and investment in SMM improvements.

109. As is true with many programmes, SMM is limited by insufficient budgets that limit the degree and level of innovation of government interventions and changes. It is also challenging for some to get sufficient cooperation from industry. One member country contributor suggested that to get the most cooperation from industry, it is helpful to communicate in a convincing way, "what's in it for them".

4.4 National Application of SMM Policy Principle 4 -- Engage all Parts of Society to Take Active, Ethically-Based Responsibility for Achieving Sustainable Outcomes

4.4.1 National Application

110. **Australia** has drafted a National Action Plan for Education for Sustainability: *Living Sustainably*, which brings together representatives from academia, non-government organisations, youth, and local government with the aim of equipping all Australians with the knowledge and skills required to live sustainably. The intent of the plan is to:

- Promote sustainability throughout the national training system;

- Support whole-institution change for sustainability in universities;

- Form partnerships with industry bodies and professional associations to develop and deliver workplace learning for sustainability;

- Work with local governments to improve their capacity to engage in best practice community education for sustainability;

- Undertake research which will recommend effective approaches to achieve enduring, system-wide change;

- Embed sustainability within the community.

111. **Belgium** is now looking to introduce a chain management approach in their policy, to identify material cycles with high potential for reduced environmental impact and to bring together different actors in that cycle to identify opportunities for greater cooperation and a coherent set of policy measures that work in different phases of the life-cycle. It is still early in the application of the chain management approach but stakeholder theory would suggest that it has good potential to achieve the desired outcomes.

112. The Belgian Public Waste Authority also initiated a transition network on sustainable materials management to bring together representatives of business, NGO, academia and government to undertake transition experiments toward sustainable materials management. This kind of network is an experiment in itself in finding new ways of governance. Instead of introducing regulations or subsidies/taxes from a top-down approach, the authorities sit together with different actors in society creating room for innovation and creating new coalitions and forms of cooperation.

113. **Czech Republic,** like other EU countries, is working to build ethical principles into SMM policy and policy instruments. For example, the Polluter Pays Principle is embedded into EPR laws and the principle of collective responsibility is embedded into take-back regulations. The Czech Republic and other EU countries also work to build sustainability knowledge and capacity through consumer awareness-raising campaigns for sustainable consumption and production by:

- Providing public information campaigns and illustrations of good practises on WEEE and other solid waste issues;

- Coordinating school-based and other small-scale local collection activities;

- Setting up Earth Day celebrations and games;

- Developing competitions, projects, workshops and learning games to support the education of the general public and children to teach them about the proper disposal of waste.

114. **The Netherlands** has adopted a Material Chain Approach (Dutch Chain Approach) to achieve SMM as part of the national Future Waste Policy. This approach represents an overall movement toward SMM by considering life-cycle impacts of waste. Implementing the Material Chain Approach engages the government as a facilitator, bringing together different actors in the material chain in order to:

- Map environmental burdens in the whole material chain;

- Determine ways to improve sustainable material performance;

- Set improvement strategies, goals and targets for each priority stream;

- Draft a plan of action for each priority stream;

- Take action;

- Monitor progress;
- Establish definitions and measurable criteria and quantitative metrics.

4.4.2 Observations, achievements and challenges

115. Australia's education objectives are broad and ambitious and not surprisingly face several challenges. They are striving to coordinate consistent approaches to education for sustainability across all levels of governments. In addition, they seek to widen the scope of education for sustainability from formal education institutions to the broader community, including industry. They seek to further extend and integrate the education initiatives by establishing partnerships and strategic links within and between governments, industry and community sectors to catalyse progress.

116. In Belgium, a major challenge noted with the chain management approach is to find sufficient actors within a value chain that are prepared to sit together and cooperate. One member country noted that sometimes the carrot and stick method is effective for engaging stakeholders, *i.e.* by creating a situation that allows stakeholders to avoid the threat of regulatory measures or taxes by their willingness to collaborate and cooperate to find solutions. However, the challenge of engaging willing stakeholders can be complicated when the stakeholders are from other countries or otherwise outside of a government jurisdiction.

5. CONCLUSIONS

117. This report identifies four broad SMM Policy Principles ("framework conditions") that support a shift from waste management to materials management in support of sustainable development. Because SMM is a relatively new approach, there are limited examples of policies developed with a comprehensive SMM framework in mind. However, many OECD Member Countries have built on existing policy frameworks in areas such as waste management, environmentally preferable procurement and extended producer responsibility to progress toward SMM. While an evaluation of policy instruments related to SMM will be covered in a separate OECD thematic report, this report contains a number of illustrative examples of national applications of individual SMM Policy Principles.

5.1 SMM Opportunities

118. Applying SMM can generate benefits by encouraging policymakers to take a systems view of materials that flow among the economic, social and environmental systems and to optimise all three aspects of sustainability as they relate to materials. SMM supports a life-cycle view of impacts associated with materials use which can help policymakers to better predict and manage downstream and long-term consequences of actions, to avoid shifting problems from one stage of the value chain to another, or shifting impacts from the present to future generations. SMM also encourages multilateral participation in the creation and execution of policies and practices related to materials use. By encouraging processes that are broadly inclusive of stakeholders, governments can generate more ideas and develop policies that are locally-relevant and more likely to gain greater support from those who are responsible for executing them. Inclusiveness also tends to increase the equity of outcomes by giving a voice to everyone who is potentially impacted, before outcomes are generated.

119. One promising approach that directly supports SMM and multiple SMM Policy Principles is the Material Chain Approach being implemented by the Netherlands and considered by Belgium. This approach represents an overall movement toward SMM in which the government plays the role of convener and facilitator, bringing together different actors in the material chain and considering the life-cycle impacts of materials. The Belgian Public Waste Authority initiated a transition network on sustainable materials management to bring together representatives of business, NGO, academia and government to undertake transition experiments toward sustainable materials management. This kind of network is an experiment in finding new forms of governance whereby authorities sit together with different actors in society creating room for innovation via new coalitions and cooperation.

5.2 SMM Challenges

120. Member countries have also encountered challenges in their pursuit of SMM objectives. These challenges provide learning opportunities and are fodder for innovative policies:

- *Decoupling growth in wellbeing from growth in material consumption* --No member country has reported complete success decoupling economic growth and development from increased consumption of natural capital. Some have reported success in reducing certain pollutants, increasing the percentage of waste diverted to landfill, and creating small-scale industrial ecosystems. Overall, however, consumption of natural resources and energy is still increasing. New strategies and synergies will be needed to accelerate decoupling.

- *Understanding material flows and impacts, particularly direct and indirect flows and international impacts* -- Understanding of domestic and international material flows and their social and environmental impacts is still incomplete and inconsistent. Building better knowledge of material impacts, combined with open information sharing among Member Countries and economic actors could advance SMM and enable better decision-making. A growing set of assessment tools with the potential to support SMM (*e.g.* material flow analysis (MFA), total cost assessment (TCA), economic input/output assessment (EIO), life-cycle assessment (LCA), ecological rucksack analysis, etc.)[60] can provide insight into the complex SMM system. Governments could share best practices regarding each individual tool and its use in combination with the others.

- *Realigning regulations and incentives to ensure that behaviour which is economically rational is also sustainable* -- To align the actions of economic actors with SMM objectives, governments could deliberately and systematically guide economic actors by taking a long-term view of actions, impacts, investments, and returns by focusing and communicating a vision for the whole ecological-social-economic system rather than maximising economic value in isolation.

- *Improving consistency of the life-cycle focus* – Product policies including Extended Producer Responsibility (EPR) could be refined to ensure that they not only fund and drive product recycling, but that they also encourage producers to address questions of design - improving SMM outcomes by eliminating toxicity and preventing waste throughout the life-cycle.

- *Advancing government-industry collaborations* -- Aligning governments and industry around common objectives can leverage the influence, ideas, skills and experience of each to generate synergies that go well beyond improving efficiency. It may be fruitful to consider how to adapt the SMM Policy Principles for use by industry to encourage a focus on preserving natural capital, to improve material, product and process design, to integrate into business strategies and to engage in best practices for stakeholder involvement.

- *Promoting productive stakeholder engagement* -- Collaborations among actors across material value chains could advance SMM by promoting potential synergies among actors who have not had the occasion to collaborate before to pursue a common goal. However, convening and engaging stakeholders can be expensive, time consuming, and sometimes frustrating. It is important to present stakeholders with clear ideas about what they will gain from participating and to host meetings that are planned thoughtfully to ensure that they are valuable for everyone, solicit equitable contributions from all parties, and produce concrete outcomes and next steps. Policymakers could support research into best practices for creating and supporting multilateral collaborations and partnerships.

REFERENCES

[1] OECD (2005), Outcome of the first OECD Workshop on Sustainable Materials Management, ENV/EPOC/WGWPR/RD(2005)5/FINAL, OECD, Paris (http://www.olis.oecd.org/olis/2005doc.nsf/Linkto/env-epoc-wgwpr-rd(2005)5-final).

[2] Fiksel, J. (2006), A Framework for Sustainable Materials Management, *Journal of Materials (JOM)*, August 2006, pp.15- 22.

[3] Ibid.

[4] Ibid.

[5] Millenium Ecosystem Assessment Board (2005), *Living Beyond Our Means: Natural Assets and Human Well-Being*, accessed September 2009 at: http://www.millenniumassessment.org/documents/document.429.aspx.pdf

[6] OECD (2001), *OECD Environmental Strategy for the first Decade of the 21st Century*, accessed October 2009 at: http://www.oecd.org/dataoecd/33/40/1863539.pdf

[7] OECD (2008), *Recommendation of the Council on Resource Productivity [C(2008)40]* (http://www.oecd.org/dataoecd/1/56/40564462.pdf).

[8] OECD (2008), *Measuring Material Flows and Resource Productivity*, Synthesis Report and Volumes I-II, accessed September 2008 at: http://www.oecd.org/document/47/0,3343,en_21571361_40266644_40464047_1_1_1_1,00.html.

[9] OECD (2008), *A Study on Methodologies Relevant to the OECD Approach on Sustainable Materials Management*, ENV/EPOC/WGWPR(2007)5/FINAL, OECD, Paris (http://www.olis.oecd.org/olis/2007doc.nsf/LinkTo/NT00008902/$FILE/JT03250103.PDF).

[10] OECD (2008), *Measuring Material Flows and Resource Productivity*, Synthesis Report (http://www.oecd.org/dataoecd/55/12/40464014.pdf).

[11] OECD (2008), *Recommendation of the Council on Resource Productivity [C(2008)40]* (http://www.oecd.org/dataoecd/1/56/40564462.pdf).

[12] OECD (2009), *Sustainable Manufacturing and Eco-Innovation: Framework Practices and Measurement*, Synthesis Report, accessed September 2009 at: http://www.oecd.org/document/37/0,3343,en_2649_34173_40695077_1_1_1_1,00.html.

[13] OSTARA Nutrient Recovery Technologies, Inc., accessed Oct 2009 at: http://www.ostara.com/. See also Phosphorus Recovery, accessed Oct 2009 at: http://www.phosphorus-recovery.tu-darmstadt.de/index.php?option=com_frontpage&Itemid=1.

[14] OECD (2009), *Sustainable Manufacturing and Eco-innovation: Towards a Green Economy*, Policy Brief (http://www.oecd.org/dataoecd/34/27/42944011.pdf).

[15] http://www-935.ibm.com/services/us/gbs/bus/html/smarter-cities.html

[16] Geiser, K. (2001), *Materials Matter: Toward a Sustainable Materials Policy*, MIT Press, Cambridge, MA.

[17] Adapted from McDonough, W. and M. Braungart (2002), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press.

[18] Clean Production Action. The Plastics Scorecard. Accessed Oct 2009 at: http://www.cleanproduction.org/Scorecard.Intro.php

[19] Anastas, P.T, and J. C. Warner (1998), *Green Chemistry Theory and Practice*, Oxford, University Press

[20] OECD (2008) Environmental Policy, Technological Innovation and Patents

[21] http://www.oecd.org/env_sustainablechemistry_platform/

[22] http://www.epa.gov/dfe/index.htm

[23] http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm.

[24] http://www.epa.gov/triexplorer/

[25] http://www.oecd.org/department/0,3355,en_2649_34377_1_1_1_1_1,00.html

[26] http://www.oecd.org/department/0,3355,en_2649_34411_1_1_1_1_1,00.html

[27] OECD (2009), *Sustainable Manufacturing and Eco-Innovation: Framework Practices and Measurement*, Synthesis Report, accessed September 2009 at: http://www.oecd.org/document/37/0,3343,en_2649_34173_40695077_1_1_1_1,00.html.

[28] http://www.sodaclubusa.com/default.htm?r=0.

[29] McDonough, W. and M. Braungart (2002), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press. (Term coined by Walter Stahel and Michael Braungart in the 1970's, http://www.product-life.org/en/cradle-to-cradle).

[30] http://www.epea.com/.

[31] Tojo, N. (2004), *EPR as a Driver for Design Change – Utopia or Reality*, Doctoral Dissertation, Lund University, Lund, Sweden (www.iiiee.lu.se).

[32] European Commission (2008), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, 2008: 2.1

[33] Ibid.

[34] http://www.oecd.org/document/16/0,3343,en_2649_37431_43442320_1_1_1_1,00.html

[35] http://www.epeat.net.

[36] OECD (2006), *Cost-Benefit Analysis and the Environment- Recent Developments*.

[37] Business-NGO Forum for Green Chemicals and Sustainable Materials. Accessed Oct 2009 at: http://www.busngoworkgroup.org/.

[38] Sustainable Packaging Coalition, accessed October 2009 at: http://www.sustainablepackaging.org/.

[39] www.freecycle.org/, accessed September 2009.

[40] www.epa.gov/dfe/, accessed October 2009.

[41] http://www.motiva.fi/en/areas_of_operation/material_efficiency

[42] http://www.cdproject.net/

[43] http://www.osha.gov/dep/oia/whistleblower/index.html

[44] OECD (2008), *Guidelines for Multinational Enterprises*, OECD, Paris, accessed October 2009 at: http://www.oecd.org/dataoecd/56/36/1922428.pdf

[45] http://www.unglobalcompact.org/aboutthegc/TheTenPrinciples/index.html; http://www.equator-principles.com/principles.shtml; http://www.sa-intl.org/index.cfm?fuseaction=Page.viewPage&pageID=473;

http://www.globalreporting.org/NR/rdonlyres/DDB9A2EA-7715-4E1A-9047-FD2FA8032762/0/G3_QuickReferenceSheet.pdf

[46] Kwinana Industries Council, accessed October 2009 at: http://www.kic.org.au See Annual Report at: http://www.kic.org.au/files/2008-KIC-report.pdf

[47] http://www.ymparisto.fi/default.asp?contentid=317660&lan=en , accessed September 2009.

[48] http://www.sitra.fi/en/Innovations/natural_resources_strategy/natural_resource s_strategy.htm.

[49] www.miljomal.nu/Environmental-Objectives-Portal/.

[50] http://www.ovam.be/jahia/Jahia/pid/1818?lang=null. (In Dutch. English version planned for 2010. Personal communication with John Wante).

[51] http://www.epa.gov/greenchemistry, accessed September 2009.

[52] http://www.epa.gov/oppt/greenengineering/index.html, accessed September 2009.

[53] http://www.epa.gov/dfe/, accessed September 2009.

[54] http://www.epa.gov.epp

[55] California Green Chemistry Initiative. http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/upload/GREEN_Chem.pdf, Accessed Oct 2009.

[56] http://www.cleangredients.org/home, accessed October 2009.

[57] http://www.epa.gov/dfe/index.htm, accessed October 2009.

[58] http://www.cleanproduction.org/Green.Greenscreen.php, accessed October 2009.

[59] http://www.energystar.gov/benchmark, accessed October 2009.

[60] OECD (2008), *A Study on Methodologies Relevant to the OECD Approach on Sustainable Materials Management*, ENV/EPOC/WGWPR(2007)5/FINAL, OECD, Paris (http://www.olis.oecd.org/olis/2007doc.nsf/LinkTo/NT00008902/$FILE/JT03250103.PDF).