
**OECD GLOBAL FORUM ON ENVIRONMENT**

**Focusing on**

**SUSTAINABLE MATERIALS MANAGEMENT**

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# Summary Paper 4:

# Considerations for Developing a Path Forward

## Working Document

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## NOTE FROM THE SECRETARIAT

This working document is a summary paper prepared by Joseph Fiksel, Executive Director of the Center for Resilience at the Ohio State University, to support the discussion of session 5 of the Global Forum on SMM.

On the basis of the work carried out so far on SMM by the OECD Working Group and Waste Prevention and Recycling and of the documents prepared for this Global Forum, the paper identifies possible ways forward for governments and international organizations which want to establish or further advance policies and approaches based on the concept of SMM.

The opinions expressed in this paper are the sole responsibility of the author and do not necessarily reflect those of the OECD or the governments of its member countries.

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## THE CHALLENGES FACING SMM

The OECD and other organisations have recognised that continuing the present pattern of global economic growth will likely result in increased material consumption and waste generation, thereby threatening the overarching goals of global sustainable development and protection of natural resources. In order to break this pattern, it is important for the world's nations to move beyond waste minimisation policies and consider interventions that address the full life cycle of material use, including the extraction of raw materials, their transport, processing, and incorporation into products, their emissions and fate during product use, and their eventual disposition or recovery at the end of product life.

The OECD Working Group on Waste Prevention and Recycling (WGWPR) has held a series of workshops to investigate policies that will encourage cost-effective reduction of material throughput and the associated environmental burdens, based on the concept of Sustainable Materials Management (SMM). OECD working definition of SMM is[1]:

*"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."*

Implementation of SMM policies and practices is a promising strategy for decoupling economic growth from natural resource consumption. However, modern industrial supply chains often extend around the world, and SMM policies should assure that environmental impacts are not merely shifted across international boundaries through mechanisms such as outsourcing. In this regard, it will be challenging to provide full accounting of the hidden material impacts throughout the product life cycle, including mining, agriculture, and transportation.

Achievement of SMM is further complicated by the interdependence between material use and consumption of other natural resources, such as energy and water. Proposed policies must account for this interdependence to avoid unintended consequences. For example, many have proposed replacement of non-renewable materials such as petroleum derivatives with bio-based, renewable materials, yet these substitute materials may consume far greater amounts of water and other ecosystem services.[2]

Due to the challenging scope and complexity of the above material life cycle issues, analysis of SMM opportunities and policy implications requires a range of analytic methods to assess the "true" environmental impacts of material use in industrial economies. OECD has compiled a summary of ten methodologies that can be used to analyse social, economic and environmental impacts across the life cycle of materials.[3] While no single methodology is sufficient to capture the full implications of SMM, it was concluded that a combination of Economic Input/Output Analysis, Life-Cycle Analysis and Material Flow Analysis will provide useful insights for policy development.

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[1] OECD Working Group on Waste Prevention and Recycling, *Outcome of the First OECD Workshop on Sustainable Materials Management*, ENV/EPOC/WGWPR/RD(2005)5/FINAL, Seoul, Korea, 28-30 November 2005.

[2] A. Baral and B. R. Bakshi, "Thermodynamic Metrics for Aggregation of Natural Resources in Life Cycle Analysis: Insight via Application to Some Transportation Fuels," *Envir. Science & Technology*, 44 (2), pp. 800–807 (2010).

[3] OECD Working Group on Waste Prevention and Recycling, *A Study on Methodologies Relevant to the OECD Approach on Sustainable Materials Management*, ENV/EPOC/WGWPR/RD(2007)5/FINAL, 25 September 2008.

## PRACTICES AND PRINCIPLES RELEVANT TO SMM

A survey of OECD countries conducted in 2007 showed that a number of them have begun to systematically assess the environmental impacts of policies that are relevant to SMM.[4] It is clear that for such policies to be successful they must engage a variety of *stakeholders* in the product chain—including suppliers, producers, retailers, consumers, recyclers and disposers—in collaborative partnerships aimed at specific materials or sectors. For example, some countries have aimed at reduction in use of hazardous substances such as mercury, lead, cadmium, and asbestos, while others have targeted product categories such as batteries and electronic equipment. Most countries recognise that conservation of natural resources requires adoption of innovative technologies as well as policies that encourage energy efficiency and material recycling.

Even in the absence of policy drivers, SMM practices have been embraced by many leading multi-national companies, since material efficiency tends to increase productivity and reduce the costs of procurement, supply chain operations, and waste management. Environmentally-conscious design and management of products and processes includes three main approaches that contribute to SMM:[5]

- **Dematerialisation**—minimising material throughput as well as the associated energy and resource consumption at every stage of the life cycle. This can be achieved through a variety of techniques, such as product life extension, source reduction (i.e., downsizing), process simplification, remanufacturing, use of recycled inputs, or substitution of services for products. This practice represents a major opportunity for decoupling economic growth from resource consumption.

- **Detoxification**—minimising the potential for adverse human or ecological effects at every stage of the life cycle. This can be achieved through replacement of toxic or hazardous materials with alternative, benign materials that meet the same functionality requirements; introduction of cleaner technologies that reduce harmful wastes and emissions, including greenhouse gases; or waste modification using chemical, energetic, or biological treatment. While detoxification can reduce environmental impacts, it may not help to reduce resource consumption.

- **Value recovery**—recovering residual value from materials and resources that have already been utilised in the economy, thus reducing the need for extraction of virgin resources (also known as revalorisation). This can be achieved by finding secondary uses for discarded products, refurbishing or remanufacturing products and components at the end of their useful life, facilitating disassembly and material separation for durable products, and finding economical ways to recycle and reuse waste streams. Value recovery goes hand in glove with dematerialisation, since repeatedly cycling materials and resources within the economy reduces the need to extract them from the environment.

[4] OECD Working Group on Waste Prevention and Recycling, *Report of the 2nd Survey on SMM-Related Activities In OECD Countries*, ENV/EPOC/WGWPR(2008)3/FINAL, 27 January 2009.

[5] J. Fiksel, *Design for Environment: A Guide to Sustainable Product Development (Second Edition)*, McGraw-Hill, New York, 2009.

The most recent OECD workshop on SMM, held in Tel Aviv, Israel in 2008, brought together leading organisations that have implemented SMM practices around the world.[6] Many companies have initiated innovative programs to understand and manage the life cycles of their products and processes, including their upstream supply chains and downstream product chains. Organisations such as the World Business Council for Sustainable Development have been instrumental in raising awareness of sustainability issues and developing relevant tools and best practices. Therefore, engagement of the business community in SMM policy development will likely be a productive approach.

The above workshop concluded that OECD should (a) examine the framework conditions and principles for SMM, including the possibilities of applying specific policies (*e.g.* SMM targets) and/or instruments (*e.g.* economic approaches); and (b) carry out case studies on priority materials, aimed at developing a better understanding of "good practices" in these areas and facilitating exploration of policy opportunities and barriers for SMM, as a way of demonstrating the utility of the SMM concept for policy-making.

In a parallel effort, OECD has compiled a wide-ranging inventory of initiatives undertaken by international organisations that address many of the above SMM practices, although this study did not examine the extent to which such initiatives have led to national-level adoption of SMM-related policies.[7] OECD's findings to date suggest a number of basic principles that should influence the development of effective SMM policies and practices.[8] These principles are presented in "Policy Principles for Sustainable Materials Management", and are listed below.

1. Preserve natural capital (where natural capital includes materials, energy, water, land, air and ecosystems).
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.

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[6] OECD Working Group on Waste Prevention and Recycling, *Front-Runners' Experience on Sustainable Materials Management, Report of the 2nd Workshop*, ENV/EPOC/WGWPR(2008)4/FINAL, Tel-Aviv, Israel, 7-9 April 2008.

[7] OECD Working Group on Waste Prevention and Recycling, *Inventory of International Initiatives Related to Sustainable Materials Management*, ENV/EPOC/WGWPR(2007)4/FINAL, 25 September 2008.

[8] OECD Working Group on Waste Prevention and Recycling, *Policy Principles for Sustainable Materials Management (Draft)*, ENV/EPOC/WGWPR(2009)12, 29 October 2009.

## AVAILABLE POLICY INSTRUMENTS

The purpose of this paper is to identify possible ways forward for governments and international organisations that want to establish or further advance policies and approaches based on the concept of SMM. Due to the broad scope of SMM, it is helpful to adopt a conceptual framework that represents the sources of materials, their pathways through the environment, and their eventual sinks. Figure 1 presents a simplified systems view that partitions the physical world into three types of interconnected systems.[9]

- **Ecological systems** provide products and services to industrial and societal systems. They contain natural resource stocks, including renewable materials (e.g., forests), non-renewable materials or energy sources (e.g., bauxite, petroleum), environmental media whose quality may be threatened (e.g., air, water, land), and renewable energy sources (e.g., solar, geothermal, wind, and tidal energy).
- **Industrial systems** utilise the above ecosystem products and services by "harvesting" material and energy resources and depositing unusable wastes back into environment. These resources flow along supply chains that begin with primary resource extraction and end with the delivery of economic goods or services, including energy for industrial, residential, and transportation uses.
- **Societal systems** consume the products, services, and energy supplied by industrial systems, and generate waste that is either recycled into industrial systems or deposited back into the environment. Consumer products include both durable and non-durable goods. Societal systems may also consume ecosystem services and resource stocks directly, e.g., through local agriculture.

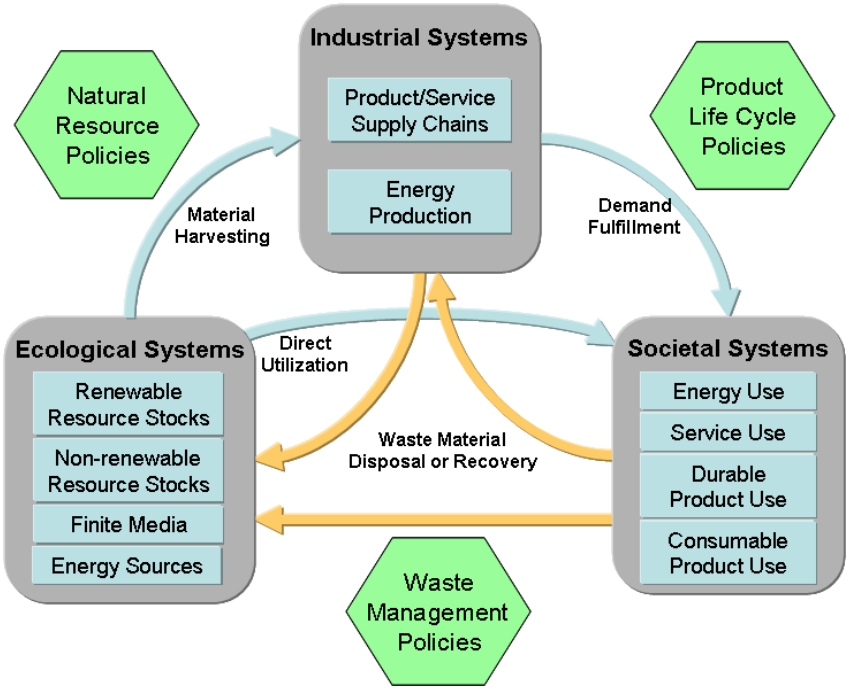


**Figure 1. Systems View of Material Flow Cycles and Policy Frameworks**

[9] J. Fiksel, "A Framework for Sustainable Materials Management," *Journal of Materials*, August 2006, pp. 15-22.

Continued population growth and economic development will generate increased demand for material throughput and will likely increase the associated waste streams. These pressures on natural resources can lead eventually to irreversible system impacts, including depletion of resource stocks (e.g., timber) or degradation of environmental quality (e.g., climate change). The inherent resilience of ecological systems allows them to tolerate such pressures up to a certain degree, but then once a threshold is reached the resulting impacts can be sudden and severe.[10] Ideally, public authorities would internalise these negative impacts into the prices facing firms and consumers, but it may not always be feasible to design policy instruments that provide the appropriate economic signals. Indeed, an emphasis on environmental life-cycle impacts, as opposed to environmental costs and benefits, raises the prospect of policies being implemented that are not economically efficient.[11] Policy-makers concerned with global environmental sustainability need to find a balance among the following **policy objectives**:

- *Decreasing total material throughput, especially of materials with adverse environmental impacts.* Policy options include encouraging the use of substitute materials or alternative technologies, e.g., through eco-design, eco-efficiency, green chemistry and engineering, or life-cycle management.
- *Decreasing the demand for resource consumption.* Restricting the availability of primary resources used for energy and raw materials may be challenging given the nature of international commodities and materials markets. Alternative policy options include: reducing consumer demand for material-intensive products and services; encouraging "smarter" consumption through dematerialisation.
- *Reducing the adverse impacts of material flows.* Policy options include: instituting closed-loop recovery systems for hazardous materials; improving the methods for detoxification or containment of hazardous waste streams to minimise their impacts upon natural capital.

When viewed from the systems perspective in Figure 1, policy frameworks can be classified in terms of their **scope of application** with regard to material flow cycles:

- **Natural resource policies** (e.g., Minerals and Metals Policy of Canada) address material flow cycles that link natural and industrial systems, including extraction, harvesting, and transport of raw materials as well as direct utilisation of natural resources (e.g., water, land).
- **Product life cycle policies** (e.g., E.U. Integrated Product Policy) address material flow cycles that link industrial systems and societal systems, including product development, transportation, energy production, supply chain operations, and waste recovery.
- **Waste management policies** (e.g., Japanese Fundamental Law for Establishing a Sound Material-Cycle Society) address the flows of waste materials into natural systems, including disposition or recycling of industrial and municipal wastes, as well as non-point source pollution control.

Within each of these areas, SMM policy-makers have a variety of options for exercising economic, physical, or operational influence upon material flow patterns. Explicit regulations can be effective for targeting specific harmful substances; however, *market-based policies* that influence the price signals for material goods may achieve broader impact. Examples of market-based policies include pollution charges,

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[10] C.S. Holling, Understanding the Complexity of Economic, Ecological, and Social Systems, *Ecosystems*, Vol. 4, pp. 390-405, 2001.

[11] OECD Working Group on Waste Prevention and Recycling, *Policy Instruments for Sustainable Materials Management: Summary Report (Draft)*, ENV/EPOC/WGWPR(2009)13, 2 November 2009

tradable permits, market friction reductions, and government subsidy reductions.[12] In the aforementioned international survey[4], OECD identified the following principal categories of **policy instruments** relevant to SMM.

- **Regulatory instruments**. Laws, directives, and regulations that direct and/or constrain material use and disposal, e.g., landfill bans; extended producer responsibility policies; restrictions on hazardous substances; renewable energy targets that reduce consumption of fossil fuels.
- **Economic instruments**. Incentives or disincentives that internalise environmental costs, e.g., subsidies or tax credits for eco-friendly products; waste disposal charges, dedicated product levies.
- **Information-based instruments**. Initiatives that raise awareness of material use considerations, e.g., dissemination of metrics and rating systems for assessment of product life cycle sustainability; eco-labeling programs that encourage reduced material and energy intensity.
- **Partnership programmes**. Voluntary collaboration with industry groups and other organisations to advance mutual goals, e.g., recycling partnerships; harmonisation of materials life cycle databases.

OECD has conducted a number of case studies on specific classes of materials and specific instances of SMM policy implementation. The broad scope of SMM poses significant policy challenges, including the complexity of the systems addressed, lack of data regarding material flows, conflicting stakeholder interests, and multiple agency jurisdictions. For example, management of the wood fibre life cycle, which affects carbon sequestration, ranges from sustainable forestry to paper recycling practices.[13] Likewise, management of the life cycle for metals ranges from mining practices to the recovery of residuals from consumer electronic products.[14]

[12] R.N. Stavins, "Experience with Market-Based Environmental Policy Instruments", November 2001, Resources for the Future, Washington, DC.

[13] OECD Working Group on Waste Prevention and Recycling, *SMM Case Study on Wood Fibres (Draft)*, ENV/EPOC/WGWPR(2009)9, 29 September 2009.

[14] OECD Working Group on Waste Prevention and Recycling, *Critical Metals and Mobile Devices: An SMM Case Study (Draft)*, ENV/EPOC/WGWPR(2009)8, 9 November 2009.

## THE PATH FORWARD

Based on the above discussion, national governments wishing to introduce policy interventions have a variety of alternative approaches to consider. Broadly speaking, SMM policy development typically will begin with a consideration of the important policy objectives (e.g., reduced material throughput, reduced demand for resources, reduced adverse impacts), the potential scope of application (e.g., natural resource flows, product life cycle stages, waste flows), and available policy instruments (e.g., regulatory, economic, information-based, partnership). To illustrate, if the policy objective is to reduce total material throughput, there are several alternative policy interventions that might be considered:

- Green procurement policies, which specify the characteristics of environmentally responsible products (e.g., recycled content), intervene in the production and distribution supply chain using a market-based economic instrument, namely purchasing power.
- Eco-labelling policies seek to influence market behavior in a less prescriptive fashion by intervening in the consumption system, using an information-based instrument to help purchasers understand product sustainability characteristics.
- Extended producer responsibility policies focus on the reduction of waste flows by using regulatory instruments that hold manufacturers accountable for the waste generated by their products at the end of their useful life.

Generally, successful interventions will involve the use of a number of mutually reinforcing policies. For example, in the case of electrical and electronic equipment, the European Union has developed a comprehensive policy framework that includes all three of the above options.

The first step in a national initiative will be to examine the existing SMM-related policies in force, which may not have been designed with the full life-cycle in mind. A mapping of important impacts and existing policies at each stage of the life cycle may reveal *policy gaps* that need to be addressed. In addition, the mix of existing policies may introduce conflicting or misleading incentives that lead to unintended consequences; for example, subsidies that favor the production of renewable biofuels may unintentionally increase the demand for water resources and drive up food prices. Therefore it is important to consider *policy coherence* in the design of an SMM policy framework. This requires integrated assessment of the collective impacts of the full portfolio of policies, and anticipation of potential conflicts or gaps that might hinder effectiveness. Ideally, the policy development process will recognise the adaptive, dynamic nature of the socio-economic systems in question, and will design interventions accordingly.

To support the development of SMM-related policies, member countries (and others) may find it helpful to identify the key sustainability aspects of concern, including environmental, economic, and social issues, associated with material life cycles within the target geographic region(s). Examples of such aspects might include *material intensity* or *gross material consumption* for specific categories of materials and/or economic goods and services (e.g., transportation); *life cycle material footprint* or *material efficiency* for specific entities such as households, corporations, or industrial sectors. Identification of key aspects will facilitate the identification of policy objectives or targets, as well as the appropriate scope of SMM-related policy development, given the existing circumstances and patterns of material flows. OECD has noted that establishment of specific SMM-related targets may be most effective if they strike a balance between high aspirations and feasibility of implementation.[15] For example, depending on the circumstances, it may be more effective for the scope of a SMM-related policy to focus on products rather than on material

[15] OECD Working Group on Waste Prevention and Recycling, *Setting and Using Targets for Sustainable Materials Management: Opportunities and Challenges (Draft)*, ENV/EPOC/WGWPR(2009)11, 2 November 2009.

commodities that are difficult to influence or regulate. It may also be helpful to institute an ongoing process for monitoring the effectiveness of SM-related policies in terms of actual impacts on the environmental and economic interests of various stakeholders. Periodic review of emerging policy impacts will enable adaptive adjustment of policies in response to changing conditions or new insights.

One of the greatest challenges of policy assessment is the emerging scientific awareness about the interconnected nature of important sustainability aspects. For example, the linkages among materials, energy and water, known as the "material-energy-water nexus", are depicted in Figure 2.[16] Arguably, material throughput is at the root of the enormous ecological footprint associated with industrial economies. However, reductions in material usage or elimination of toxic materials may inadvertently increase the consumption of energy, water, or other critical resources. Clarification of this nexus and the available tools for analysing the implied policy impacts might be an important consideration for OECD's path forward in supporting the policy development efforts of member countries.

Finally, the policy development process needs to take into account the characteristics of national political systems, how decisions are made, and how consensus is achieved among institutions, interest groups and other stakeholders. Understanding the relationships between those institutions and the political norms, trade-offs, and rules that govern their functions (constitution, laws, rules) should play an important role in the successful implementation of SMM.

In view of the challenges discussed above, OECD might provide valuable assistance to member countries by further documenting SMM policy development guidance, and by initiating a series of case studies to investigate the applicability and effectiveness of SMM principles and policy instruments to real-world situations in different parts of the globe. The mobile devices and wood fibres case studies referenced earlier could provide a starting point for mapping material and product life cycles, analyzing policy gaps and coherence, exploring possible policy interventions, and evaluating the impacts upon the nexus of material, energy, and water resources. Such investigation will likely be most valuable if undertaken in partnership with interested parties, including private sector and non-governmental organisations.

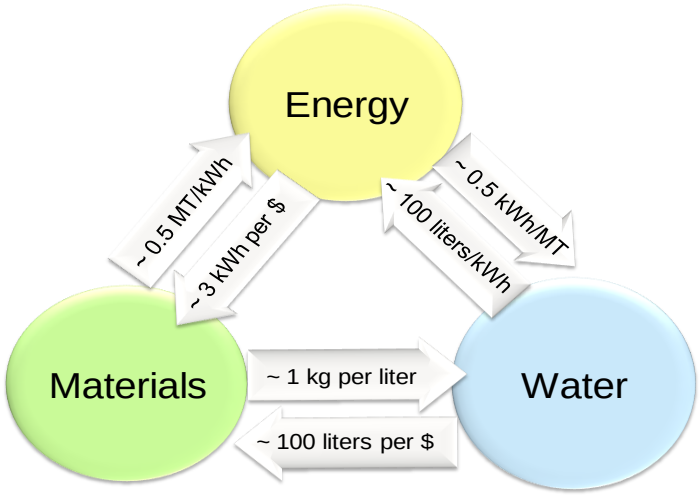


**Figure 2. The material-energy-water nexus of essential resources[16]**
(e.g., approximately 100 liters of water are consumed per dollar of material value produced)

[16] J. Fiksel, "Life Cycle Assessment: How to Quantify Environmental Sustainability from a Supply Chain Perspective", *Chemical Engineering Progress*, May 2010.

## CONCLUSIONS

There will continue to be a fundamental tension between society's interests in environmental protection and the increasing demand for materials associated with economic growth and improved quality of life. Therefore, effective policy making for industrial sustainability requires an understanding of global material flows. Whether or not policies are classified as SMM, policy makers must adopt a life cycle perspective that encompasses the social, ecological, and economic dimensions of sustainability. In particular, environmental policies should not neglect social issues such as fairness and equity across different social strata, across national boundaries, and across generations.

The investigation of SMM policy opportunities by OECD has revealed a number of key points:

- The scope and complexity of material life cycles, as well as the interdependence of natural, industrial, and societal systems, pose significant challenges to policy makers. Integrated policy formulation is essential for dealing with these complex issues.

- Development of SMM policies should emphasize several key principles—preservation of natural capital, life cycle design of products, utilisation of a diversity of policy instruments, and broad engagement of stakeholders.

- SMM practices around the world, motivated both by public policy and private sector initiatives, have demonstrated a variety of promising strategies including dematerialisation, detoxification, and value recovery. Yet, despite such progress, complete decoupling of material use from economic growth has not occurred in developed nations. Moreover, based on current trends, developing nations will continue to increase their material throughput.

- Further progress in SMM will require insights into the relative impacts of resource consumption and waste generation for different classes of substances. Material flow analysis methods need to be augmented by methods that account for varying human and environmental risks associated with use of these materials, and for understanding the material-energy-water nexus.

- SMM policies should take advantage of the natural synergy between the environmental goal of dematerialisation and the economic goal of industrial prosperity, and should reinforce business value drivers that promote increased resource productivity.

- SMM policies should adopt an integrated perspective covering the global life cycle of materials. Policy integration should strive to overcome the traditional boundaries between substances, material categories, environmental media, industry sectors, and political jurisdictions. For example, outsourcing of production to developing countries may simply shift the material burdens with no real improvement or even a decline in global sustainability.

This paper suggests a path forward for OECD and its member countries to address the challenges and barriers associated with SMM policy development. OECD can provide general guidance for identification of policy gaps, key policy objectives, appropriate life cycle scope, available policy instruments, and integrated assessment of potential impacts and policy coherence. Moreover, OECD can work with member countries to pursue specific case studies that involve design of an SMM policy portfolio, analysis of expected impacts, monitoring of actual impacts, and policy adaptation.

The interconnectedness of the global economy implies that individual nations cannot pursue SMM in isolation. To overcome the many challenges of SMM and achieve genuine progress will require active collaboration among national governments, international agencies, corporations, and non-governmental organisations. Indeed, it appears that such collaboration will be necessary for the community of nations to achieve sustainable and equitable economic growth over the long term.

## KEY QUESTIONS FOR FORUM PARTICIPANTS

**What are key considerations for the development of SMM policies?**

- What economic and/or environmental criteria should be used in various national settings to establish priorities for particular categories of materials or products (e.g., renewables, metals, fuels)?

- What are the relative advantages and disadvantages of different types of policies (e.g., regulatory, market-based, information-based) that can be included in an SMM policy portfolio?

- What approaches are possible to facilitate the integration of SMM policies across different regulatory jurisdictions (e.g., trade and commerce, environmental protection) and political boundaries?

- What steps can OECD and its member countries take to help establish an integrated policy development process that includes policy formulation and evaluation?

**How can SMM policies be scoped to assure effective implementation?**

- How can policy makers establish appropriate system boundaries corresponding to a "life cycle" perspective? What types of intra-national and international cooperation will be required?

- Taking into account the social, environmental, and economic conditions in your country, what are the most important aspects of sustainability to be considered (e.g., transportation, food supply)?

- For key industrial sectors in your country or region, what life cycle stages (e.g., resource extraction, processing, transport, production, distribution, use, and end-of-life) will be important focal points?

**What are the preferred approaches for stakeholder involvement in SMM?**

- For your country or region, what is the appropriate balance between regulatory mandates and voluntary initiatives for pursuit of SMM? Who are the key stakeholder groups?

- What are the most effective methods for involving these stakeholder groups in the formulation of SMM policies and/or implementation of SMM initiatives?

- To what extent and in what form should SMM principles and recommended practices be communicated to the general public?